THE COLLECTING NET

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CRUISES OF THE *ATLANTIS* DURING THE PAST WINTER

C. O'D. ISELIN

Director, Woods Hole Oceanographic Institution

Shortly after the outbreak of war in Europe it was decided to keep the *Atlantis* within the Neutrality Patrol Zone. However, off this coast a relatively wide area is included, for the eastern limit of the patrol is as much as 600 miles off shore. As a further precaution large flags were sewed to both sides of the mizzen, for this sail remains up practically the whole time when the *Atlantis* is at sea.

During the autumn months two hydrographic sections were secured, crossing the Gulf Stream along a line extending from Montauk Point to Bermuda. In late January a third profile was completed. In all 15 of these series of subsurface temperature and salinity observations have been obtained in the past two and a half years. The objective is a study of long-period variations in the transport of the Gulf Stream. Assuming the 2000 decibar level (approximately 2000 meters) as being (*Continued on page* 4)

M. B. L. Calendar

FRIDAY, July 5, 1940,
8:00 P. M.
M. B. L. Auditorium
Lecture:
"Oxidation and Reduction in Organic and Biological Chemistry."

Dr. Leonor Michaelis,
Member of Rockefeller Institute for Medical Research,
New York, N. Y.

The first weekly seminar of the season will be held on Tuesday, July 9.

SEMI-CENTENNIAL OF COLD SPRING HARBOR BIOLOGICAL LABORATORY

DR. ERIC PONDER

Director, Biological Laboratory, Cold Spring Harbor

The fiftieth anniversary of the founding of the Biological Laboratory at Cold Spring Harbor is being celebrated today. The speakers will be Mr. Arthur W. Page, President of the Board of Directors of the Long Island Biological Association; Dr. Harold C. Urey, Professor of Chemistry at Columbia University, and Dr. Robert Cushman Murphy, Curator of Oceanic Birds at the American Museum of Natural History, members of the Board of Directors of the Association. Following the addresses, tea will be served at Blackford Hall, and a series of exhibits will be set up in the John D. Jones Laboratory. The exhibits have been arranged by Professor Richard T. Cox and Dr. Walter Rosenblith of the Department of Physics at New York University, Dr. Harold A. Abramson of the Mount Sinai Hospital and the College of Physicians and Surgeons of Columbia University, Dr. L. R. Blinks of the Department of Biology at

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Monday, June 24th

Rudolf Höber, University of Pennsylvania: Correlation between the molecular configuration of organic compounds and their active transfer in living cells.

Tuesday, June 25th

W. J. V. Osterhout, The Rockefeller Institute: Some models of protoplasmic surfaces.

Wednesday, June 26th

Henry B. Bull, Northwestern University Medical School: The chemistry of the lipids.

Thursday, June 27th

Harold A. Abramson, Manuel Gorin, and Eric Ponder, College of Physicians and Surgeons, Columbia University, and The Biological Laboratory: Electrophoresis and the chemistry of cell surfaces.

Hans Neurath, Duke University School of Medicine: Some chemical and physical properties of the proteins.

Monday, July 1st

Francis O. Schmitt and Kenneth J. Palmer, Washington University: X-ray diffraction studies of lipide and lipide-protein systems.

G. W. Scarth, J. Levitt, and D. Siminovitch, McGill University: Plasma-membrane structure in the light of frost-hardening changes.

Tuesday, July 2nd

Kenneth S. Cole, College of Physicians and Surgeons, Columbia University: Membrane impedance.

Balduin Lucke, University of Pennsylvania: The living cell as an osmotic system and its permeability to water.

Wednesday, July 3rd

M. J. Kopac, New York University: The physical properties of the extraneous coats of living cells.

Robert Chambers, New York University: The relation of extraneous coats to the organization and permeability of cellular membranes.

Friday, July 5th

S. C. Brooks, University of California: The intake of radioactive isotopes by living cells.

D. R. Hoagland, University of California: Salt accumulation by plant cells with special reference to metabolism.

Monday, July 8th

Daniel Mazia, University of Missouri: Binding of ions by the cell surface.

L. R. Blinks, Stanford University: The relation of metabolism to the permeability of plant cells.

Tuesday, July 9th

Eric Ponder, The Biological Laboratory: The red cell as an osmometer.

Wednesday, July 10th

B. W. Zweifach, New York University: The structural basis of permeability and other functions of blood capillaries.

Thursday, July 11th

Robert F. Furchgott, Northwestern University Medical School: Observations on the structure of red cell ghosts.

David F. Waugh and Francis O. Schmitt, Washington University: Investigations of the thickness and ultrastructure of cellular membranes by the analytical leptoscope.

Monday, July 15th

H. Burr Steinbach, Columbia University: Electrolyte balance of animal cells.

Tuesday, July 16th

Hugh Davson, Dalhousie University: The permeability of the erythrocyte to cations.

John Scudder, College of Physicians and Surgeons, Columbia University: Relation of ammonia to erythrocyte permeability to cations.

Wednesday, July 17th

Harold A. Abramson and Manuel Gorin, College of Physicians and Surgeons, Columbia University: Permeability of the skin.

CRUISES OF THE *ATLANTIS* DURING THE PAST WINTER

(Continued from page 1)

motionless, these observations indicate that the flow has varied between a maximum of 95 and a minimum of 76 million cubic meters per second during recent years.

Early in January a biological survey of the waters on Georges Banks was attempted. Five additional surveys have been completed since the middle of March. In this case the main objective is a study of the factors influencing the survival of young haddock. The new additions to the haddock population on Georges Banks are known to fluctuate widely from year to year and it is hoped that it will be possible to find out whether or not a large part of these variations occurs in the first few weeks after the eggs are released. It is hoped that it can be found out whether physical or biological factors are chiefly responsible for the loss of so many of the young haddock.

From the middle of January to the middle of March the *Atlantis* cruised southward in order to avoid the worst of the winter weather. Observations were secured at anchor in the Gulf Stream off Jacksonville, Florida, on short-period internal waves. In addition, various experiments were attempted to further develop seismic methods of determining the thickness of submarine sediments in deep water. As it turned out, sending the *Atlantis* south this winter was a mistake. While New England experienced cold, settled weather with mainly moderate winds, south of Cape Hatteras it blew half a gale during most of February.

On the voyage southward one of the sailors became extremely sick. In fact, it seemed likely to Captain McMurray that he had an acute appendix case on his hands. At the time a heavy westerly gale was blowing and the only port which the *Atlantis* could make in a hurry was Bermuda. Captain McMurray was not particularly anxious to put in at Bermuda for on deck

he had 600 lbs. of T. N. T. which was later to be used by Prof. Ewing for his seismic work. However, the sailor seemed desperately sick and on nearing Bermuda the *Atlantis* was spoken by an English naval vessel. Much to Captain McMurray's relief the boarding officer turned out to be Captain Whitfield, formerly from the Bermuda Biological Station and probably the only officer in the British navy who could understand why the *Atlantis* was carrying 600 lbs. of T. N. T. Incidentally, it also turned out that most of the sailor's trouble was sea sickness.

On June 18 the *Atlantis* sailed for ten days on Georges Banks with a scientific party of seven, headed by Dr. George L. Clarke. This was cruise number 100, so it will perhaps be of interest to add a few statistics. Since her launching in June 1931 the *Atlantis* has sailed a total of 158,000 miles and has been 1900 days at sea. During this time nearly 3000 stations have been occupied for subsurface temperature and salinity observations. Approximately 2400 hauls have been made with nets of various kinds. Of the original crew only one member remains, Chief Engineer Backus. Most sailors find that they can learn all they want to know about oceanography in a single winter cruise on the *Atlantis*.

THE BIOLOGICAL FIELD STATIONS OF FRANCE

HOMER A. JACK

Science Education Department, Cornell University

Professor C. O. Whitman, first director of the Marine Biological Laboratory, in a discussion on biological observatories, quoted the distinguished French zoologist, Henri Lacaze-Duthiers, as saying in 1891:

> We have been able to count as many as seventeen or eighteen stations on our coasts in the course of 1891. Are they all born to live? Will they all endure as long as the pompous announcements that have accompanied or preceded them would have us believe? Have not some discounted too quickly the future? . . . Is this not also an exaggeration and a dissipation of precious energies, which, if concentrated into a single strong organization, might render very great service?

Professor Lacaze-Duthiers' prediction was correct. Today only nine of the seventeen French marine stations existent in 1891 are in operation. Today it might be said, too, that France, even with its two thousand miles of coast line, is dissipating her energies on the fourteen marine stations which were in operation up to the beginning of the Second World War.

Beginning on the Straits of Dover and the English Channel, marine laboratories are located at Ambleteuse, Wimereux, Havre, and Luc-sur-Mer. Stations are also situated at Dinard, Roscoff, Concarneau, Le Croisic, and Arcachon on the Atlantic Ocean. French Mediterranean stations include those at Banyuls, near the Spanish border, Sète, Endoume, Tamaris-sur-Mer, and Villefranche. Of the freshwater biological stations, the most important are at Aix-les-Bains on Lake Bourget, at Besse near Clermont-Ferrand, and at Lake Orédon in the Pyrenees. Other inland field stations include the laboratory on Pic-du-Midi in the Pyrenees, the geobotanical station of Professor Braun-Blanquet at Montpellier, and the institute at Col du Lautaret in the French Alps. In all, there are twenty-one biological field stations in France, or one to about every two million inhabitants.

France enjoys the distinction of having the oldest biological station in continuous operation. This is the *Laboratoire de Zoologie et de Physiologie maritimes du College de France*, located at Concarneau. Founded in 1859, this institution is generally recognized to have been the first biological station to be established in the world, preceding Agassiz's Anderson School of Natural History at Penikese by fourteen years and the Marine Biological Laboratory by twenty-nine years. The Concarneau laboratory was established by Professor C. C. Coste after consultations with Professor Valenciennes who collected in the region as an assistant to Cuvier. Spanning the gap, then, from Cuvier to the present, this station today has an annual budget of about 80,000 francs and a two-story stone building. It is especially equipped for physiological research, but offers no formal instruction to students.

The most important French station is often considered to be the *Station Biologique de Roscoff*. It was founded by Professor Lacaze-Duthiers in 1872 and now contains a campus of sixty acres and five stone buildings. It is equipped with a large experimental aquarium room with forty-seven aquaria, dark rooms, a library with two thousand bound volumes and seventy current scientific periodicals, zoological and botanical collections, stockrooms, and a workshop. There are twenty-five large research laboratories and ten smaller ones, all equipped with running sea- and fresh-water, electricity, and gas. Qualified foreign investigators are normally admitted to the station at all times of the year. Investigators may reside in buildings owned by the station and take their meals at one of several small hotels

within two minutes' walking distance from the laboratory.

The station at Roscoff is also renowned for the formal instruction in marine biology which it offers. Students from all parts of France and other countries come to this Brittany port to take a four-week course, beginning the middle of July or the third week of August. The instruction consists of morning conferences, laboratory work, and field trips. More unique to Americans is the system that, although the station is attached to the Sorbonne, there are no examinations, no attendance requirements, no credit, and—for students registered at French universities—no tuition. The registration is limited to thirty-five students who reside in the station's buildings and get their meals at a nearby hotel.

Space does not allow a detailed examination of the other marine stations of France. That at Wimereux was under the able direction of Professor Maurice Caullery until his retirement a short time ago. The *Laboratoire Arago* at Banyuls-sur-Mer is not unlike the one at Roscoff, being also established by Professor Lacaze-Duthiers. It was put under the direction of Professor Chatton, the protozoologist, in 1937 and he has put energy into its administration. The station at Villefranche is now an annex of the one at Banyuls, although until the World War it was owned and sponsored by a group of Russian naturalists.

The best-equipped fresh-water station is the *Station d'Etudes Hydrobiologiques du Lac du Bourget* at Aix-les-Bains. It was established in 1933 by the National School of Waters and Forests at Nancy and is now housed in a two-story modernistic building. There are five special laboratories for investigators and each of these is supplied with 110-volt A.C. electricity and running lake water. Investigators are expected to pay a laboratory fee of 190 francs a month (normally about $5.00) and to obtain board and lodging at nearby *pensions* for 1,200 francs a month (about $32.00).

Of the other inland stations of France, perhaps the best known is the *Station Internationale de Géobotanique Méditerranéene et Alpine* at Montpellier. In addition to being one of the few truly international stations of the world (for it had been supported by national committees of phytosociologists in Holland, Switzerland, Germany, Poland, Rumania, and France), it has gained distinction by sponsoring an annual excursion to study the flora and geobotany of special areas in Europe. An inland station of a different type is that on Pic-du-Midi, situated 9,437 feet above sea level in the French Pyrenees. While this observatory is primarily devoted to physics, it does offer its facilities for biological research at high altitudes. The *Institute de Botanique Alpine Marcel Mirande* at Col du Lautaret likewise offers opportunities for the study of biological forms at high altitudes, this time 6,888 feet above sea level in the French Alps.

* * *

Since the beginning of the current war and more especially since the start of its aggressive phase, the author has heard little of the work or fate of the biological stations of France. While the scientific work at most of these institutions is undoubtedly curtailed, it is believed that some of the research at these stations—as at the ones in Germany—is continuing despite the war. As the French biologist peers into his aquarium, however, he reflects that at least one director of a French biological station was killed in the last war and already several stations are in enemy hands. Further pessimism is found in the recent report of President Fosdick of the Rockefeller Foundation: ". . . Of the 240 enlisted students of the Ecole Normale Supérieure in Paris, an institution which supplies the French universities with professors, 120 were killed [in the last World War]. Among the graduates of this school, 560 who were already professors in the universities were mobilized; 119 were killed." This is no indictment of Germany. It is an indictment of war and its effect on the potentialities of science in all countries.

PHYSIOLOGY CLASS NOTES

The Physiology circus has begun. At present there seem to be four rings, but closer examination reveals rings within rings, with overlapping and intertwining which only the ringmasters—from long experience—can untangle. The big rings themselves get somewhat confused, and if you should start to follow the fate of a Limulus heart, you'll suddenly find yourself trying to decide whether a white Thunberg tube is blue. Sichel's jugglers, however, throw their cells around in their own little corner and the rest of us wouldn't know whether they catch them again or not. Superficial attention would indicate that Irving's Van Slykers stay in their own ring, but watch carefully and you'll notice furtive sallies forth to appropriate the equipment of other innocent performers. The Fisher troupe integrates its numerous acts well, except for the game of hide-and-go-seek set up at frequent intervals by its leader. Prosser's clowns furnish levity at the ex-

pense of clam hearts which never did get used to cigarette smoke and applause.

Sunday after much effort, we took a holiday on boat and beach. Recruits from other circuses swelled our numbers. They (the numbers) wouldn't have needed swelling if Dr. Irving hadn't kidnapped his own group, and if some of our own conscientious fellow performers hadn't loved their work too much to leave it. (We notice they didn't get much of a jump on us.) But the recruits were good even if they weren't Physiologists. They withstood the drenching sea water, burning (!) sun and sand, raw hamburger and sweet harmony nearly as well as the best of us.

And now our cytochrome oxidase has had its efficiency increased, we tackle Warburg, Limulus, Haldane and Fundulus with new vigor and the show is better than ever. —*J. L. C.*

EMBRYOLOGY CLASS NOTES

In the brief space of one week this year's embryology class has shown itself to be made up of a group of gentlemen (and gentlewomen) and scholars and judges of good—uh—food. The members of the class have brought fame to themselves by being the admitted epicureans of the colony, and justifiably so. They are the first to enter the mess hall and the last to leave. As exponents of culture they have shown their fervor by attending practically *en masse* the Monday night concert. Music lovers at heart, one-sixth of them have even gone so far as to join the local church choir in an effort to let loose their desire to make music. But their greatest fame still rests on their gustatory powers and hefty appetites. Especially on the appetites of certain particular members who stop at not one, not two, not three but four helpings of anything and everything.

Despite the extra-curricular activities, class work has been going on in earnest with only two major and one minor interruptions. The regular work in the lab consisted of the work on the development of the teleosts in general and the *Fundulus heteroclitus* in particular as outlined by Dr. Goodrich. Minor catastrophes such as a seven day fundulus with no circulation and a cunner with four polar bodies were experienced, but in the end science triumphed and such things were proven to be merely optical illusions. In addition to the prescribed work, some members of the class have been doing some experimental work on fundulus. Hybridization experiments were tried using a cross of *Fundulus heteroclitus* and *Fundulus majolis* and also by using a cross between *Fundulus heteroclitus* and mackerel. Following Dr. Stockard's methods, other students are producing cyclopean monsters by treating the fundulus eggs with alcohol or with magnesium chloride.

The first major interruption was Dr. Schotté's lecture on gastrulation. Dr. Schotté was responsible for putting the class in a momentary state of collapse for he told us of his Amherst boys who would come home from dates with the girls across the way and then want to know the details of the Concresence Theory that the Smith girls had been talking about on their date.

The second major interruption was the trip to the fish traps that we made on Saturday. The purpose of the trip was to obtain mackerel at the traps which we could strip for experimental work in the lab.

The minor interruption was the inopportune arrival in the lab of one misled "Puffer", who made a rapid exodus under the hands of two true investigators who desired to know what made a "Puffer" puff.

The intellectual efforts of the class have probably been induced by this week of exceeding cold which has reduced the lure of Rocky Beach and the tennis courts and given the lab a cozy air which was made complete by the addition of a radio on which to hear such important events as the Louis-Godoy fight. When the cold spell lifts and the estimable members of the class can creep far enough out of their long underwear and six sweaters, there will undoubtedly be one lonely lab and one concerted shout for bathing suits. Only the hardier souls have dared go in the water yet. Until that time, the only chorus for which they can get up enough energy to squeak is, "Please pass the potatoes!" —*Margie Jolly*

PROTOZOOLOGY CLASS NOTES

Early in the morning of Friday, June 21, 1940, the potential protozoologists gathered in the lab to be greeted by a pleasant introduction to the course given by Dr. Kidder. In this, he pointed out to them the nature of the work and warned them gently of the impending pitfalls which are now apparent.

The class consists of almost equal numbers of graduates and undergraduates of eastern colleges and universities, including one from Canada. As well as drawing and identifying a fair number of genera, they will learn various techniques used in the study of Protozoa and later apply this to an individual problem. The whole atmosphere of the

lab is condusive to uninterrupted study except for the many and continued noisy outbursts which ascend from the department below and make us wonder just what are the projects in which the physiologists are engaged.

Dr. Calkins at the opening of the course was in the Berkshires officiating at his son's wedding. He has since returned and given several very interesting lectures touching upon the history of the Marine Biological Laboratory at Woods Hole, the position of Protozoa in the living world, their organizations, classification and economic importance.

The protozoologists have turned to the well-established standards of their predecessors and have spent many hours delving into the private lives of the horrible Hypotrichs and the fearsome flagellates. Above all else they have concentrated on the elusive Euplotes craftily evading low, not to mention high, power. There is as yet little consensus of opinion as to the nature of membranelles and undulating membranes, nor have they agreed as to the relative merits of cirri as locomotor organs but they are convinced said organs are efficient.

Most of the class is still taking it easy on sharp turns after a six-mile field trip the first day. It seems one gets a bit stiff after sitting for the training period. On this extensive sightseeing hike, primarily in search of Protozoa, among the local wet spots they visited Crane's Water Garden, Cedar Swamp, Endicott Hollow, Copeland's Pool, Typha Pool, Wood Pond, Lillie's Ditch, Mill Pond and Eel Pond. Deticking proved one of the chief occupations of the afternoon, this being an efficient introduction of this famous arachnid to various members of the class and much to their consternation was accompanied by the ever present exposure to the no less famous plant, poison ivy. However the collecting was most satisfactory due to the constant efforts of Miss Dewey and Dr. Kidder, and the beasts of the marsh and pond are happily wandering about in the jars in the lab awaiting their chance at cover-slip and slide.

Particular difficulty was encountered when the pH of Buzzards Bay was determined. Just who dripped acid into the bottle after making their determination wasn't found out, but several people were convinced that sea water is acid.

Time is not lost however, and drawings and identifications increase in number from day to day. Inspired by the lab motto which occupies a most prominent area of the laboratory wall, hour by hour they "study Nature not books" as suggested by Louis Agassiz. As we all know, the elements opening the season have been condusive to indoor occupations and the class has been wondering how long it will be before conditions more favorable to some of the lighter outdoor pastimes will lure them from swivel chair and 'scope. To date the Protozoans have had no competition. More power to Leuwenhoek's "Wee Beasties"!

—Doris Marchand and Katherine Macdonald

THE M. B. L. CLUB IN 1940

A large and enthusiastic group opened the season's activities of the M. B. L. Club with a mixer Saturday evening. Dancing followed a period of introductions and conversation.

Artistic name cards designed by Mary Chamberlain enabled all to identify newcomers and sometimes by a sly glance to recall a name forgotten during the winter.

Students in the courses were special guests and wore distinctive labels. Larval fish were the badge of the embryologists, daisies of the students of algae, Protozoologists were identified by an animal as easy to name as most protozoa, physiologists by sea horses, while workers not in the courses had sailboats on their markers, perhaps as a hint of their greater freedom.

Mrs. Duryee was assisted in making the occasion a happy one by Mrs. Lynn, Mrs. Abramowitz, Mrs. Marshall Smith, Mrs. Jay Smith, Lucille Nason, Virginia Dewey, Alice Zimmerman and Mary Goodrich.

The first of the weekly concerts of recorded music was held somewhat informally Monday evening. The program of others will be announced each week.

The club house now shines with two new coats of white paint applied by volunteers led by President Duryee. Other important improvements since last season are the repairing of the seawall and foundations, and a board walk from the street.

The fine condition of the furnishings and interior of the club house is due largely to the work of Mr. and Mrs. Bosworth, the latter the club hostess.

The purpose of the M. B. L. Club is to promote social relations among the scientific workers and their families while at Woods Hole. The club provides magazines and newspapers, facilities for cards, chess, checkers, and ping-pong. Each Saturday the club is filled for the weekly dance and the Monday concerts of recorded music, usually symphonic, have proved most successful. The club maintains beach party equipment which members may borrow.

The privileges of the club are open to members of the Woods Hole scientific laboratories, their families, and guests. *—P. S. Crowell*

THE GROWTH SYMPOSIUM

The second growth symposium held under the auspices of the Society for Development and Growth met at Salisbury Cove, Maine, from June 20 to 25. Drs. Ballard, Duryee, Hamburger and Harvey drove up from Woods Hole to attend the sessions. In all about eighty biologists were present. The papers presented and those taking part were: "Structure of Protoplasm:" *Speaker,* O. L. SPONSLER; *Discussion leader,* DOROTHY M. WRINCH. "Synthesis of Protoplasmic Constituents:" *Speaker,* RUDOLF SCHOENHEIMER. "Colloid Chemistry of Development and Growth:" *Speaker,* HERBERT FREUNDLICH; *Discussion leader,* E. F. ADOLPH. "Chemical Factors of Growth:" *Speaker,* G. S. AVERY. "Physical Factors of Growth:" *Speaker,* D. M. WHITAKER. "Cell Division and Development:" *Speaker,* A. B. DAWSON; *Discussion leader,* B. H. WILLIER. "Size-Controlling Factors:" *Speaker,* V. C. TWITTY; *Discussion leader,* R. G. HARRISON. "Pathology of Development:" *Speaker,* H. S. N. GREENE. "Theories of Organization:" *Speaker,* F. S. C. NORTHROP.

The Genetics Society of America will hold a meeting at Woods Hole on August 29 and 30. Inaugurated in 1934, summer meetings have been held annually at the Marine Biological Laboratory since that date, with the exception of last year, when many of the Society's members were attending the Seventh International Congress of Genetics at Edinburgh on the eve of the European War. The customary clam-bake will be held on the evening of the 29th; the next evening the Friday lecture will be one of especial interest for geneticists. Dr. L. J. Cole is President of the Society, and Dr. E. W. Lindstrøm is Secretary-treasurer.

THE WOODS HOLE CHORAL CLUB

The first rehearsal of the Woods Hole Choral Club for 1940 will be held on Tuesday, July 2. The Choral Club, which is being revived after a year of abeyance, will be under the direction again of Professor Ivan T. Gorokhoff, director of choral music at Smith College. Miss Galina I. Gorokhoff will be accompanist. Officers of the club include Dr. Eliot R. Clark, professor of anatomy at the University of Pennsylvania Medical School, *President,* and Dr. Charles Packard, associate director of the Marine Biological Laboratory, *Secretary-Treasurer.* Rehearsals will be held every Tuesday night immediately after the seminar, and on Thursday nights at 8 o'clock. A concert will be presented in the latter part of August. All members of the Woods Hole summer community interested in singing good music under competent direction are cordially invited to attend.

MOUNTAIN LAKE BIOLOGICAL STATION

A new laboratory and classroom building has opened at the Mountain Lake Biological Station of the University of Virginia for its eleventh summer season, June 24 to August 31. This new building has been made possible by the General Education Board and has cost $55,000 for construction and equipment. It provides space for classrooms, professors' offices, laboratories for students and research workers, and a library. Dr. Ivey F. Lewis, Miller professor of biology, and dean of the University of Virginia, is director of the station. Others on the staff this year are Dr. Robert K. Burns, Jr., University of Rochester; Dr. Robert E. Coker, University of North Carolina; Dr. John M. Fogg, Jr., University of Pennsylvania; Dr. Mary S. MacDougall, Agnes Scott College; Dr. Paul M. Patterson, Hollins College; Dr. Bruce D. Reynolds, University of Virginia; Dr. Jacob G. Harrar, Virginia Polytechnic Institute, and Dr. Lorande L. Woodruff, Yale.

A new dormitory has been opened by the Marine Biological Laboratory. It is the former Howes residence on Water Street which was purchased by the Laboratory a few years ago and which had been occupied by Dr. Samuel E. Pond. The dormitory, which contains accomodations for eighteen or nineteen boys, was remodeled during the winter.

The Coast Guard Canteen, located across the street from the M. B. L. Mess, will be used this summer as an exhibition hall by apparatus companies. The Bausch and Lomb Optical Company and the Spencer Lens Company have already made arrangements for space.

CURRENTS IN THE HOLE

At the following hours (Daylight Saving Time) the current in the Hole turns to run from Buzzards Bay to Vineyard Sound:

Date	A. M.	P. M.
June 29	11:41	
June 30	12:20	12:35
July 1	1:08	1:25
July 2	2:00	2:13
July 3	2:50	3:00
July 4	3:34	3:46
July 5	4:17	4:33
July 6	5:01	5:18
July 7	5:51	6:03
July 8	6:35	6:56

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

The Collecting Net

A weekly publication devoted to the scientific work at marine biological laboratories.

Edited by Ware Cattell and Robert Chambers with the assistance of Boris I. Gorokhoff and Peggy Browning; Contributing Editor, Homer A. Jack.

Entered as second-class matter, July 11, 1935, at the U. S. Post office at Woods Hole, Massachusetts, under the Act of March 3, 1879, and re-entered, July 23, 1938.

Introducing

Dr. Ernest James William Barrington, Lecturer in Zoology, University College, Nottingham, England; Rockefeller Fellow in the Department of Physiology, McGill University, Montreal.

Born and raised in London, England, Dr. Barrington attended Christ's Hospital and Oxford University, where he received his B.A. in 1931, B.Sc. in 1932 and M.A. in 1935. He was then appointed lecturer in zoology and subsequently head of the department at Nottingham, England. He occupied this position until he came to America on leave last August to study as a Rockefeller fellow at McGill University under the direction of Dr. P. B. Babkin.

Dr. Barrington's research work for his Bachelor's degree was carried out with Dr. G. R. de Beer on the embryology of the head of the duck. Upon graduation he continued his work in the field of embryology, publishing a description of the development of the tail in Pleuronectes and Gadus.

His later work has been concerned with the application of physiological methods to problems of comparative zoology, and has been chiefly focused on the digestive system of the chordates; his publications have dealt with the structure and physiology of the digestive system of Amphioxus, Clossobalanus and the ammocoete larva of the lamprey.

His work at Montreal dealt with the influence of secretin on pancreatic secretion in cats, in preparation for a study of the nervous and hormonal control of the pancreas in the lower vertebrates. As part of the general problem of the origin of the pancreatic mechanism, he has also turned his attention to the control of blood-sugar in the ammocoete, with a view to establishing the existence of islet tissue in lampreys, and he hopes to continue this work at Woods Hole this summer.

For recreation, Dr. Barrington has music as a hobby. In particular, he enjoys playing the piano, of which he did a good deal in Montreal. He expects to return to England in early September to resume his duties at the University of Nottingham.

SCIENTIFIC WORKERS AND THE WAR

DR. ROBERT CHAMBERS
Research Professor of Biology, New York University

It is gratifying that a great many scientists and also members of the American Association of Scientific Workers have taken issue with the newspaper interpretations of a "Peace Statement" which the Association prepared and made public. The primary purpose of the Association is to develop increased cooperation between the scientific laboratories and the newspapers, and also to publicize the dangers of pseudo-science which is becoming increasingly widespread throughout the country.

The purpose of many who assisted in the preparation of the peace statement was to disclaim, as scientists, the popular conception that scientific research is directly responsible for the horrible engines of war. There were some sentences in the statement which might well have been omitted, and it was on the interpretation of these sentences that the newspapers prepared headlines such as "Scientists Sue for Peace."

The publication of the peace statement in *Science* was quickly followed by a counter-statement by those who objected to the implications involved. There also appeared in the press numerous letters indicating the strong attitude of American scientists in general that we must use our influence in helping our brother democracies against the evil forces of totalitarianism. In a recent issue of *Science* there appeared a statement by members of the Boston-Cambridge branch of the American Association of Scientific Workers in which they urge "the United States Government to take all steps necessary for hemisphere defence, including such aid to the Allies as most effectively furthers this aim."

The present conflict in Europe has reached a stage which behooves us to think seriously and to apply all our energies towards adequate means of maintaining our democratic ideals. Our government is extending aid as far as possible to the Allies, and if those in the government who know the present situation should call upon us to go into the war, we should be ready so to do.

It is to be hoped that the Association, purged of pacifistic tendencies, may continue in its highly important purpose of acquainting the public with what science means to the investigator. The question of peace or war is another issue. There are times when righteous indignation requires a drastic stand. War is frightful but we must remember that even the Prince of Peace became angered and drove the money-changers out of the Temple.

ITEMS OF INTEREST

DR. B. H. WILLIER, who has been chairman of the division of biological sciences at the University of Rochester, has been appointed chairman of the work in biology at Johns Hopkins University and in that capacity will coordinate the departments of botany, plant physiology, and zoology. His position there will be Henry Walters professor of zoology, succeeding Dr. Herbert S. Jennings, who has retired.

DR. DETLEV W. BRONK, professor of biophysics and director of the Johnson Foundation for Medical Physics at the University of Pennsylvania, has been appointed head of the department of physiology at Cornell University Medical College. Dr. H. Keffer Hartline, assistant professor of biophysics at Pennsylvania, joins the department at Cornell as an associate professor.

DR. C. L. TURNER, chairman of the department of zoology at Northwestern University, Evanston, Illinois, has resigned in the belief that the chairmanship of departments should rotate among its members. Dr. J. W. Buchanan, professor of zoology, will succeed him in the post. Dr. Turner will continue on the faculty as professor of zoology.

DR. C. S. SHOUP has been promoted from assistant professor to associate professor of biology at Vanderbilt University.

DR. DONALD F. POULSON, and DR. EDGAR J. BOELL, instructors in biology at Yale University, have been promoted to assistant professorships.

DR. S. MERYL ROSE, who has been assistant in zoology at Columbia University, has been appointed instructor in biology at Amherst College.

DR. P. S. CROWELL, assistant professor in zoology at Miami University, Oxford, Ohio, has been made upper class advisor for liberal arts majors in biology at that university.

DR. E. NEWTON HARVEY, Henry Fairfield Osborn professor of biology at Princeton University, is the author of the recently published book "Living Light", a study of bioluminescence.

The Children's School of Science and Junior Laboratory will open on Monday July 1 and will remain in session until August 9.

DR. ROSS G. HARRISON, Sterling professor of biology at Yale University, was awarded the honorary degree of Doctor of Science at commencement exercises at Columbia University this June. Dr. Alfred E. Cohn of the Rockefeller Institute of Medical Research was also a recipient.

With the closing of the Biological Laboratory at the Dry Tortugas, its 70-foot power boat, *Anton Dohrn*, has been transferred to the Woods Hole Oceanographic Institution by the Trustees of the Carnegie Institution. The vessel was expected to arrive on Friday under the command of Captain Mills, who is about to retire. Richard Harvey, son of Dr. and Mrs. E. Newton Harvey, is a member of the crew.

DR. VICTOR C. TWITTY, professor of zoology at Stanford University, who arrived in Woods Hole on Wednesday, gave a special lecture before the embryology class the following day. He spoke on "Size-controlling Factors in Amphibian Embryology."

PROFESSOR OSCAR E. SCHOTTÉ, who gave a lecture before the embryology class on June 20, will spend most of the summer at the Amherst College biological laboratory working on rejuvenation of tissues in collaboration with Professor E. G. Butler of Princeton University, who will be guest investigator there.

DR. E. ALFRED WOLF will conduct, as in previous years, a course in "German for the Science Reader" for persons connected with the Marine Biological Laboratory. The group will meet on Tuesdays and Fridays at 7:00 P. M.

MISS DOROTHY HAMILTON, an assistant biologist at the U. S. Bureau of Fisheries at Woods Hole, was married on May 20 in Mt. Washington, Mass., to Dr. Glenn Algire, who was investigator at Woods Hole last summer. Dr. Algire is leaving Woods Hole on Monday in order to interne at the Hospital of the University of Maryland Medical School; Mrs. Algire will continue her work here.

MISS CAMILLA RIGGS, daughter of Mr. and Mrs. Lawrason Riggs, Jr., treasurer of the Corporation of the Marine Biological Laboratory, will be married to Dr. John W. Meigs, son of Dr. and Mrs. Edward Browning Meigs, at Juniper Point next Saturday.

MISS THELMA LEE NUETZEL was married to Dr. Carl C. Smith in Rockport, Indiana, on November 24, 1939. Dr. Smith has just received his Ph.D. degree in biochemistry from the University of Cincinnati, where he will be a research associate in cardiology this fall. Mrs. Smith is a graduate of the School of Applied Arts at the University of Cincinnati.

DR. ROBERT CHAMBERS and his family are this summer occupying the Fay residence on the main road to Falmouth.

DIRECTORY FOR 1940

KEY

Laboratories		Residence	
Botany Building	Bot	Apartment	A
Brick Building	Br	Dormitory	D
Lecture Hall	L	Drew House	Dr
Main Room in Fisheries Laboratory	M	Fisheries Residence	F
Old Main Building	OM	Howes	Ho
Rockefeller Bldg.	Rock	Hubbard	H
Supply Dept.	S	Kahler	Ka
		Kidder	K
		Whitman	W

MARINE BIOLOGICAL LABORATORY

THE STAFF

Packard, C. assoc. director. asst. prof. zool. Inst. Cancer Research, Columbia.

ZOOLOGY

Investigation

Calkins, G. N. prof. proto. Columbia.
Conklin, E. G. prof. zool. Princeton.
Grave, C. prof. zool. Washington (St. Louis).
Jennings, H. S. prof. zool. California.
Lillie, F. R. prof. emb. Chicago.
McClung, C. E. prof. zool. Pennsylvania.
Mast, S. O. prof. zool. Hopkins.
Morgan, T. H. dir. biol. lab. California Tech.
Parker, G. H. prof. zool. Harvard.
Woodruff, L. L. prof. proto. Yale.

Instruction

Bissonnette, T. H. prof. biol. Trinity. in charge.
Crowell, P. S., **Jr.** instr. zool. Miami.
Jones, E. R. prof. zool. William & Mary.
Lucas, A. M. assoc. prof. zool. Iowa State.
Martin, W. E. asst. prof. zool. DePauw.
Matthews, S. A. asst. prof. biol. Williams.
Mattox, N. T. instr. zool. Miami.
Rankin, J. S., **Jr.** instr. biol. Amherst.
Waterman, A. J. asst. prof. biol. Williams.

PROTOZOOLOGY

Investigation (See Zoology)

Instruction

Calkins, G. N. prof. proto. Columbia. in charge.
Dewey, Virginia asst. zool. Vassar.
Kidder, G. W. asst. prof. biol. Brown.

EMBRYOLOGY

Investigation (See Zoology)

Instruction

Ballard, W. W. asst. prof. biol. & anat. Dartmouth.
Costello, D. P. asst. prof. zool. North Carolina.
Goodrich, H. B. prof. biol. Wesleyan. in charge.
Hamburger, V. assoc. prof. zool. Washington (St. Louis).
Schotté, O. assoc. prof. biol. Amherst.

PHYSIOLOGY

Investigation

Amberson, W. R. prof. physiol. Maryland Med.
Bradley, H. C. prof. physiol. chem. Wisconsin.
Garrey, W. E. prof. physiol. Vanderbilt Med.
Jacobs, M. H. prof. physiol. Pennsylvania.
Lillie, R. S. prof. gen. physiol. Chicago.
Mathews, A. P. prof. biochem. Cincinnati.

Instruction

Chambers, R. res. prof. biol. New York.
Fisher, K. C. asst. prof. exper. biol. Toronto.
Höber, R. visiting prof. physiol. Pennsylvania.
Irving, L. prof. biol. Swarthmore. in charge.
Prosser, C. L. asst. prof. zool. Illinois.
Shannon, J. A. asst. prof. physiol. New York Med.
Sichel, F. J. M. instr. physiol. Vermont Med.

BOTANY

Investigation

Brooks, S. C. prof. zool. California.
Duggar, B. M. prof. physiol. & econ. bot. Wisconsin.
Goddard, D. R. asst. prof. bot. Rochester.
Sinnott, E. W. prof. bot. Columbia.

Instruction

Runk, B. F. D. instr. bot. Virginia.
Taylor, W. R. prof. bot. Michigan. in charge.
Thompson, R. H. teaching asst. Stanford.

INVESTIGATORS

Abell, R. G. instr. anat. Pennsylvania Med. Br 117.
Abramowitz, A. A. res. asst. phys. Harvard. Br 122. D 318.
Albaum, H. G. instr. biol. Brooklyn. Br 110.
Alexander, L. E. asst. prof. biol. Fisk (Tenn.). L 25.
Allee, W. C. prof. zool. Chicago. Br 332. A 101.
Alley, Armine dem. biol. McGill. OM 1. W D.
Alsup, F. W. grad. phys. Pennsylvania. Br 220. Dr Attic.
Amberson, W. R. prof. phys. Maryland Med. Br 109.
Andersch, Marie assoc. prof. biochem. Womans Med. (Penn.) Br 217-B.
Anderson, R. S. biophysicist Memorial Hospital (N. Y.). Br 343.

Angerer, C. A. instr. physiol. Ohio State. Br 111.
Arena, J. F. de la fel. Guggenheim Found. Br 310.
Armstrong, C. W. J. dem. biol. Toronto. OM 4. Ka 23.
Armstrong, P. B. prof. anat. Syracuse Med. Br 318. A 202.
Badger, Elizabeth res. asst. biochem. Cincinnati. Br 341. W E.
Baker, H. B. prof. zool. Pennsylvania. Br 221.
Baker, R. res. assoc. phys. Columbia. Br 114.
Ball, E. G. assoc. physiol. chem. Hopkins Med. Br 233.
Ballard, W. W. asst. prof. biol. & anat. Dartmouth. OM 40. D 211.
Barnes, Martha R. asst. zool. Illinois. OM 44. W F.
Barrington, E. J. W. (Nottingham, England) Rockefeller fel. phys. McGill. Br 312.
Barth, L. G. asst. prof. zool. Columbia. Br 228.
Belfer, S. res. asst. biochem. Wisconsin. Br 122-A.
Bissonnette, T. H. prof. biol. Trinity (Conn.). OM 28.
Blinks, L. R. prof. plant phys. Stanford. Br 222.
Bliss, A. F. asst. biophys. Columbia. Br 314. Ho 6.
Bodine, J. H. prof. zool. State U. Iowa. Br 107.
Boell, E. J. instr. zool. Yale. Br 323. (July 28).
Botsford, E. Frances asst. prof. zool. Connecticut. L 22.
Bowen, W. J. instr. zool. Hopkins. Br 329.
Bradley, H. C. prof. phys. chem. Wisconsin. Br 122-A.
Brill, E. R. grad. biol. Harvard. Br 217-M.
Bronfenbrenner, J. J. prof. bact. and immun. Washington Med. (St. Louis). Br 234.
Bronk, D. W. prof. biophys. Pennsylvania. Br 115.
Brooks, Matilda M. res. assoc. biol. California. Br 322.
Brooks, S. C. prof. zool. California. Br 322.
Broomall, Annabelle grad. phys. Pittsburgh. Rock 7.
Brownell, Katharine A. res. asst. phys. Ohio State. Br 111. A 204.
Buchsbaum, R. instr. zool. Chicago. Br 227. (July 15).
Buck, J. B. instr. zool. Rochester. Br 324.
Budington, R. A. prof. zool. Oberlin. Br 218.
Burt, R. L. grad. asst. biol. Brown. OM 21. K 9.
Cable, R. M. assoc. prof. parasit. Purdue. Br 223.
Calkins, G. N. prof. proto. Columbia. Br 331.
Carothers, E. Eleanor res. assoc. zool. U. Iowa. L 28.
Carson, H. L. instr. zool. Pennsylvania. OM Base. J.
Chambers, E. New York Med. Br 328.
Chambers, R. res. prof. biol. New York. Br 328.
Cheney, R. H. prof. biol. Long Island. Br 118. A 302.
Churney, L. res. fel. zool. Pennsylvania. Br 125. D 111.
Claff, C. L. res. assoc. biol. Brown. OM 38. A 208-9.
Clark, E. R. prof. anat. Pennsylvania Med. Br 117.
Clark, L. B. asst. prof. biol. Union. Br 315. (July 15).
Clement, A. C. asst. prof. biol. Charleston (S. C.). Br 217-H.
Clowes, G. H. A. res. dir. Lilly Res. Labs. Br 328.
Cohen, I. res. asst. biol. New York. Br 311.
Cole, K. S. assoc. prof. phys. Columbia. Br 114. A 105.
Colwin, A. L. instr. biol. Queens (N. Y.). OM 45.
Compton, A. D., Jr. master biol. Choate (Wallingford, Conn.). Bot 1.
Copeland, D. E. asst. biol. Harvard. OM 41.
Copeland, M. prof. biol. Bowdoin. Br 334.
Cornman, I. teaching fel. biol. New York. Br 328. (Aug. 20).
Costello, D. P. asst. prof. zool. North Carolina. Br 123. D 202.
Crawford, J. G. Milton Acad. (Milton, Mass.). Br 309.
Croasdale, Hannah T. tech. asst. bot. Dartmouth. Bot 1. (July 15).
Crouse, Helen V. fel. zool. Missouri. OM Base. A. H 3.
Crowell, S. asst. prof. zool. Miami. OM 25.
Curtis, H. J. Rockefeller fel. phys. Columbia. Br 114.
Curtis, W. C. prof. zool. Missouri. Br 335. (Aug. 1).
Dent, J. N. grad. asst. zool. Hopkins. Bot 6. Dr 1.
Dewey, Virginia C. grad. biol. Brown. OM 22. D 311.
Dienes, Priscilla Yale Med. Br 234.
Diller, Irene Corey res. assoc. zool. Pennsylvania. Br 219. (Aug. 1).
Diller, W. F. asst. prof. zool. Pennsylvania. Br 221. (Aug. 1).
Donnellon, J. A. asst. prof. biol. Villanova. Rock 3.
Dowling, Delphine L. instr. bot. Vassar. Bot 1. D 311.
Doyle, W. L. asst. prof. biol. Bryn Mawr. Br 336. D 201.
DuBois, E. F. prof. med. Cornell Med. Br 317.
Duryee, W. R. visiting asst. prof. biol. New York. Br 301. D 312.
Dytche, Maryon M. grad. asst. phys. Pittsburgh. Rock 7.
Eder, H. Harvard Med. Br 122.
Evans, D. asst. prof. biol. Mississippi. OM Base. E.
Evans, L. T. asst. prof. zool. Missouri. L 21.
Evans, T. C. res. asst. prof. zool. U. Iowa. Br 107.
Failla, G. physicist Memorial Hosp. (N. Y.). Br 306.
Fisher, K. C. asst. prof. expt. biol. Toronto. OM 4.
Frank, Sylvia R. grad. resident scholar zool. Columbia. Br 314. H 7.
Frisch, J. A. prof. biol. Canisius (Buffalo). OM 39.
Gabriel, M. L. asst. zool. Columbia. Br 314.
Garrey, W. E. prof. phys. Vanderbilt Med. Br 215.
Giddings, C. B. grad. asst. biochem. Cincinnati Med. Br 341. Dr 3.
Giese, A. C. Rockefeller fel. phys. Princeton. Br 230-231.
Gilbert, W. J. grad. asst. bot. Michigan. Bot 1. Dr 6.
Goldin, A. grad. zool. Columbia. Br 314. Ho 8.
Goodrich, H. B. prof. biol. Wesleyan. Br 210. D 310.
Goulding, Helen J. grad. biol. Toronto. OM 1. D 306.
Granick, S. res. asst. biol. Rockefeller Inst. (N. Y.). Br 207.
Grant, R. lect. zool. McGill. Br 217-K.
Grave, C. prof. zool. Washington. (St. Louis). Br 327.
Guttman, Rita tutor phys. Brooklyn. Br 110.
Hamburger, V. assoc. prof. zool. Washington (St. Louis). L 24.

Harnly, M. H. assoc. prof. biol. New York. Br 342.
Harris, D. L. instr. zool. Pennsylvania. Br 125. D 111.
Harris, J. E. res. assoc. obs. & gyn. Iowa State. Br 107. D 214.
Hartman, F. A. prof. phys. Ohio State. Br 111. D 218.
Harvey, E. N. prof. phys. Princeton. Br 116.
Harvey, Ethel B. res. invest. zool. Princeton. Br 116.
Haywood, Charlotte assoc. prof. phys. Mt. Holyoke. Br 335. A 207.
Heilbrunn, L. V. assoc. prof. zool. Pennsylvania. Br 220.
Hendley, C. D. asst. zool. Columbia. Br 314. Ho 6.
Henson, Margaret teaching fel. biol. New York. Br 217-F.
Hill, S. E. prof. biol. Russell Sage. OM 40.
Hinchey, M. Catherine grad. biol. Pennsylvania. Br 217-D.
Höber, R. visiting prof. phys. Pennsylvania Med. Br 313.
Hobson, L. B. Chicago Med. Bot 1. D 207.
Holz, A. Marie Univ. scholar. zool. Columbia. Br 314. H 7.
Howe, H. E. ed. Indus. & Engineering Chem. Br 203, 216.
Hunninen, A. V. prof. biol. Oklahoma City U. Br 217-K. Dr 9.
Hunter, Laura N. asst. prof. biol. Pennsylvania Women. OM 45.
Irving, L. prof. biol. Swarthmore. OM 2. A 108-9.
Jacobs, M. H. prof. gen. phys. Pennsylvania. Br 205.
Jenkins, G. B. prof. anat. George Washington. OM 46.
Johlin, J. M. assoc. prof. biochem. Vanderbilt Med. Br 108.
Jones, E. R., Jr. prof. biol. Wm. & Mary. OM 33.
Kabat, E. A. instr. path. Cornell Med. Br 110.
Kalmanson, G. M. res. fel. bact. Washington (St. Louis). Br 234.
Katzin, L. I. res. worker zool. California. Br 217-G.
Keefe, E. L. res. asst. biol. Washington (St. Louis). Br 217-J.
Kidder, G. W. asst. prof. biol. Brown. OM 21. D 204.
Kindred, J. E. prof. anat. Virginia. Br 106. (Aug. 1).
Kleinholz, L. H. res. asst. biol. Harvard. Br 213.
Knowlton, F. P. prof. phys. Syracuse Med. Br 226.
Kopac, M. J. asst. prof. biol. New York. Br 328. D 213.
Korr, I. M. instr. phys. New York Med. Br 126.
Laurence, Maria grad. bot. Marywood (Penn.). Rock 3.
Leuchtenberger, Cecilie asst. path. Mt. Sinai Hosp. (N. Y.). L 34. (July 15).
Leuchtenberger, R. asst. path. Mt. Sinai Hosp. (N. Y.). L 34. (July 15).
Lewis, Lena A. res. asst. phys. Ohio State. Br 111. D 106.
Lillie, F. R. prof. emb. Chicago. Br 101.
Lillie, R. S. prof. gen. phys. Chicago. Br 326.
Loveless, Mary H. instr. immun. Cornell Med. Br 110.
Luckman, C. E. grad. zool. Pennsylvania. OM Base. F.
Lynn, W. G. Rockefeller fel. zool. Yale. Br 343. D 101.
MacKnight, R. H. instr. zool. Northwestern. Br 217-L.
McClung, C. E. dir. zool. lab. Pennsylvania. Br 219.
Marrazzi, A. S. asst. prof. pharmacol. New York Med. Br 339.
Marrazzi, Rose fel. pharmacol. New York Med. Br 339.
Martin, Phyllis C. asst. prof. biol. Pennsylvania Women. Rock 2.
Martin, Rosemary D. C. asst. biol. Toronto. OM 4. D 306.
Martin, W. E. asst. prof. zool. DePauw. OM 31.
Mast, S. O. prof. zool. Hopkins. Br 329.
Mathews, A. P. prof. biochem. Cincinnati. Br 341.
Matthews, S. A. asst. prof. biol. Williams. OM 27.
Mattox, N. T. instr. zool. Miami. OM 32.
Mavor, J. W. prof. biol. Union. Br 315.
Mazia, D. asst. prof. zool. Missouri. Br 310. D 316.
Menkin, V. instr. path. Harvard Med. LH 27.
Michaelis, L. mem. Rockefeller Inst. Br 207.
Milford, J. J., Jr. grad. asst. biol. New York. OM 41.
Miller, Ruth N. assoc. prof. anat. Woman's Med. Penna. Br 217-E.
Molter, J. A. grad. zool. Pennsylvania. OM Base. C.
Moog, Florence grad. zool. Columbia. OM Base. H 7.
Morgan, T. H. prof. biol. California Tech. Br 320.
Morrill, C. V. assoc. prof. anat. Cornell Med. Br 317.
Moser, F. res. assoc. zool. Pennsylvania. Br 220. D 111.
Nachmansohn, D. res. fel. phys. Yale Med. Br 204.
Navez, A. E. instr. science Milton Acad. (Milton, Mass.). Br 309.
Nonidez, J. F. prof. anat. Cornell Med. Br 340.
Northrop, J. H. mem. Rockefeller Inst. Med. Res. (Princeton). Br 209.
O'Brien, J. P. grad. zool. Hopkins. Bot 6.
O'Neal, J. D. grad. phys. Pittsburgh. Rock 7.
Olson, M. instr. zool. Minnesota. Br 217-N.
Orr, P. R. asst. prof. biol. Brooklyn. L 23.
Osterhout, W. J. V. mem. Rockefeller Inst. Br 208.
Oxford, A. E. Rockefeller fel. biochem. Wisconsin. Br 121. (July 15).
Packard, C. asst. prof. zool. Inst. Cancer Res. Columbia. Br 102.
Park, T. asst. prof. zool. Chicago. Br 303. A 106.
Parker, Alice E. instr. anat. Colorado. Med. OM 1. D 205.
Parker, G. H. prof. zool. Harvard. Br 213. A 308-9.
Parmenter, C. L. prof. zool. Pennsylvania. Br 221. A 303.
Plough, H. H. prof. biol. Amherst. Br 330. (Aug. 1).
Price, Dorothy res. assoc. zool. Chicago. Br 217-O.
Prosser, C. L. asst. prof. zool. Illinois. OM 3.
Ramsdell, Pauline A. res. asst. phys. chem. Hopkins Med. Br 233.
Rankin, J. S. instr. biol. Amherst. OM 24.
Rimmler, L., Jr. res. asst. biol. Syracuse Med. Br 318. Dr 10.
Ris, H. asst. zool. Columbia. Br 314. (Aug. 1).

Rogers, C. G. prof. comp. phys. Oberlin. Br 218. D 209.
Ronkin, R. R. grad. zool. California. Br 322. Ka 24.
Rose, S. M. asst. zool. Columbia. Br 344.
Ruebush, T. K. instr. zool. Yale. L 26.
Rugh, R. assoc. prof. zool. New York. Br 342.
Runk, B. F. D. instr. biol. Virginia. Bot 26. K 14.
Russell, Alice M. instr. zool. Pennsylvania. Br 217-C.
Sayles, L. P. asst. prof. biol. C.C.N.Y. Rock 6.
Schaeffer, A. A. prof. biol. Temple. Br 214.
Scharrer, Berta indep. invest. Rock. Inst. Br 207.
Scharrer, E. fel. Rock. Inst. Br 207.
Schechter, V. instr. biol. C.C.N.Y. Br 315. (July 15).
Schram, Mildred W. S. sec. Internat. Cancer Res. Found. L 28, 29.
Scott, A. C. asst. prof. biol. Union. Br 312.
Selsam, Millicent E. Columbia. Br 315.
Shapiro, H. instr. phys. Vassar. Br 110.
Shaw, Myrtle senior bact. N. Y. State Dept. Health. Br 122-B. D 303.
Shelden, E. F. instr. phys. Ohio State. Br 111.
Sichel, Elsa Keil head sci. dept. Vermont State Normal Sch. (Johnson, Vt.). OM 4. K 8.
Sichel, F. J. M. asst. prof. phys. Vermont Med. OM 4. K 8.
Skow, R. K. res. asst. plant phys. Stanford. Br 222.
Slifer, Eleanor H. asst. prof. zool. State U. Iowa. Br 217-A.
Smith, C. C. res. assoc. med. Cincinnati Gen. Hosp. Br 9.
Smith, D. C. assoc prof. phys. Maryland Med. OM 8. (Aug. 1).
Smith, J. A. prof. biol. Springfield. Br 6.
Smith, M. E. Hopkins Med. Br 224. Ka 1.
Snedecor, J. grad. asst. zool. Indiana. L 31. Dr Attic.
Speidel, C. C. prof. anat. Virginia. Br 106. D 315.
Spofford, W. R. instr. anat. Cornell Med. Br 317. (Aug. 1).
Steinbach, H. B. asst. prof. zool. Columbia. Br 228.
Stern, K. G. res. asst. prof. physiol. chem. Yale Med. Br 204.
Stilwell, E. Frances instr. biol. Woman's Med. Pennsylvania. OM Base. H.
Stokey, Alma G. prof. bot. Mt. Holyoke. Bot 1.
Stunkard, H. W. prof. biol. New York. Br 232.
Summers, F. M. instr. biol. C.C.N.Y. Br 331. D 204.
Tashiro, S. prof. biochem. Cincinnati Med. Br 341.
Taylor, W. R. prof. bot. Michigan. Bot 24.
Terry, R. L. grad. zool. Pennsylvania. OM Base. Dr.
Thivy, Francesca grad. bot. Michigan. Bot 1.
Thompson, R. H. teaching asst. Stanford. Bot.
Townsend, Grace prof. biol. Great Falls Normal (Mont.). Br 122-D. W E.
Trinkaus, J. P. asst. zool. Wesleyan. Br 210.
Trombetta, Vivian V. instr. bot. Smith. Bot 1.
Tucker, G. H. instr. zool. Duke. Br 121.
Turner, C. L. prof. zool. Northwestern. Br 225.
Walther, R. F. res. asst. phys. Ohio State. Br 111. Dr 2.
Waterman, A. J. asst. prof. biol. Williams. OM 26. (July 26).
Weiss, P. A. assoc. prof. zool. Chicago. Br 301.
Wenrich, D. H. prof. zool. Pennsylvania. Br 219.
Whaley, W. G. instr. bot. Columbia. Br 321.
Whiteley, A. H. teaching asst. zool. California. Br 322. Ka 24.
Whiting, P. W. assoc. prof. zool. Pennsylvania. Rock 2.
Wichterman, R. asst. prof. biol. Temple. Br 217-H.
Wiercinski, F. J. grad. zool. Pennsylvania. OM Base. Dr Attic.
Wilbur, K. M. instr. zool. Pennsylvania. OM Base. G. 12.
Wilde, C. E., Jr. Dartmouth. Bot 1. Ho 3.
Willier, B. H. chairman div. biol. sci. Rochester. Br 324.
Wolf, E. A. assoc. prof. biol. Pittsburgh. Rock 7.
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THE BIOLOGICAL FIELD STATIONS OF GERMANY

HOMER A. JACK

Science Education Department, Cornell University

Germany has always been a leader in sponsoring biological field stations, although these have often been outside German territory. The first German biological stations to be established were on the Mediterranean and Adriatic Seas. In 1870 the Berlin Aquarium founded a station at Trieste in order to obtain a steady supply of living marine specimens. Under the leadership of Dr. Otto Hermes this station soon offered laboratory facilities to visiting German investigators. Also at that time Anton Dohrn, then a young German zoologist who had just studied with Haeckel and Gegenbauer at Jena, established the Zoological Station of Naples. Although this institution has never been strictly a German station, from its inception it was heavily subsidized by German funds and attracted numbers of German investigators.

While the establishment of field stations on German territory was (*Continued on page* 31)

M. B. L. Calendar

TUESDAY, July 9, 8:00 P. M.
Seminar: Papers on cellular physiology presented under the chairmanship of Dr. Robert Chambers, Research Professor of Biology, New York University.

FRIDAY, July 12, 8:00 P. M.
Lecture: Dr. Kenneth V. Thimann, Associate Professor of Plant Physiology, Harvard University: "Hormones and the Physiology of Growth in Plants."

OXIDATION AND REDUCTION IN ORGANIC CHEMISTRY

DR. LEONOR MICHAELIS

Member, Rockefeller Institute for Medical Research

All life as we know it is dependent on the existence of such chemical compounds as constitute the realm of organic chemistry. These compounds show two properties which at first glance seem to be contradictory: an enormous reactivity, on the one hand, and a remarkable sluggishness in the manifestation of this reactivity on the other hand. All organic compounds react with oxygen; the affinity of such a reaction is great enough to release very large amounts of energy, indeed enough energy for the maintenance of life. On the other hand, in spite of the high affinity for oxidation, organic compounds, such as sugar, fat or proteins, can exist even in contact with oxygen for a practically unlimited time at ordinary temperatures. There is some barrier acting as a brake to the reactivity, and the organism has to avail itself of specific catalysts, the respiratory enzymes, to overcome that barrier. Thereby, the energy of

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Photograph by Howard M. Wood, New Bedford, Mass.

AN AERIAL VIEW SHOWING THE LOCATION OF THE THREE BIOLOGICAL LABORATORIES IN WOODS HOLE

the process is dealt with much more economically than in a sudden, rapid or explosive reaction. Rather is the process conducted through successive steps leading through a well planned path most suitable for the utilization of the energy by the machinery of the living organism.

The problem of this lecture is to account for this remarkable lack of reactivity of organic compounds, which for purely unsophisticated considerations ought to be reactive toward oxygen to such an extent as not to be capable at all, of existence, in the presence of oxygen, for any appreciable length of time.

Let us start the discussion of this problem by an example, say, the oxidation of ethyl alcohol, C_2H_6O. The first known product of this oxidation is acetaldehyde, C_2H_4O. Any oxidation of an organic compound is primarily the detachment of hydrogen, or something analogous to it, such as the attachment of a hydroxyl group. In order to arrive from alcohol to aldehyde, one has to proceed not in one single elementary step of oxidation, involving one hydrogen atom, but a double step involving two hydrogen atoms. The first step, schematically speaking, is the loss of one H atom: $C_2H_6O \rightarrow C_2H_5O + H$. The second is the loss of another H atom, $C_2H_5O \rightarrow C_2H_4O + H$. Whatever may be the structural formula of the intermediate form C_2H_5O, it will be a free radical containing one tervalent carbon atom.

If we maintain that carbon should be quadrivalent, then this intermediate compound has no chance of existence to any measurable extent. It should be a compound much less stable than alcohol, hence much more reactive than alcohol. So, in order to pass from alcohol to a less reactive substance such as aldehyde, we have to pass through a compound, which is even more reactive than alcohol itself. We may say: the energy content of alcohol, when passing to aldehyde, decreases, the process taken as a whole. However, it has to climb over an energy hill. Once the top of the hill is reached, the energy will fall down spontaneously. But the necessity of climbing over this hill is the barrier of the reaction and makes alcohol resistent against oxygen under ordinary conditions.

This argument is so simple that one should expect it to be known and acknowledged for a long time. What has been acknowledged is that there is some barrier, and that some activation energy is necessary to overcome some kind of energy hill. However, astounding as it may be, it has not been recognised that the intermediate free radical is the impersonation, or the substrate, of this barrier. On the contrary, whenever the mechanism of oxidation of organic compounds was discussed, it was taken for granted that in general the oxidation is primarily and essentially a bivalent one, and that an intermediate stage, or any univalent oxidation, does not occur. This can be best shown by studying the current theories on reversible oxidation-reduction as observed by potentiometric titration of many organic dyestuffs. The simplest prototype of such a reversible oxidation-reduction process is

$$\underset{\text{(Quinone)}}{O{:}C_6H_4{:}O} + H_2 \rightleftharpoons \underset{\text{(Hydroquinone)}}{HO{\cdot}C_6H_4{\cdot}OH}$$

According to what has been just now said this process should be split into two successive steps, such as

$$(1) \quad \underset{\text{(Hydroquinone)}}{HO{\cdot}C_6H_4{\cdot}OH} \rightleftharpoons \underset{\text{(Semiquinone)}}{HO{\cdot}C_6H_4{:}O} + H$$

$$(2) \quad \underset{\text{(Semiquinone)}}{HO{\cdot}C_6H_4{:}O} \rightleftharpoons \underset{\text{(Quinone)}}{O{:}C_6H_4{:}O} + H$$

The substance called semiquinone contains one tervalent carbon. It is a free radical, and it has never been prepared to any easily detectable amount. (What is known as solid quinhydrone is not this radical but a compound of double molecular size, containing no tervalent carbon.)

Our thesis, when exemplified for this particular case, is that hydroquinone, in order to be oxidised to quinone, cannot be oxidised directly in one step but has to pass through an intermediate step, which is the semiquinone, a free radical, with an unsaturated valence. This free radical is a very unstable compound, its formation requiring much energy. To convert hydroquinone to semiquinone, amounts to winding up an elastic spring. It requires the expenditure of energy. The necessity of passing through this stage makes hydroquinone a relatively stable compound even in the presence of oxygen. This is true at least in acid solution. Why hydroquinone is much easier to oxidise in an alkaline solution will be understandable from what follows. You may guess it even now: because in alkaline solution, the formation of such a radical requires less energy, and it will presently be shown why this is the case.

Now, though this particular semiquinone is very unstable and capable of existence in equilib-

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rium with its parent substances, quinone and hydroquinone, only to a very small extent, its existence must not be entirely denied. As regards the stability of such free radicals, it may vary from case to case to a wide extent, and for the sake of clarification we may somewhat schematically distinguish three possibilities:

1) In some cases, the existence of the intermediate free radical cannot be demonstrated experimentally at all. Whether or not it exists in minute quantities is a matter of hypothesis. An example: no radical intermediate between alcohol and aldehyde has ever been shown to exist.

2) In a second group of cases, the existence of the intermediate radical can just be detected by refined methods.

3) In a third group, the existence of the free semiquinone radical is easy to demonstrate.

Let us discuss these three cases in detail by some examples. We begin with the third case.

A good example is pyocyanine, a bacterial dyestuff, or riboflavin (vitamin B_2). When such a dyestuff, in a sufficiently acid solution, is gradually reduced, one can see a twofold change of color. For instance, an acid solution of pyocyanine is red; on reduction it first turns green, then colorless. The intermediate green compound can be shown to be a free radical by two entirely independent methods, a potentiometric and a magnetometric one. The potentiometric method is used as follows. The dyestuff is titrated with a reducing agent and the electric potential as established at a bright platinum electrode, is plotted against the degree of reduction. The shape of the titration curve allows one to infer whether any intermediate compound is formed at all, and what is the molecular size of the intermediate compound as compared with the molecular size of the dyestuff itself; furthermore, whether the intermediate compound differs from the original dyestuff by one single, univalent step of oxidation, or by two. Hereby it can be learned from a mathematical analysis of the titration curve whether or not the intermediate compound is a free radical.

The second method is based on the observation of the magnetic properties of the substance. A regular organic compound contains always an even number of electrons, and these are arranged in pairs. Each pair consists of two electrons with opposite spin. If the spin of an electron should be detectable at all by some physical property, it cannot be manifest in a compound with an even number of electrons because for each pair of electrons these effects are cancelled out due to the opposite sign of the spins. However, as free radical must contain an odd number of electrons, and the spin of the odd electron is not cancelled out, the effect of such spin is to make the molecule paramagnetic: it is attracted by a magnet. A spinning electron is equivalent to a circular electric current, and it has been known for more than a hundred years that a circular electric current is equivalent to a magnet. For this reason, any free radical must be paramagnetic, and ordinary molecules must not be paramagnetic, but show that very faint diamagnetism, common to all matter, manifested by a very faint repulsion by a magnet, instead of attraction.

Though in principle this method seems to be very simple, the technical difficulties which prevented its application for this particular task have been overcome only quite recently. The method adopted consists in mixing a solution of a suitable substance with some reagent such as to bring about the reduction quite gradually. E.g., glucose in an alkaline solution is such a reducing agent which under proper conditions stretches the period of the reduction process over a whole hour or more. During this period, successive measurement of the magnetic properties of the solution are performed. The solution, in a cylindrical container, is suspended at one end of a balance-beam, and the force by which it is attracted by an electromagnet is measured in terms of the weight which compensates the pull of the electromagnet on closing the electric current. (Two cases were demonstrated in lantern slides.) It can easily be seen that during the observation a change of the magnetic force occurs, reaching a maximum in the midpoint of the reduction. By means of the theory of para-magnetic susceptibility, on the basis of the modern quantum theory, it can be calculated how much of the dyestuff is present in the form of the free radical in the midpoint of reduction, and this result can be compared with the one obtained by the potentiometric method. In this particular case shown in the lantern slide, the substance to be reduced was duroquinone (the parent substance of the vitamin tocopherol), dissolved in .1 N NaOH. Both methods agreed in the result that in the midpoint of titration as much as 52 per cent of the substance is present as the free semiquinone radical. It should be emphasized that in a less alkaline solution, this percentage is much smaller and gradually, going to acid solutions, becomes so small that our methods are scarcely sensitive enough to show its existence. However, since the methods are not at all very sensitive and the decrease of the percentage in free radical is quite gradual with decreasing alkalinity, it is justified to assume the presence of some small amount of the radical, say, in 1% of the total substance, even in acid solution. By this

example it is shown what is meant by the second case where there is no good direct method of showing the presence of a radical, but sufficient indirect evidence for its existence in a small amount.

Now we pronounce the following important thesis: Whenever the semiquinone radical can exist, the process of oxidation and reduction is reversible. Or, on the other hand: the reversibility of oxidation-reduction process is correlated to the existence of a semiquinone radical in not too small an amount. If the establishment of the intermediate step requires little energy, the energy hill over which the process has to climb is small and may be quite insignificant. Then the whole bivalent oxidation-reduction is reversible. Reversible systems of this kind have been known for a long time in organic chemistry, namely all the vat-dyes such as indigo, and many other dyestuffs such as methylene blue. They had scarcely been known to exist in the living organism fifteen years ago. Since, they have been discovered to exist in a great variety. They are the respiratory enzymes and a number of the vitamins. To give a few examples: Warburg's yellow respiration enzymes and the great variety of enzymes similar to it discovered in recent years; and a number of quinone-like substances, such as Vitamin K, or phtiocol, the yellow pigment of the tubercle bacillus. Since these dyestuffs are reversibly oxidised and reduced, they can be utilized as catalysts for oxidation and reduction of other substances, and since, due to the reversibility of the process, they are never used up, they need be present only in very small amounts. Their very low concentration in the organism is the reason why they have been discovered only in recent years and in spite of their great importance for the process of respiration have escaped the attention of scientists until a few years ago.

All these reversible systems play the role of catalysts. The energy of the organism is derived, however, from the oxidation of irreversible systems, such as sugar, fat, and protein. Whereas the oxidation and reduction of the reversible systems take place in cycles, the oxidation of, say, sugar, proceeds in a series of steps to the formation of CO_2 and H_2O. This process cannot be reversed, except by the green plant with expenditure of radiant energy of the sunlight.

The irreversibility of the oxidation of sugars, fats or proteins may be correlated to the fact that the oxidation here also can proceed only in successive univalent steps. The first necessary step, then, is the formation of a free radical. This requires the expenditure of so much energy that the radical is never formed in any measurable quantity. If the oxidation has to proceed through the free radical, then the concentration of the radical must be one factor in determining the rate of the oxidation. If this concentration happens to be too small, it may be the limiting factor for the process, and the whole process of oxidation is stopped. This is why the foodstuffs are relatively stable toward oxidising agents and especially toward oxygen.

The various respiration enzymes are catalysts which have the task of overcoming the lack of reactivity and furthermore to select one of the possible paths of oxidation. These enzymes can form a loose compound with the substrate to be oxidised. If the radical of this compound can be more easily formed than with the uncombined substrate, the enzyme may be said to catalyse the oxidation.

It remains to correlate the stability of free radical with its chemical constitution. In this respect a very useful principle can be applied which is the result of a quantum-mechanical consideration. This principle is that of resonance. This term, in quantum mechanics, is used in the following sense.

Very often, a chemical formula for a given compound may be written in two or more ways without the implication that one of them should represent the true state. So, the formula for benzene can be written in various ways, of which the two Kekulé-structures are the most important ones. They differ only in the distribution of the valence dashes, each dash standing for an electron pair. The ambiguity is concerned only with the distribution of the electrons but not with the distribution of the atomic nuclei. If such a condition prevails, none of the possible formulae represents the true state, but the real state is something intermediate that cannot be expressed by any single formula of the customary type. This statement is easy to understand and needs no quantum mechanics for explanation. However, there is something that quantum mechanics has added to this statement, namely that this ambiguity with respect to the distribution of the electrons imparts to the molecule a greater stability than otherwise would be expected. This ambiguity of structure is designated as resonance. Let us demonstrate it at least by one example.

It was stated at the beginning that a quinone of the general type O=X=O, where X stands for C_6H_4 or any other suitable ring structure with conjugated double bands, yields as the first step of oxidation the semiquinone, O=X—OH. In a sufficiently alkaline solution, it detaches a hydrogen ion, and then has the form O=X—O^-. There is no reason, however, why the negative

charge should be attached to the right hand oxygen. Just as well one could write $^{-}O—X=O$. This ambiguity produces the phenomenon of resonance and makes the radical a rather stable one in spite of the very unsaturated condition of such a compound. However, in an acid solution, where we have the structure $O=X—OH$, no analagous ambiguity arises, and the lack of resonance makes such a radical very much less stable than the other form as it arises in an alkaline solution. This is why the stability of the radical depends largely on the acidity or alkalinity of the solution and why the ease of oxidation so largely depends on the pH of the solution. In some cases, alkalinity favors the establishment of radicals, namely when the radical is a negatively charged ion, or can form such an ion. In other cases, acidity favors the formation of a radical, namely whenever the semiquinone is, or can form, a positively charged ion. This idea can be shown to hold to the finest detail, but we have to restrict ourselves, for the time alloted to such a lecture, to the statement of the principle, regretting not to be able to show the large experimental material accumulated during the past few years. For details, see: Cold Spring Harbor Symposium on Oxidation-reduction, 1939; and New York Academy of Sciences, Monograph of November Meeting, 1939.

(This article is based on an evening lecture entitled "Oxidation and Reduction in Organic and Biological Chemistry," delivered at the Marine Biological Laboratory on July 5.)

THE CONTRIBUTIONS OF DR. FRANK R. LILLIE TO OCEANOGRAPHY

Dr. Edwin G. Conklin

Emeritus Professor of Biology, Princeton University

Note: These comments by Professor Conklin were made on April 23 on the occasion of the presentation of the Agassiz Medal for Oceanography by the National Academy of Sciences.

In these times of exaggerated nationalism it is fortunate that we can still emphasize the internationalism of science. The Murray Fund of the National Academy of Sciences is peculiarly international in its foundation and purpose. It was established in 1911 by Sir John Murray, Canadian by birth, Scot by adoption, internationalist in science, to honor the memory of Alexander Agassiz, Swiss-born American, cosmopolitan as the ocean in his research work. Of the seventeen awards of the Agassiz Medal which have been made hitherto, fourteen were given to foreign oceanographers, three to American. Of the foreign awards, five went to Norwegians, two to Swedes, two to Danes, two to Britons and one each to oceanographers of Holland, Germany and Monaco.

The eighteenth award of this medal is to one who is a Canadian by birth, American by adoption and an internationalist in his sympathies and services, Frank Rattray Lillie, thirteenth president of the National Academy of Sciences. For twenty-six years he was director of the Marine Biological Laboratory at Woods Hole, Mass., and he was president of that institution from 1926 to 1939. During nearly half a century his research activities have been largely associated with marine biology and particularly with normal and experimental embryology and cytology, problems of fertilization and parthenogenesis, and during all these years he has stimulated or directed the research work of many hundreds of investigators. The Marine Biological Laboratory, one of the greatest institutions of its kind in the world, in large part owes its physical plant, its financial endowments and, best of all, its stimulating and cooperative atmosphere to his wise guidance and friendly supervision.

Recognizing the needs of the more extensive cultivation of the wide field of oceanography, he conferred with the late Dr. Wickliffe Rose, president of the General Education Board, on the needs of a more comprehensive provision for research in this science, and at the annual meeting of the academy in 1927 he introduced a resolution, "that the president of the academy appoint a committee on oceanography from the sections of the academy concerned to consider the share of the United States in a world-wide program of oceanographic research." The members appointed were William Bowie, E. G. Conklin, B. M. Duggar, John C. Merriam, T. Wayland Vaughan and F. R. Lillie, *chairman*.

The following year, through the efforts of Dr. Lillie and Wickliffe Rose, the General Education Board made a grant of $75,000 to finance a thorough study of the problems as well as the needs of a comprehensive program of oceanography. Dr. Henry B. Bigelow was appointed secretary of the committee on oceanography to collect information and prepare a report on the present status of this science in America and Europe. This report was presented to the academy and to the Rockefeller Foundation and was later published in a volume of 263 pages. At the same time T. Wayland Vaughan made a

special study of the status of oceanography in the Pacific area, and ultimately extended this to a survey of the "International Aspects of Oceanography," which was published in a quarto volume of 225 pages in 1937 with funds remaining from the original grant of the General Education Board.

After Dr. Bigelow's report had been carefully considered and generally approved and the decision had been reached to establish a central oceanographic station at the most suitable place on the Atlantic coast, the Woods Hole Oceanographic Institution was incorporated in 1930 and its board of trustees petitioned the Rockefeller Foundation for funds for building, equipment, research ship and endowment; one month later the foundation granted $2,000,000 for this purpose and later added $1,000,000 to the endowment.

As a member of the committee on oceanography and of the board of trustees, I know how much of all this success was due to the efforts of Dr. Lillie, and how little to the rest of those whose names were associated with his.

Dr. Lillie served as president of the Woods Hole Oceanographic Institution from its incorporation until his retirement at his own request last summer, when Dr. Bigelow, who had been director from the time of its foundation, was chosen president. In all this labor of awakening interest in oceanography, in securing large endowment, in building and equipping the station and in organizing its main lines of research, Dr. Lillie took the leading part ably seconded by Dr. Bigelow.

This is the leading privately endowed oceanographic institution in the world. Already it has drawn to itself many of the leading oceanographers of the world. Its research ship, the *Atlantis*, has sailed more than 150,000 miles on research voyages; more than 240 research papers and monographs have been published from the institution since its foundation. The National Academy of Sciences may well be proud of the fact that it took so important a part in sponsoring this notable institution, without any cost to itself.

For this important researches and his wise leadership in marine biology, for his enduring contributions to the science of oceanography in the founding and endowing of the Woods Hole Oceanographic Institution, for his modest but effective leadership in causing this country to assume its share in a world-wide program of oceanographic research, the committee on the Murray Fund presents to you, Mr. President, for the eighteenth award of the Agassiz Medal, Frank Rattray Lillie.

THE BIOLOGICAL FIELD STATIONS OF GERMANY

(Continued from page 25)

retarded by the development of these Mediterranean institutions, the first biological station to be founded in Germany had the distinction of being the first permanent fresh-water station in the world. This was the biological station at Plön, in Holstein, founded in 1892 by Dr. Otto Zacharias. In the same year the biological station at Helgoland was opened and soon the establishment of other field stations followed. Today German marine stations are located at Helgoland and Husum on the North Sea and at Kiel, Kloster, and Rossitten on the Baltic. Lakeside stations are to be found at Langenargen and Wasserburg on Bodensee and at Plön and Seeon. River stations are at Krefeld near the Rhine, Saarbrücken on the Saar, and Bellinchen on the Oder. Finally a mountain station is situated at Garmisch, on Wettersteingebirge. In all, there are fourteen biological field stations in Germany, or one to about every five million inhabitants.

The largest German station is the Biological Station of Helgoland (*Biologische Anstalt auf Helgoland*). Located in the North Sea, the island of Helgoland is some six hours by boat from Hamburg. The island's sandstone cliffs are strikingly banded and rise perpendicularly from the sea on all sides except one; this, the Unterland, contains most of the inhabitants as well as the biological station. Begun as an itinerant zoological station along the North Sea Coast, this station was opened in a remodeled lodging house in 1892, two years after the island was ceded to Germany by Great Britain. In 1902 a public aquarium was opened in connection with the station and in 1937 a new, six-story laboratory and aquarium building was completed. This new structure contains, in addition to a large public aquarium which had 73,000 visitors in 1937, offices and laboratories for students, investigators, and the permanent staff. Headed by Professor A. Hagmeier, the staff consists of five custodians, sixteen scientific assistants, nine fishery technicians, ten clerks, two machinists, and six laborers. The 34-meter research vessel, *Makrele*, is connected with the station as are several smaller vessels. The station has an auxiliary laboratory on Helgoland harbor near the vessel's dock and annexes also at Sylt and Wesermünde.

The Helgoland station offers four courses to students. These are a five-week laboratory course in marine biology, a two-week course in marine biology, a two-week laboratory course in botany, and a three-week course for biology teachers. A large laboratory is available for classes and accommodates a maximum number of thirty students. The tuition for students is five marks* a week. The station can also accommodate about fifty foreign or German investigators who are expected to pay a laboratory fee of twenty-six marks a month. In 1939 students and investigators could obtain board and lodging at a station-owned residence for about thirty-five marks a week.

On the island of Helgoland is also located the Helgoland Bird Observatory (*Vogelwarte Helgoland*) which merits distinction for being one of the few field institutions in the world devoted to research and instruction in ornithology. Attached to the Biological Institution of Helgoland, the observatory is located in a separate building about half a mile from it on the Oberland. In addition to housing bird skin collections and extensive bird-banding files, this institution has working places for ten investigators and a classroom for thirty students. Another German ornithological station is the Rossitten Bird Observatory of the Kaiser Wilhelm Institute (*Vogelwarte Rossitten der Kaiser Wilhelm-Gesellschaft*). Located on the Couric Isthmus in East Prussia, this station offers a seven-day field course in ornithology to students. Its research facilities include three auxiliary field headquarters at Ulmenhorst, Elbing, and Windenburg.

The Hiddensee Biological Research Station (*Biologische Forschungsanstalt Hiddensee*) at Kloster was founded in 1930 under the auspices of the University of Greifswald with the purpose of offering "instruction and research in the plant ecology, microclimatics, hydrobiology, and ornithology of the region." On an island in the Baltic Sea, two and one half hours by boat from Stralsund, this station makes working places available to four investigators throughout the year. At the disposal of the investigator is a small library, a hydrobiological laboratory, regular meteorological observations, and motorboats. Investigators may live at the institution, either preparing their own meals or eating at nearby hotels. Courses for students are given in ornithology, hydrobiology, and ecology.

Another recently-organized German station is the Institute for Oceanography of the University of Kiel (*Das Institut für Meereskunde der Universität Kiel*) located at Kitzeberg, a suburb of Kiel. At present the institute is housed in a converted three-story dwelling and contains an experimental aquarium, a low temperature room, library, storerooms, living rooms for guests, and laboratories for geology, zoology, botany, hydrography, fishery-biology, chemistry, and bacteriology. The institute does not offer formal instruction, but two large laboratory rooms are available throughout the year to qualified visiting investigators. The first volume of the institute's scientific journal, *Kieler Meeresforschungen*, was issued in 1936-37.

A short distance from Kiel, on Greater Plön Lake, is situated the Hydrobiological Institute of the Kaiser Wilhelm Institute (*Hydrobiologische Anstalt der Kaiser Wilhelm-Gesellschaft*). Under the direction of the noted limnologist, Dr. A. Thienemann, this is one of the best known freshwater stations in the world. For many years it was housed in a three-story brick building, but in 1938 work was begun on new quarters. The institute is open all year to visiting investigators and occasionally classes from the University of Kiel spend some days in its laboratories.

On Bodensee, in southwestern Germany, is located the Institute for Lake Investigation and Management of the Kaiser Wilhelm Institute (*Institut für Seenforschung und Seenbewirtschaftung der Kaiser Wilhelm-Gesellschaft*). Its three-story building contains a classroom, library, and laboratories for pisciculture, bacteriology, chemistry, botany, and guests. A three-week course in limnology is given in July, the tuition being about twenty marks. Visiting investigators may work in the institute's laboratories by paying a fee of twenty-one marks a month.

The Alpine Laboratory of Schachen near Garmisch (*Alpenlaboratorium auf dem Schachen bei Garmisch*) is located more than six thousand feet above sea level, about one hundred kilometers from Munich. Sponsored by the Bavarian Ministry for Instruction and Culture and by the Union for the Protection of Alpine Plants, this station is housed in a log building containing one small laboratory and living quarters for four persons. The laboratory is open from June fifteenth to October first to investigators in the fields of

*The exchange rate for the period in which the cost of tuition or living is given was about two and one-half marks to an American dollar, although Americans could obtain tourist marks at the rate of about five to the dollar and use them for tuition or living expenses at German biological stations.

ecology, alpine botany, and plant sociology. Ordinarily there are no laboratory fees.

* * *

The usual question asked about the biological stations of Germany deals with their fate under the Nazi regime. While it is too early perhaps to evaluate the work of these institutions, it must be admitted that at least until 1939 the physical plants of the German stations prospered under the Hitler regime. One biological station was founded since he assumed power and the laboratory quarters of several others have been augmented. Whether this has been due to Nazi appreciation of the work of biological stations or to a carry over of plans made before 1934, it is difficult to ascertain. In recent years there has been admittedly a decline in the number of beginning students at several German biological stations. It is claimed that this was due not so much to the absorption of students into war industries or the military forces as to the relatively large number of students who—as in this country—stayed on in university during the hard times of the early thirties.

Marine stations are particularly vulnerable to demolition during modern warfare because naval bases often coincide with marine biological ones. Thus both Helgoland and Kiel have been targets of the Royal Air Force during the past nine months. What the fate of the stations located in these places has been is not known. The author, however, knows of the intense military activity on the island of Helgoland in September 1938. Men were working on fortifications twenty-four hours a day and engineers were trying to find oil just beyond the bird traps of the bird observatory on Oberland. Cameras were not allowed and civilians were forbidden to enter the harbor. Such was the atmosphere around the largest German biological station one year before the Second World War.

(This article includes only the stations on the territory occupied by Germany prior to March 13, 1938.)

The Woods Hole Oceanographic Institution's ketch *Atlantis* returned to Woods Hole on June 27 after a ten day survey trip to Georges Banks. Work in studying the feeding habits of food fish was conducted on this trip under the direction of Dr. George L. Clarke of Harvard University. The next trip of the *Atlantis* is scheduled for July 9 when it will establish an anchor station south of Martha's Vineyard for use in measuring ocean currents.

The *Anton Dohrn*, which has been transferred from the Tortugas Laboratory to the Woods Hole Oceanographic Institution, arrived in Woods Hole last week-end and is now tied up at the Institution's pier. The power boat is 70 feet long, contains two 50-hoursepower engines, and is capable of a speed of nine knots per hour. It carries dredging equipment suitable for use up to a depth of three hundred fathoms. The *Dohrn* was operated by the Tortugas Laboratory together with two smaller boats, the *Vellela* and the *Darwin*. The *Dohrn* was used for communication with the mainland, for dredging and for other collecting purposes. No funds are as yet available for operating the launch and there appears to be little likelihood that the Woods Hole Oceanographic Institution will be able to use the ship in the near future.

DR. ERIC G. BALL, an associate at the Johns Hopkins School of Medicine, was awarded the one thousand dollar Eli Lilly and Company prize in biological chemistry of the American Chemical Society for chemical studies of certain biological substances including the hormone adrenalin and vitamins B_2 and C. The prize was presented to Dr. Ball by Dr. Samuel C. Lind, president of the Society, at its meeting in April. Dr. Ball delivered his award paper, "The Nature of the Enzyme Xanthine Oxidase" before a symposium on vitamins and nutrition on April 10. Dr. Ball was cited specifically "for his research on the oxidation-reduction properties of cell pigments such as phtiocol, echinochrome, and the cytochromes, adrenalin and related compounds, vitamin C, vitamin B_2, or riboflavin, and nicotinic acid amide."

DR. W. C. ALLEE, professor of zoology at the University of Chicago, received the honorary degree of doctor of laws in June from Earlham College, Richmond, Indiana. The citation reads: "He is a scholar who believes that scholarship should serve society, a scientist and an author who seeks to apply natural laws to the social, the economic and the spiritual world." Dr. Allee has been elected an alumni trustee of the college.

The Collecting Net

A weekly publication devoted to the scientific work at marine biological laboratories.

Edited by Ware Cattell and Robert Chambers with the assistance of Boris I. Gorokhoff and Peggy Browning; Contributing Editor, Homer A. Jack.

Entered as second-class matter, July 11, 1935, at the U. S. Post office at Woods Hole, Massachusetts, under the Act of March 3, 1879, and re-entered, July 23, 1938.

Introducing

Dr. Arthur Charles Giese, Rockefeller Foundation Fellow at Princeton University; Assistant Professor of Biology at Stanford University.

On Sabbatical leave from his position at Stanford University, Dr. Giese has spent the past academic year conducting research at Princeton University with Dr. E. Newton Harvey, and is now continuing this fellowship work at Woods Hole with him.

After receiving his B.S. in biology at the University of Chicago, Dr. Giese did graduate work at the University of California and Stanford University, receiving his Ph.D. at the latter institution in 1933. The research work for the degree concerned itself with the lethal effects of ultra-violet light on Paramecium, and was conducted under the direction of Dr. C. V. Taylor and Dr. P. A. Leighton.

Since then Dr. Giese has been concerned chiefly with the effects of ultra-violet radiation on various biological processes, a subject of many applications to medical and biological problems. While the question of lethal effects of ultra-violet rays has been rather extensively investigated, much of the work on the effects of these rays upon respiration, growth and irritability has been sketchy and often contradictory in its conclusions.

Dr. Giese's work at present deals with the effects of ultra-violet rays on respiration. He has chosen a species of luminous bacterium for his work, because in this way the metabolic activity can be checked not only by direct measurement of oxygen consumption, but also by the amount of luminescence.

He has been working out the conditions under which ultra-violet radiation has an inhibitory, a negligible, or a stimulatory effect, and attempting to determine the essential nature of the radiation effects upon respiration.

Dr. Giese plans to return to his position at Stanford University this fall. He is accompanied in Woods Hole this summer by Mrs. Giese and their son, Teddy. Among his hobbies he lists tennis and music, particularly playing the 'cello.

ADDITIONAL INVESTIGATORS

Baker, L. A. res. asst. Eli Lilly & Co. Br 319.
Brink, F., Jr. res. asst. biophys. Pennsylvania. Br 115.
Brown, D. E. S. asst. prof. phys. New York. Br 304.
Butler, P. A. asst. zool. Northwestern. Br 225. K 15.
Calabrisi, P. instr. anat. George Washington Med. OM 46.
Catherine Francis instr. Hallahan H. S. (Pa.), Rock 3.
Commoner, B. tutor biol. Queens (Long Island). Br 305.
Ferguson, F. P. grad. asst. zool. Minnesota. Br 210. K 6.
Finkel, A. J. res. asst. zool. Chicago. Br 332.
Graham, Judith grad. phys. Chicago. OM 4.
Hauguard, G. asst. Carlsberg Lab. (Denmark). Br 207.
Hemstead, G. W. Union. Br 312. Ho 7.
Hickson, Anna K. res. chem. Eli Lilly & Co. Br 319.
Hunter, G. W., III asst. prof. biol. Wesleyan. (Aug. 24).
Jacobs, Joye asst. phys. Maryland Med. Br 109.
Kaylor, C. T. instr. anat. Syracuse. Br 226.
Krahl, M. E. res. chem. Eli Lilly & Co. Br 333. A 301.
Kriete, B. C. grad. asst. zool. Cincinnati.
Lancefield, D. E. assoc. prof. biol. Queens (Long Island). Br 305.
M. Joseph teacher Nativity H. S. (Scranton, Pa.). Rock 3.
McVay, Jean asst. zool. Northwestern. Br 313. H 3.
Merwin, Ruth M. res. asst. zool. Chicago. Br 332.
Meyerhof, Bettina res. asst. biochem. Hopkins Med. Br 204.
Morgan, Lilian Br 320.
Netsky, M. Pennsylvania Med. Br 205.
Neubeck, C. E. asst. chem. Pittsburgh. Br 333.
Pirenne, M. H. Belgian-Amer. Found. fel. Br 334.
Ray, O. M. instr. phys. North Dakota Agri. Br 107.
Shannon, J. A. asst. prof. phys. New York Med. OM 5.
Spratt, N. T. res. asst. emb. Br 324.
Whitaker, D. M. prof. biol. Stanford.

CURRENTS IN THE HOLE

At the following hours (Daylight Saving Time) the current in the Hole turns to run from Buzzards Bay to Vineyard Sound:

Date	A. M.	P. M.
July 6	5:01	5:18
July 7	5:51	6:03
July 8	6:35	6:56
July 9	7:23	7:48
July 10	8:17	8:39
July 11	9:06	9:36
July 12	10:05	10:37
July 13	11:05	11:41
July 14	12:03	12:24
July 15	12:44	1:02

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

ITEMS OF INTEREST

DR. AND MRS. CHARLES PACKARD will be at home to members of the Marine Biological Laboratory on Sunday afternoons, July 7, 14, and 21 from 4:30 to 6 o'clock.

DR. THEODOSIUS DOBZHANSKY, professor of genetics at the California Institute of Technology, has been named professor of zoology at Columbia University and will direct research in the University's laboratory of genetics. Dr. Marcus M. Rhoades, geneticist of the U. S. Department of Agriculture, has been also appointed associate professor of botany at the University. They will collaborate in the laboratory with Dr. Leslie C. Dunn, professor of zoology, who will become head of the department there on July 1.

DR. A. P. MATHEWS, Andrew Carnegie professor of biochemistry and head of the department at the University of Cincinnati College of Medicine, retired this spring. His place has been taken by Dr. Milan Logan, chemist at the Forsyth Dental Infirmary at Harvard University.

DR. DIXIE YOUNG, who has been at Woods Hole several years, has been promoted from assistant professor to associate professor in the department of zoology at the University of Oklahoma.

DR. GEORGE P. CHILD has been promoted from instructor to assistant professor of biology at Amherst. He will take a summer course in spectroscopy at the Massachusetts Institute of Technology.

DR. G. W. MOLNAR, who took the invertebrate zoology course at the Marine Biological Laboratory in 1939, has been appointed instructor in zoology in Miami University.

MR. MORRIS K. WINBORN received his Master's degree at the Amherst College commencement exercises in June. Mr. Winborn, who was a student in the invertebrate zoology class at Woods Hole last summer, will work for his doctor's degree at Harvard.

DR. A. V. HILL, Foulerton professor of physiology, University College, London, has recently returned to Europe after spending two months in Washington where he was associated with the British Embassy. Shortly before coming to America Dr. Hill was elected a member of Parliament from Cambridge.

The D. Appleton-Century Company and the J. B. Lippincott Company have been exhibiting their books in the lobby of the Marine Biological Laboratory building during the past week.

MISS CONSTANTIA HOMMANN, daughter of Mrs. Smith Hommann, was married on June 22 at Lee, Mass., to Mr. Gary Nathan Calkins, Jr., son of Dr. Calkins, director of the protozoology course and trustee of the Marine Biological Laboratory.

MISS RUTH MORRISON was married to Dr. Jay A. Smith on October 31 of last year at Swayzee, Indiana. Dr. Smith was head of the department of biology at Springfield College, Springfield, Mass., last year. Mrs. Smith graduated from DePauw University in 1938.

MISS VIRGINIA SAFFORD was married to Dr. Edward Black on June 22 at East Northfield, Massachusetts, and the couple is now taking a trip through Canada. Dr. and Mrs. Black both worked at the Marine Biological Laboratory last summer.

MISS ANNE DUNAY was married to Dr. Paul Calabrisi, instructor in anatomy at George Washington University Medical School, on June 27 at Washington, D. C. Dr. Calabrisi is working with Dr. G. B. Jenkins at Woods Hole.

DR. LORANDE L. WOODRUFF, professor of protozoology at Yale University, is spending the first half of the summer at the Mountain Lake Biological Station, Mountain Lake, Virginia. He will arrive in Woods Hole about August 1.

DR. HAROLD H. PLOUGH, professor of biology at Amherst College, is spending the early part of this summer at the U. S. Bureau of Fisheries Laboratory at Beaufort, North Carolina, but will come to Woods Hole for the month of August. Dr. Plough was on the crew of the *S. S. City of Flint* when it rescued part of the survivors of the torpedoed liner *S. S. Athenia* at the outbreak of the war last September.

At lunch on Wednesday there were 292 people eating at the Laboratory Mess Hall which is 9 less than for the corresponding meal last year. With the present arrangement of seating fourteen people to a table, the capacity of the hall is 312.

A sea wall has been built during the winter by the Marine Biological Laboratory at the Breakwater bathing beach in order to protect the tennis courts. The structure is four feet high, twelve feet wide, and about one hundred feet long.

The United States Bureau of Fisheries was merged last week with the Bureau of Biological Survey to form a new bureau to be known as the Fish and Wildlife Service. The combined bureaus, headed by Dr. Ira N. Gabrielson, are part of the Department of the Interior.

EXTRA-CURRICULAR ACTIVITIES AT THE M. B. L.

M. B. L. CLUB

The membership of the M.B.L. Club reached 203 at noon on Thursday, according to Mrs. M. Bosworth, the Club hostess.

The first regular phonograph record concert of the season was presented last Monday evening. A crowd of nearly two hundred filled the Clubhouse to capacity to hear a program of recordings which included "La Mer," by Debussy, "Sonata in C Sharp Minor," by Beethoven, and "Jupiter Symphony (No. 41 in C Major)" by Mozart. Concerts are planned each Monday evening for the remainder of the summer. Dr. Jay A. Smith and Dr. J. B. Buck are in charge of these musical evenings.

Another of the regular Saturday evening dances will be held this evening at nine o'clock. The committee in charge of refreshments for this dance will be: Mrs. A. A. Abramowitz, *Chairman*, Miss Rosemary Martin and Miss Helen Goulding.

The beach-party equipment of the Club has been used several times already this summer.

Miss M. Lucille Nason has recently been appointed chairman of the social committee.

A new net has recently been obtained for the Club's ping-pong table. New paddles have also been provided, with the name of the Club burnt into the handles by James Snedecor, who has recently been appointed to the house committee of the Club.

An afternoon tea was held recently at the Club. The house committee wishes to call attention to the fact that the facilities of the Club are available to any of its members that wishes to hold a tea in the Clubhouse.

M. B. L. TENNIS CLUB

The official tennis season was launched at a meeting of the M. B. L. Tennis Club on the evening of July 2nd. The meeting was held on the lawn behind Old Main Lecture Hall for the purpose of outlining current needs and activities.

President Krahl announced the opening of the Beach and Colas Courts under the supervision of Mr. A. J. Stunkard. The clay court adjacent to the Mess Hall will be ready for play within several days, probably by July 5th. It was also announced that a supply of tennis balls would be made available at cost to all members. Arrangements for the annual tournaments were placed in the hands of the executive Committee.

The two clay courts at the beach were built several seasons ago in order to reduce traffic on the Mess court. These were constructed at considerable expense for the summer of 1938, but the storms of the following winter so damaged them that complete reconstruction was necessary. A second raid on the treasury placed the club deeply in the red. It is hoped, therefore, that the present schedule of dues will provide the necessary revenue without hardship to the many local enthusiasts.

Membership rates adopted for the season were:

Regular membership	$6.00
Membership for students only	
Early summer courses	2.50
Late summer courses	3.50
Limited membership—Colas courts only	
Full season	3.50
Half season	2.00

Guests—50c per hour. Tickets obtainable from A. J. Stunkard (groundskeeper) or F. M. Summers (Br. 331). —*F. M. Summers*

CHORAL CLUB

The first meeting of the Woods Hole Choral Club was held on Tuesday in the Coast Guard Canteen. Thirty-one members of the scientific community interested in singing attended the rehearsal. Because of the holiday, it was decided not to hold a rehearsal on the fourth of July, but beginning next week meetings will be held regularly on Tuesdays immediately after the seminar and on Thursdays at eight o'clock. Interested persons may still join the Club; no previous training or experience is necessary.

EMBRYOLOGY CLASS NOTES

(Apology to S. Pepys.) June 26, 1940. This day did our honorable professor, Dr. Costello, expound some of the theories concerning the problem of cell lineage in preparation for some of our lab work during the week. The nimble nereis was the animal under observation and did as well as one can expect a nereis to do under the circumstances. This night we are to attend the observation of the breeding habits of the wily beasts down on the floating dock.

June 27, 1940. Arose this morning with a feeling of despondency and a sensation of cold feet. Despondency was caused by the fact that after preparing ourselves for the philosophical aspect of the nereis swarming, breeding and dying we didn't see any nereis. Cold feet were produced

by the futile and prolonged hope that the nonchalent nereis would leave the murky depths for a view of the bright lights, but we were left with our hopes and with our cold feet.

This day we had the pleasure of hearing Dr. Twitty tell us about experimentation in transplantation work in embryos. The regular laboratory work continued with work on the nereis. More brethren in the class are being misled into believing that tonight the notorious nereis will be less exclusive and give them a view of their private life.

June 28, 1940. After another night of cold feet and not much luck the wily nereis were acknowledged to be just a fable and a myth by all except a few false prophets. After high hopes and electric lights had been set up for them the nasty nereis declined our invitation and stayed secluded wherever it is that nereis stay secluded. The greatest difficulty that we experienced was keeping the dock on an even keel so that the nereis fishermen wouldn't be submerged.

Dr. Costello did speak again this morning on the subject of experimentation in fertilization and localization in neresis eggs. The laboratory work consisted of observation of the cell lineage in crepidula.

This night Dr. Duryee explained his special side-show, the structure of the egg nucleus and also explained the definition of an optomist. (Ed. Note.—Optomist . . . One who goes into a bar optomistically and comes out misty optically.)

June 29, 1940. Today Dr. Ballard introduced us to the colorful private life of the tunicate styela. Their development was studied as long as the individual members could hold out against desires to go swimming and to see Donald Budge.

July 1, 1940. Hydrozoa were attacked with vigor this morning after a day of rest and piety. The laboratory was deserted this evening, however, as the culture-loving embryologists find the lure of the classics more impelling than the lure of the medusae of hydrozoa.

July 2, 1940. The squid and Dr. Hamburger (or should one say Dr. Hamburger and the squid) were the outstanding features of the laboratory this day. The pleasant weather even made it imperative for some of the members to go in swimming.

TO WHOM IT MAY CONCERN: The Embryology Demons hereby challenge any other eligible groups to a softball game, the winners to receive one keg of beer from the losers (you bring the beer). Anyone knowing of a spare third-baseman or wishing to schedule a game communicate with the "General" in the lab. —*Margie Jolly*

PROTOZOOLOGY CLASS NOTES

The second week of the protozoology course is well under way with the ardent students still glued to the 'scope chasing Condylostoma, Uroleptus, Coleps and the graceful Dileptus hither and yon around the slippery slide. Among the forms found this week was the hovering Holotrich, Chlamydon, unmistakable for its clear black "railroad track" structure, the circuit of which runs just inside the periphery. Great joy was exhibited by this discovery as it followed without difficulty the path of the devious key as well as, for once, resembling closely Kahl's exquisite illustration. Animals that are always welcome from the artist's point of view are those that at least stop swimming around madly at least a second or two before complete extinction or those that are normally in a comparatively sessile state. Some of these made their appearance this week and among them were the Zooanthamnium colony, Stentor and Vorticella of the same family, also the calm but murderous Suctonains. Even the ever present "never say die" old standbys Paramoecium and Amoeba lent themselves to the artist's eye.

Around the lecture table, they have gathered each morning to hear Dr. Calkins tell about the various types of habitats in which the Protozoans live and what kinds are found where. Perhaps the most interesting of those which he mentioned was the well known Noctaluca which lights the warmer seas on summer nights. They are so abundant in some places that one can bring them into the lab at night and write ones name on the surface of the water and watch its phosphorescent glow for some time afterwards. He also told of his work on those forms which play havoc with drinking water causing bad tastes and smells on wash day and never fail to bring the "dead fish in the main" complaint.

The basis for classification of the ciliates and flagellates with discussion of the so-called "gross structure" of the cilia, cirri, undulating membranes, membranelles, flagalla and other parts has convinced the class that there is more to the little animals than meets the eye.

Much of the time this week has been spent working on the isolation cultures of Glaucoma which has been thriving on the hay tea and multiplying profusely in a twenty four hour interval. The art of counting these minute creatures is one which has caused many a silent, patient and nerve racking moment, when it was found that the solitary parent could produce at least one hundred offspring in the brief period. Further complica-

tions arose by the considerable increase in the number while the frantic investigator counted.

On a solitary field trip, one member of the class reported a tussle with "no trespassing signs," his conscience, and a landowner in his efforts to enrich the cultures in the lab. These efforts were well repaid by an excellent hunting ground from no other than Fay's ditch, which has been this week's password.

This same enterprising person also made himself popular at the mess one night by ordering a hard boiled egg. Perhaps it is just as well that the long suffering waiter did not know that only one millimeter of this was to feed a gluttonous Glaucoma.

Our friends the Embryologists have remarked in their notes of the previous weeks that they are first to answer the call for food and the last to leave the eating establishment. Where as apparently the Protozoologists, in contrast, can hardly tear themselves from their investigations to keep sufficiently sustained to carry on their work as early in the morning or late at night there are always busy occupants to be seen in the lab.

The day of rest broke the monotonous train of rain and cold and with the spirit of the whole thing in mind, the protozoologists varied their methods of rest with such occupations as sunbathing, swimming, boating and soft ball, returning to the lab metamorphosed into lobsters. They found themselves ready to enumerate the glorious Glaucoma and outshine their efforts of the previous week while" time marches on."

—Doris Marchand

BOTANY CLASS NOTES

This report is being written exclusively for the consumption of embryologists, physiologists and zoologists, and others, who have the habit of making scathing remarks about the work of the marine algologist. It is to be hoped that, hereafter, they will be treated with greater respect!

The marine algae course is a combination of the taxonomic and morphologic method of study; that is, the vegetative and reproductive structures of various types of algae—greens, reds, and browns—are studied; and species gathered on collecting trips are identified. We have, up to date, covered a great many of the Chlorophyceae (green algae), and are looking forward to reds and browns.

We also have our traditions—evening tea, about ten when we work late—Ritz crackers—peanut butter for Dr. Runk. We were told that Dr. Taylor goes swimming only every fourth year and, since he went last year, he is immune for another three. We were introduced to Ferric Chloride (3% solution) and ticks. So you see we, too, are on the inside looking out!

Field trip days are the ones we live for. They involve getting out of bed at an unearthly hour (quarter of eight), substituting for the next to best meals of the week, jam, ham and egg sandwiches, with an orange thrown in, and getting a nifty sunburn. This field tripping has its compensation, however. Boat rides and a chance to see algae in the raw are appreciated, as is the chance to see the great wide out-of-doors before the sun is completely set.

We have been on two field trips: the first to Cedar Swamp and points north. Cedar Swamp is really a lovely place, especially when it is up around your waist, and with all your cigarettes in your hip pocket! Why algae can't be considerate and grow on the edges of nice shallow pools is more than we could really understand; but then, we are always game for a swim, especially in nice muddy water where the next step may take you way below the level of the water! That was Cedar Swamp—only a half a day and no boat, but quantities and quantities of algae and protozoa and worms of all sorts. The afternoon of the day was spent in identifying algae and admiring protozoa.

The Cuttyhunk field trip occurred after a delay long enough to give the sandwiches a good ripe flavor. Cuttyhunk Island consists of many hills and fresh water ponds, and a social center of about eight or ten houses. The fresh water ponds were quite productive and mercifully shallow, but nothing really noteworthy happened—no one fell in; and no one got bitten by a snapping turtle; and no one missed the boat; and no one got poison ivy; and no one discovered a rare species of anything! From Cuttyhunk Island, we made a short trip to Nashawena Island—another fresh water pond surrounded by sand dunes, but with no social center—where we took care of the situation in short order! The evening was spent in identifying algae and admiring protozoa!

The time in between field trips is spent, obviously, in the laboratory when the morphological part of the marine algae course is worked out. As any discussion of this aspect of the course would probably be too specialized for the consumption of the protozoologists and embryologists and others for whose benefit this report is being written, it will be omitted from this article!

But tomorrow is a new day. Another field trip will have come and gone, and we will have seen the morning sun again. The evening will have been spent identifying algae and admiring protozoa!

—Jane Sanders

The A. B. C. of Woods Hole for 1940

All Schedules Set to Daylight Saving Time — Bold Type Indicates P. M.

POST OFFICE

	Week Days	Sundays
Mail Arrives	7:00, 10:45, 3:30, 7:00	10:45
Mail Ready	8:00, 11:45, 4:00, 7:30	11:45
Mails Close	6:00, 10:00, 5:00	5:30

All mails should be deposited at least ten minutes before closing time to insure dispatch.

BUS SCHEDULE

Falmouth — Woods Hole

	Daily	Daily
Falmouth (Leave)	10:26	3:31
Woods Hole (Due)	10:35	3:40

	Daily	Daily	Daily
Woods Hole (Leave)	10:50	4:00	5:35
Falmouth (Due)	10:58	4:08	5:43

RELIGIOUS SERVICES

Church of the Messiah (Episcopal)
Sundays: 8:00 Holy Communion; 11:00 Morning Prayer (Choral Eucharist, first Sunday in the month).
Holy Days: 8:00 Holy Communion.

Methodist Episcopal Church
Morning Worship, 11:00. Church School, 10:00.

First Orthodox Congregational Church
Evening Service, 7:30.

St. Joseph's Roman Catholic Church
Mass: Sundays, 6:45, 9:30, and 11:00. Weekdays, 7:00.

LIBRARY HOURS

Mon., Wed., and Sat.
3:00 to 5:00
7:00 to 9:00

Telegraph Office

Weekdays
8:00 to 9:00

Sundays
9:00 to 11:00
4:00 to 6:00

TRAIN SCHEDULE*

	Ex. Sun.	Ex. Sun.	Ex. Sun.	Sun. only	Sun. only†
Woods Hole	6:30	10:30	**5:45**	**6:00**	**7:55**
Boston	8:46	**12:50**	**7:57**	**8:10**	**9:55**

	Ex. Sun.	Sun. only	Sat. only‡	Ex. Sun.	Ex. Sun.
Boston	8:20	8:35	**12:25**	**1:10**	**5:00**
Woods Hole	10:45	10:45	**2:30**	**3:30**	**7:09**

*All trains stop at Falmouth. †Also runs Labor Day. ‡Discontinued after September 1.

BOAT SCHEDULE*

Leaves	Daily	Daily	Weekdays¶	Daily	Weekdays‡	Fri., Sat., Sun.£	Fridays¶
New Bedford	7:00	9:30	**2:00**	**2:30**	....	**7:30**	....
Woods Hole	8:30	10:50	**3:20**	**3:50**	**7:15**	**8:45**	**9:30**
Oak Bluffs	9:20	11:40	....	**4:50**	....	....	**10:15**
Vineyard Haven	....	....	**4:20**	....	**8:00**	**9:30**	....
Nantucket (due)	11:35	**2:00**	....	**7:00**	....	....	12:15

Leaves	Daily	Daily	Sundays¶	Daily	Weekdays‡	Daily	Sundays¶
Nantucket	....	7:00	**2:00**	**2:30**	....	**5:00**	....
Vineyard Haven	6:10	....	....	....	**6:00**	....	....
Oak Bluffs	....	9:15	**4:00**	**4:30**	....	**7:00**	**9:00**
Woods Hole	6:55	10:15	**5:00**	**5:30**	**6:45**	**7:45**	**9:45**
New B'df'd (due)	8:15	11:30	....	**6:45**	....	**9:00**	....

*Schedule effective to Sept. 5, incl.
¶Discontinued after August 31.
‡Does not run Labor Day.
£Daily after August 31.

THE COLLECTING NET

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THE BIOLOGICAL FIELD STATIONS OF THE BRITISH ISLES

MR. HOMER A. JACK
Science Education Department, Cornell University

Thomas Huxley was in the chair. It was March 31, 1884 in the rooms of the Royal Society in London. Among those in attendance were Joseph Hooker, John Murray, John Rae, and Francis Galton. The Duke of Argyll arose and presented a resolution which *The Times* the next day reported as follows:

"In the opinion of this meeting there is an urgent want of one or more laboratories on the British Coast . . . where accurate researches may be carried on, leading to the improvement of zoological and botanical science . . . The fact of their being called together to form a voluntary society to carry out these objects implied a discovery on the part of those who had taken a leading part in this matter that the work was not likely to be taken up by the Government. . . . In this respect the British government has always stood rather behind those of other countries, whether monarchical or republican."

Such were the first formal efforts toward the foundation of the Plymouth Laboratory of the Marine Biological (*Continued on page* 51)

M. B. L. Calendar

TUESDAY, July 16, 8:00 P. M.

Seminar: Dr. S. C. Brooks: "Ion Intake by Living Cells."

Dr. L. I. Katzin: "The Use of Radioactive Tracers in the Determination of Irreciprocal Permeability of Biological Membranes."

Dr. K. C. Fisher: "Urethane and the Respiration of Yeast Cells."

Dr. Matilda M. Brooks: "Spectrophotometric Determinations on Hemoglobin and its Derivatives."

FRIDAY, July 19, 8:00 P. M.

Lecture: Dr. K. S. Cole: "Electrical Properties of Cell Membranes."

DIGESTION STUDIES ON SALIVARY CHROMOSOMES

DR. DANIEL MAZIA
Assistant Professor of Zoology, University of Missouri

Even chromosomes as large as the salivary gland chromosomes of certain Diptera cannot easily be studied by ordinary chemical methods. We do have as a starting point the results of gross analysis of tissues rich in nuclear material and observations based on staining and optical techniques. We learn from these that chromosomes may be largely composed of two types of substance: nucleic acids and basic proteins belonging to the classes protamines or histones. We may also, by histochemical techniques, learn something about the gross localization of these materials, but nothing concerning the intimate molecular architecture of the chromosome.

The digestion method provides one means of direct attack on molecular architecture. Our modern enzyme chemistry is beginning to tell us exactly what chemical linkages are split by particular enzymes, and to demonstrate that the

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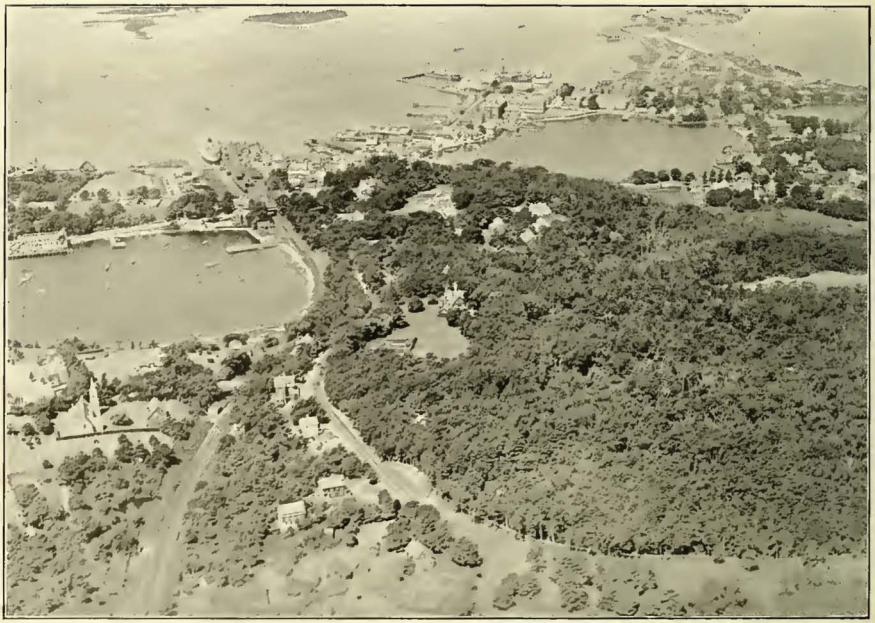
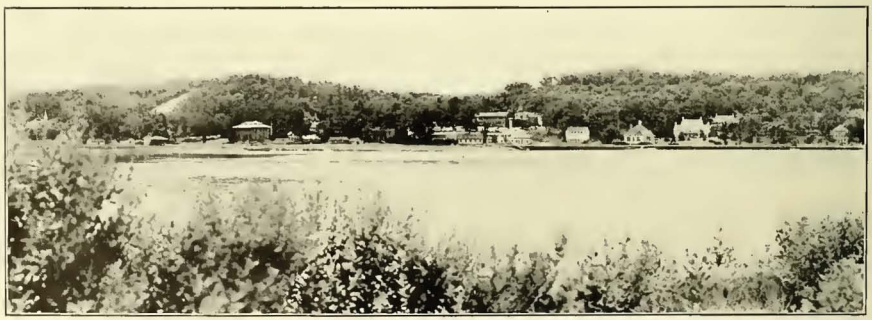


AERIAL VIEW OF WOODS HOLE

Showing in the foreground at the left, the Church of the Messiah and the Falmouth Road; in the background (from left to right) Little Harbor and the U. S. Lighthouse Service, the steamboat wharf, the drawbridge, the Bureau of Fisheries buildings, the Eel Pond, main building of the Marine Biological Laboratory, the Brick Dormitory and Penzance Point.



THE BIOLOGICAL LABORATORY AT COLD SPRING HARBOR

Showing (from left to right) the main building of the Carnegie Institution, summer laboratory buildings, Blackford Hall, dormitories, main building of The Biological Laboratory (in the background), and several summer residences.

specificity extends not only to the bonds attacked, but to the neighboring chemical configurations. By observing the ways in which specific enzymes affect structures such as chromosomes, we may expect to learn something about the chemical linkages on which the structure is based. The lines along which we have made progress are two. First, we have learned something concerning the interrelation between proteins and nucleic acids in salivary chromosomes. Second, we have discovered certain facts concerning the proteins and nucleic acids themselves.

The general form and elasticity of chromosomes has suggested to most an underlying fibrous structure. This would suggest a protein structure, but this idea has raised difficulties. The proteins found in the nucleus are so highly basic and so poor in sulphur-containing amino acids that the conditions seem unfavorable to fibre formation. On the other hand, nucleic acids extracted by certain methods have very high molecular weights and are capable of forming fibres. Some have suggested, therefore, that the continuity of chromosomes was based on nucleic acid fibres. Others, Wrinch in particular, have proposed that the highly basic polypeptide chains could be bound together by chains of nucleotides oriented transversely in the chromosome.

The possibility of a continuous nucleic acid structure was eliminated in the classic experiments of Caspersson, who found that tryptic digestion caused disintegration of the chromosomes. To test the theory that the protein fabric is tied together by a nucleic acid woof, Miss Jaeger and I reversed Caspersson's experiment and treated chromosomes with a mixture of enzymes which specifically digest nucleic acid. When, after such treatment, salivary glands were stained by Feulgen's method, the chromosomes were not visible in *Drosophila* or *Chironomus*, and only faintly visible in *Sciara*. If, now, a technique for demonstrating protein, the ninhydrin reaction, is used, it may easily be demonstrated that the chromosomes are still present in the same size and form as in the controls. Thus nucleic acid can be removed without destroying the basic structure of the chromosomes.

By investigating more closely the details of this digestion, we may learn something about the linkage between the protein and nucleic acid. Instead of using a mixture of nucleases, we may use preparations which can split only nucleotides and preparations in which the nucleotidase—identical with alkaline phosphatase—is inhibited by addition of excess phosphate. The results are clear cut; the results obtained with mixed nucleases may be obtained with phosphatase alone, indicating that the nucleic acid is linked to protein through phosphoric acid.

If this simple picture is true, then, when phosphatase acts, the purine and pyrimidine bases as well as the Feulgen-staining desoxyribose should be removed. The presence of these may be studied by ultraviolet photomicrography, since the pyrimidine bases show a very high specific absorption of ultraviolet around wavelength 2600A. Phosphatase treated glands and controls (boiled phosphatase treated) were photographed by Mr. Hayashi at visible wavelength 4358A and ultraviolet wavelength 2650A. In the controls the very strong selective absorption of 2650A is very striking. In phosphatase-treated glands, though the chromosomes are faintly visible, there is no evidence of selective absorption by chromosomes. We are dealing in these experiments, therefore, not with some effect on the Feulgen reaction, but with the actual removal from the chromosome of the main components of nucleic acid. Thus it is evident that the continuity of the chromosomes does not depend on nucleic acid.

This would imply a difficult situation chemically, since, the protamines and histones would not seem to be very suitable for fibre formation. This difficulty, however, does not exist in fact. Using methods adapted from Langmuir, we have attempted to prepare monomolecular films and, from these, fibres of protamine and histone. With protamine we had no success, but with histone it is very easy to form fibres which are quite elastic and which, in their behavior toward enzymes (which cannot be discussed here), are analogous to salivary gland preparations. There is, therefore, no real difficulty in the concept of a continuous fibre structure composed of histone. Evidence that this may exist in the chromosome is appearing in other digestion experiments.

(This article is based upon a seminar report presented at the Marine Biological Laboratory on July 9.)

The Collecting Net was entered as second-class matter July 11, 1935, at the Post Office at Woods Hole, Mass., under the Act of March 3, 1879, and was re-entered on July 23, 1938. It is devoted to the scientific work at marine biological laboratories. It is published weekly for ten weeks between July 1 and September 15 from Woods Hole, and is printed at The Darwin Press, New Bedford, Mass. Its editorial offices are situated in Woods Hole, Mass. Single copies, 30e; subscription, $2.00.

SOME PROPERTIES OF THE RESIDUE FROM RAPIDLY DISINTEGRATED ARBACIA EGG CYTOPLASM

Dr. M. J. Kopac
Visiting Assistant Professor of Biology, New York University

Interfacial reactions between oils and protoplasm in order to be interpreted must be compared with results obtained from interfaces between oils and proteins or protein complexes. Danielli and Harvey measured the tensions of *mackerel egg oil-egg content* interfaces and compared these values with those obtained by Harvey and Shapiro on *mackerel egg oil-protoplasm* interfaces. In this way, the marked surface activity of protoplasm was attributed to the globulin fraction of the cytoplasm.

In our studies, it was necessary to re-investigate *oil-protoplasm* interfacial tensions as measured by other methods. We found that certain oils when brought in contact with the cytoplasm of intact Arbacia eggs gave very low tensions while others gave considerably higher values. To determine whether the oil phase was responsible for these anomolies, it was decided to measure the tensions of the same oils against an aqueous extract of Arbacia eggs.

Previously, it was found that Arbacia eggs when treated with urea and immediately immersed in 0.53M KCl-solutions showed the highest coalescency with oil drops, thereby indicating the absence of extraneous coats. Urea removes the vitelline membrane (Moser) and KCl prevents the accumulation of a hyaline layer, the secretion of the latter being induced by urea-treatment. Under these conditions, the eggs are bounded only by the delicate, protoplasmic surface layer.

It was also observed that immediately on entry of an oil drop by coalescence, a peripheral disintegration of the egg follows, yielding a mass of disintegrating protoplasm unbounded by any surface. Furthermore, it was noticed that any other slight injury to the cellular surface also results in complete disintegration of the egg. Slight mechanical agitation completely disperses the cytoplasmic components into the KCl-solution. There is no coagulation in KCl.

The following method of obtaining residue from disintegrated eggs is based on the above investigations: (1) Wash eggs in at least 3 changes of 0.52M NaCl-solution to remove jelly. (2) Transfer to 1M urea-solution. (3) Within 3 to 4 minutes wash eggs free of urea with 0.53M KCl-solution. (4) Transfer to measured volume of fresh KCl-solution. (5) Flush eggs repeatedly (1 to 2 minutes) in KCl through a fine bore pipet. The latter step completely disintegrates more than 99 percent of the eggs. (6) Centrifuge the resulting suspension gently to remove undisintegrated eggs and foreign particulate debris. (7) Decant, and recentrifuge suspension at high speeds to separate granules and other formed elements which escape from the eggs. (8) Separate granular from non-granular fractions by pipet transfer.

The non-granular fraction is of interest since it must contain most of the residue of the cytoplasmic matrix. Such extracts are usually colorless, but in some cases a brownish or pinkish tint may be seen. The fluid gives a beautiful Tyndall effect, and appears opalescent under ordinary illumination. Elastic properties can be demonstrated, resembling in this respect the dilute solutions of purified myosin in 0.3M salt solutions.

With the above procedure, it was possible to measure the interfacial tension between oil and non-granular fluid extract within 8 to 10 minutes after the eggs were disintegrated. Prior to disintegration, these eggs were viable and capable of development on insemination. The time factor could be decreased by employing higher centrifugal accelerations for a more rapid separation of granular from non-granular components.

For the following measurements, a volume of 0.4 cc. of unfertilized eggs was added to 4.5 cc. of 0.53M KCl. Only the granule-free fraction was used.

The surface activities of this residue were determined by comparing the tensions of *oil-water [0.53M KCl]* interfaces with those of *oil-water [0.53M KCl + egg residue]* interfaces. It was found that these tensions were reduced more at oleic acid surfaces (0.6 dyne/cm.) than at cottonseed oil interfaces (5.7 dynes/cm.), being in agreement with tensions previously measured with similar oils against the intact cytoplasm. The tensions of the interfaces in absence of egg residue were 7.5 and 12 dynes/cm., for oleic acid and cottonseed oil, respectively. The recently developed flow-pressure method was employed in measuring all tensions.

According to Langmuir, the tension lowering should be proportional to the amount of surface active molecules adsorbed at the interface. We were able to determine the approximate degree of interfacial adsorption by employing the drop-retraction method.

The sudden emergence of an oil drop expelled from the micropipet by a given flow-pressure brings the surface of the oil into immediate contact with the aqueous phase. The area of this sphere of diameter, d_o, represents the initial ad-

sorbing surface. The fraction of this surface which is coated by spread-out protein molecules is determined by slowly retracting the drop until its surface begins to wrinkle. If proteins are absent in the aqueous phase, the drop may be entirely retracted with no wrinkling. The diameter of the retracted drop is measured at the wrinkling point, this being the critical diameter, d_c. Since the adsorbed molecules are unable to escape into one or other of the two phases, the total number of molecules remains constant at the interface, and the reduction in interfacial area produces an increase in concentration. When the critical concentration is reached, the Devaux effect appears, and the tension becomes zero. On the basis of Devaux', and Langmuir and Waugh's work, this wrinkling indicates that the oil surface is completely covered by at least a monolayer of protein molecules.

The adsorption ratio, δ, is the fraction of the total adsorbing surface which is covered with protein molecules, and its value is approximately equal to d_c^2/d_o^2.

Cottonseed oil when brought in contact with the egg residue shows an adsorption ratio, δ, of 0.1 within 30 seconds and this increases to 0.2 in 10 minutes. Oleic acid under similar conditions shows a δ of 0.9+ within 10 seconds and this increases to 1 in less than 2 minutes. If oleic acid is kept in contact with egg residue, the drop will wrinkle spontaneously within 2 minutes indicating that its surface is completely coated by at least one monolayer of protein molecules.

There is a significant difference between the amounts of protein adsorbed on cottonseed oil and oleic acid, thereby explaining, qualitatively, the marked difference between the tension-lowering activity of egg residue on these oils. Accordingly, oleic acid, which shows the greatest adsorption tendencies, also has the lowest interfacial tension against the aqueous egg residue.

These results demonstrate the feasibility of studying *oil-water* interfaces not only in individual cellular systems but also on material extracted from cells within a few minutes after death. The correspondence between interfacial tensions as measured on living systems and the extracted cellular material is very close. The latter material must contain not only proteins but also protein complexes, particularly those involving lecithin.

The more important result is that each oil appears to present to proteins a characteristic surface for adsorption. Thus certain oils may favor greater adsorption, and also promote a more complete globular → planar transformation than others. We believe that a wide survey of various oil phases of known characteristics and containing known substances in solution, for example, lecithins, hydrocarbons, polycyclic hydrocarbons, et cetera, will indicate the precise effect of molecular configuration of oils on adsorption and subsequent spreading of protein molecules. Likewise, the field is opened for investigating the effect of other substances dispersed in the aqueous phase on the adsorbability of proteins on oil surfaces, as for example, lecithin + protein complexes.

(This article is based upon a seminar report presented at the Marine Biological Laboratory on July 9.)

INTERRELATIONS BETWEEN EGG-NUCLEUS, SPERM-NUCLEUS AND CYTOPLASM

MR. EDWARD L. CHAMBERS

Eli Lilly Research Laboratories

What I am about to describe is really a three-ring circus. Too bad the performers, the egg-nucleus, the sperm-nucleus and the cytoplasm cannot be brought before you to perform. However, I shall do my best to describe their antics, and why they behave as they do.

In the development of eggs fertilized before budding off of the second polar body three series of phenomena are observed.

First of all, the entrance of the spermotozoon into the egg before the formation of the first polar body causes the polar bodies to be budded off earlier than in the unfertilized egg.

The entrance of the spermatozoon into the egg after the formation of the first polar body has no accelerating action.

TABLE I.

Time after removal of eggs from ovaries to sea water when inseminated.	Time after removal to sea water when first polar body formed	Time after removal to sea water when second polar body formed
20′	66′	96′
40′	69′	99′
60′	72.5′	102.5′
70′	74.5′	104.5′
90′	74.5′	104.5′
unfertilized	74.5′	104.5′

The second phenomenon is that the sperm-aster never appears before two or three minutes after the second polar body has budded off irrespective of when the sperm had entered the egg prior to the appearance of the polar bodies. Thus when eggs are inseminated 20 minutes after their removal to sea water, 77 minutes are required for the appearance of the sperm-aster. However, when the eggs are inseminated at the time of second polar body formation 30 minutes elapse before the appearance of the aster.

The third phenomenon is that the egg goes through three distinct stages of maturation after the breakdown of the germinal vesicle. To compare cleavage times of eggs inseminated at various intervals it is necessary to correct for the varying times of polar body formation. When such a correction has been made, we find that the first stage in maturation extends from 20 minutes to 60 minutes after removal of the eggs from the ovaries to sea water. During this period the sperm-nucleus lies entirely quiescent in the egg-cytoplasm. The second stage is from 60 minutes to 70 minutes. This is a period of transition, during which the sperm-nucleus develops very slowly. The final stage in maturation extends from 70 minutes (shortly before time of first polar body formation) to any later time. Over this range the sperm-nucleus develops at maximal rate. Since the rate of development of the sperm-nucleus is directly proportional to the time of cleavage, the following table demonstrates what has been just described.

Table II.

Time after removal from ovaries to sea water when inseminated	Time after removal to sea water when cleavage occurs
20′	168.5′
40′	168.5′
60′	169.0′
70′	172.5′
80′	182.5′
90′	192.5′
110′	212.5′

What factors determine when the sperm-aster forms? Does the egg-nucleus control the development of the sperm-nucleus? Is the cytoplasm the controlling force, or do both play a rôle?

These questions were answered by cutting eggs in half immediately and at varying intervals after the dissolution of the germinal-vesicle. Both halves were inseminated at the same moment. The asters appeared nearly but not quite simultaneously in both. In the non-nucleated half the aster formed at the same instant as the second polar body was pinched off in the nucleated half, whereas in the nucleated half the sperm-aster appeared three to four minutes after the formation of the second polar body. The fact that the sperm nucleus must wait for such a long time shows that the state of the egg-cytoplasm has a major rôle in controlling the growth of the sperm-aster. Fifty minutes must elapse after the breakdown of the germinal vesicle before the fluid contents of the germinal vesicle have completed their action.

The egg-nucleus also plays a part in controlling the growth of the aster, since the appearance of the sperm-aster is slightly but always delayed in the nucleated half. A confirmation of the inhibitory action of the egg-nucleus while active in producing polar bodies on the sperm-aster was made by compressing eggs before the formation of the polar bodies. This prevented the formation of the polar bodies. As a result the appearance of the aster was very much delayed.

Finally, is the question whether the acceleration in formation of the polar bodies in the presence of the sperm-nucleus is due to the action of the sperm-nucleus on the egg nucleus or on the cytoplasm. This action of the sperm-nucleus is attributable to its effect on the cytoplasm, since the development of the non-nucleated fragments is even ahead of the nucleated fragments. Further, the time when the spermatozoon is first no longer able to exert an accelerating action on the egg corresponds precisely with the time when the maturation of the cytoplasm is completed (70 minutes after removal of the eggs to sea water, shortly before the pinching off of the first polar body). We have, therefore, a remarkable series of events. The spermatozoon enters the egg and hastens the maturation of the cytoplasm. The cytoplasm reaches complete maturation shortly before the formation of the first polar body. The matured cytoplasm simultaneously allows both egg-nucleus and cytoplasm to start development—on the one hand the polar bodies are pinched off, on the other hand the sperm-aster develops. Finally, the egg-nucleus while it is active exerts a delaying action on the sperm-nucleus, thereby insuring against the confusion of two different streaming phenomena.

(This article is based upon a seminar report presented at the Marine Biological Laboratory on July 9.)

THE BIOLOGICAL FIELD STATIONS OF THE BRITISH ISLES

(Continued from page 45)

Association of the United Kingdom. Actually this laboratory was not opened until June 30, 1888 or eleven days before the first session of the Marine Biological Laboratory at Woods Hole. In the meantime, Professor William Herdman and the Liverpool Biological Committee established a biological station at Puffin Island (which later was moved to Port Erin) and John Murray sponsored a floating laboratory ("The Ark") in Scottish waters which lead to the establishment of the Marine Biological Station of the Scottish Marine Biological Association at Millport. In recent years field stations have been established at Loughe Ine, in Eire, and at Ambleside, in the English lake district. These are the most important field stations in the British Isles, although others are situated at Cullercoats in Northumberland (Dove Marine Laboratory), at Blakeney Point in Norfolk (Blakeney Point Research Station), and on the River Itchen at Southampton (Branch of Southern Rivers of the Laboratory of the Freshwater Biological Association of the British Empire).

The Plymouth Laboratory of the Marine Biological Association of the United Kingdom is located within the city of Plymouth on Citadel Hill, overlooking Plymouth Sound. With the aid of the laboratory's 88-foot steam drifter, *Salpa*, and the 25-foot motorboat, *Gammarus*, the Devon and Cornwall coasts are quite accessible from the laboratory. These coasts with their varied geological nature support an extensive marine fauna which is exposed by the considerable rise and fall of the tide. A shore fauna on sandy, muddy, and rocky bottoms is available in both sheltered and exposed places. A good summary of the habitats and species available for study near the Plymouth Laboratory may be found in the second edition of *Plymouth Marine Fauna*, published by the Marine Biological Association of the United Kingdom in 1931.

The Plymouth Laboratory is principally housed in three buildings. The main building contains a public aquarium (which 32,000 persons visited in 1937) and caretaker's quarters on the first floor, administrative offices and investigators' rooms with experimental tanks on the second floor, and reference collections and additional investigators' rooms on the newly-constructed (1939) second floor. The three-story Allen Building is devoted exclusively to the library of the association, consisting of some twenty thousand volumes. The North Building contains a biological supply department, dark rooms, research laboratories for investigators, and laboratories for chemistry, physiology, and fisheries. All laboratories are supplied with 210-volt A.C. and 100-volt D.C. electricity, compressed air, gas, and running fresh- and sea-water. The laboratory does not have dining rooms or dormitories, but students and investigators may obtain board and lodging at nearby hotels or boarding houses for two guineas a week (about $9.83).

With an annual budget of about sixteen thousand pounds (about $74,800), the Plymouth Laboratory is able to serve several aims. Its resident staff of thirteen investigators, headed by Dr. Stanley Kemp, gives special attention to fishery problems, life history studies, the physiology of marine organisms, and the hydrographic conditions in the adjacent waters of the English Channel. Results of research work carried on at the Plymouth Laboratory are usually published in the *Journal of the Marine Biological Association of the United Kingdom*. The facilities of the laboratory are open to a maximum of thirty visiting investigators throughout the year. While normally investigator's fees are five guineas a month (about $24.57), in practice the Marine Biological Association usually welcomes as guests research workers from foreign universities and the British Dominions. Course-work in marine biology is also given at Plymouth. This is given for two-week periods at the Easter recess of the universities or in autumn by resident members of the laboratory staff or by outside professors.

The second important English marine station is the Marine Biological Station at Port Erin. Located on the Isle of Man in the Irish Sea four hours by boat and one additional hour by bus from Liverpool, this station is now under the control of the Department of Oceanography of the University of Liverpool. The buildings of the station contain a public aquarium and museum, classrooms, staff offices and laboratories, library, research cubicles, and laboratories for chemistry and fisheries. There are laboratory accommodations for ninety students, although the station staff does not conduct any instruction. Courses are given by professors in public schools and universities who come to Port Erin with their classes for two-week sessions during the Easter recess. The station charges ten shillings (about $2.34) for tuition and students live at nearby boarding houses for two guineas for the fortnight. Nine cubicles are also available to qualified investigators who are expected to pay a laboratory fee of two pounds a month (about $9.36). Results of research work carried on at Port Erin have often been published in the *Memoirs on Typical British*

Marine Plants and Animals of the Liverpool Marine Biological Committee, of which the thirty-first volume was published in 1937.

The Marine Biological Station of the Scottish Marine Biological Association is located at Millport on the Firth of Clyde, two hours by train and boat southwest of Glasgow. The organization and work of this institution are similar to those of the Plymouth Laboratory, although the Millport Laboratory lays greater stress on instruction. Three types of courses are offered: 1—a two-week course for senior university students during the Easter recess, conducted by Richard Elmhirst, director of the station; 2—an eight-day course for teachers during the autumn and also conducted by Mr. Elmhirst; and 3—a junior course during Easter recess conducted by outside biologists. The station has accommodations for forty-six students and charges one guinea a week (about $4.91) for tuition. Board and lodging may be obtained at nearby lodging houses for a minimum of £1 15s. a week (about $8.19). In addition to laboratories for a resident staff of four biologists, eighteen research places are available to competent investigators who are expected to pay a laboratory fee of £1 1s. 6d. a week (about $5.03). The *Annual Report of the Scottish Marine Biological Association* contains a summary of the research work conducted at this institution.

On Lake Windermere in the English lake country is located the Laboratory of the Freshwater Biological Association of the British Empire. Organized only eleven years ago, the laboratory now has a permanent staff of seven biologists and an annual income of £4,084 (about $19,113) with which "to promote the investigation of the biology (in the widest interpretation of the word) of the animals and plants found in fresh (and brackish) waters, with special emphasis on explaining the factors which control the productivity of life in fresh waters." Situated in a large stone castle, several miles from the town of Ambleside, this station contains well-equipped laboratories, a good hydrobiological library, and living quarters for staff and investigators. There are laboratory and living accommodations for about twelve investigators who are expected to pay four pounds a month (about $18.72) for the use of the laboratory facilities and £9 10s. a month (about $44.46) for board and lodging. A two-week course in the principles of freshwater biology is given by members of the station staff during the Easter recess. A summary of the scientific and educational work of the laboratory is published in the *Annual Report of the Freshwater Biological Association of the British Empire.*

The Cork University Biological Station is located on Loughe Ine, Skibbereen, about sixty miles from Cork. This lough communicates with the sea by a very narrow-stepped channel which makes the average ebb period at the station nine and one-half hours. The purpose of this institution is "to work out the ecology of the immediate neighborhood and to provide research facilities to visiting biologists." The institution consists of three simple buildings which can accommodate about fifty workers with benchroom and ordinary equipment. Rowboats are available and larger vessels for dredging can be hired at the nearby town of Baltimore. Courses in marine biology and in ecology are given at the station, tuition being ten shillings a week (about $2.34). Students and investigators ordinary live in nearby farmhouses, paying about eight guineas a month (about $37.44). From its foundation in 1925, this station has been under the able direction of Professor Louis P. W. Renouf who has written an excellent account of the preliminary work and ecological location of the laboratory in the *Journal of Ecology* (19:410-38).

* * * * *

American biologists are often eager to know whether the Plymouth Laboratory is "the Woods Hole" of the British Isles or of all Europe. This is not an easy question to answer, for Woods Hole means different things to persons with different educational philosophies and scientific interests. The laboratory at Plymouth is certainly the nearest British approach to the Marine Biological Laboratory, having a relatively large budget and an international clientele. Some biologists believe that the Plymouth Laboratory is superior to the Marine Biological Laboratory at Woods Hole in having resident investigators with a coordinated research program, thus making use of the laboratory facilities throughout the year. The greatest drawbacks of the Plymouth Laboratory, however, are just what make the Woods Hole institutions what they are. The English laboratory is not only located within the large city of Plymouth (population: 210,000), but—like all of the older English field stations—it does not have its own dining and dormitory accommodations. Students and investigators at the Plymouth Laboratory must reside in boarding houses which, though only five or ten minutes walking distance from the laboratory, are in thickly populated sections of the city. The students, investigators, and staff work together at Plymouth as at Woods Hole. There are, however, less opportunities for those attached to the Plymouth Laboratory to live and play and think together—which, in the minds of a number of American biologists, has become a very important function of Woods Hole.

M. B. L. TENNIS CLUB

About seventy persons have joined the M.B.L. Tennis Club so far this summer, according to Mr. A. J. Stunkard, groundskeeper for the Club.

Work on the Clay Court adjacent to the M.B.L. Mess Hall was completed and the court was ready for use on Tuesday. The clay courts at the beach were ready on Sunday, July 7. The Colas courts had been ready for some time previously.

Exhibits have been displayed by the General Biological Supply House and the Macmillan Company in the lobby of the Marine Biological Laboratory during the past week.

The first staff meeting of the Woods Hole Oceanographic Institution was held on Thursday at eight o'clock in the lounge of the Institution. Dr. S. A. Waksman spoke on "Aquatic Bacteria in Relation to Organic Matter Transformation."

DR. ALFRED H. STOCKARD, assistant professor of zoology at the University of Michigan, has been appointed director of the Michigan Biological Station, succeeding Professor George R. LaRue, chairman of the Department of Zoology.

REPRESENTATION BY INSTITUTIONS AT THE M. B. L.

The following institutions are represented by three or more investigators registered at the Marine Biological Laboratory this summer.

Pennsylvania	34
Columbia	20
New York University	16
Hopkins	8
Yale	8
Harvard	7
Ohio State	7
Pittsburgh	7
Rockefeller Institute	7
Cornell	6
Brown	5
California	5
Cincinnati	5
Stanford	5
Toronto	5
Washington (St. Louis)	5
Lilly Laboratories	4
Missouri	4
Northwestern	4
Princeton	4
Syracuse	4
Union	4
Amherst	3
Brooklyn	3
C. C. N. Y.	3
Dartmouth	3
McGill	3
Michigan	3
Queens	3
Virginia	3
Wesleyan	3
Wisconsin	3
Women's Medical College of Pennsylvania	3

ADDITIONAL INVESTIGATORS

Marine Biological Laboratory

Bowser, E. R., Jr. Pittsburgh. Rock 7.
Bush, J. J. Amarillo H. S. (Texas). OM Base.
Dressler, Elsie L. grad. genetics. Pittsburgh. Rock 7.
Evans, Gertrude instr. biol. Beliot. Br 332.
Glancy, Ethel tutor biol. Queen's (N. Y.). OM Base.
Griffiths, R. B. instr. biol. Ariz. Br 127. Dr 10.
Höber, Josephine res. asst. phys. Pennsylvania. Br 313. D 212.
Jones, W. D. grad. phys. Pennsylvania. Br 205.
Leonard, E. J. res. asst. zool. OM Base.
Papandrea, D. A. Albany Med. Br 122. Dr 8.
Perrot, M. visiting fel. zool. Princeton. Br 127. Dr 10.
Rous, P. mem. Rockefeller Inst. Br 207.
Schotté, Oscar E. assoc. prof. biol. Amherst. Br 330.
Shelden, F. F. instr. phys. Ohio State. Br 111. Dr 5.
Thompson, R. H. teach. asst. biol. Stanford. Bot 25. Ka 3.
Whiting, Anna R. guest invest. Pennsylvania. Rock 2.
Workman, Grace res. asst. biol. Toronto.OM 4. W D.
Yancey, Maude J. grad. asst. zool. North Carolina College. emb.

Woods Hole Oceanographic Institution

Barnes, C. assoc. physical oceano. U.S.C.G. 302.
Dobson, J. asst. biol. Queens (Ontario). 314.
Ketchum, B. H. bacteriologist. 203. (August).
Montgomery, R. B. jr. oceano. 208.
Pace, N. visiting invest. California. 103.
Phleger, F. B. asst. prof. geol. Amherst. 212.
Scott, W. J. lab. asst. Swarthmore. 201.
Schallek, W. B. visiting invest. Harvard. 306.
Sykes, R. asst. Brown. 209.
von Brand, T. asst. prof. biol. Catholic University. 105.
Whitcley, G., Jr. teach. biol. Hill School (Pottstown, Pa.). 111.
Zabor, J. W. instr. chem. Williams. 109.

DR. AND MRS. CHARLES PACKARD will be at home to members of the Marine Biological Laboratory on Sunday afternoons, July 14 and 21, from 4:30 to 6:00 o'clock.

DR. PAUL A. REZNIKOFF, assistant professor of medicine at the Cornell University Medical College, had a cottage built in the Gansett tract during the past winter.

MR. EDWARD CHAMBERS has been accepted for pilot training in the Hyannis Airport Corps under the auspices of Hyannis State Teachers' College and Civil Aeronautics Authority.

The Woods Hole Oceanographic Institution ketch *Atlantis* sailed Tuesday, July 9, for a ten-day trip to a point about two hundred miles south of Woods Hole. On board were Dr. Edmund Watson of Queens College and Professor Maurice Ewing of Lehigh University. Dr. Watson will make current meter observations in deep water, and Professor Ewing has seismic equipment to determine the sediments of the ocean bottom.

The Collecting Net

A weekly publication devoted to the scientific work at marine biological laboratories.

Edited by Ware Cattell and Robert Chambers with the assistance of Boris I. Gorokhoff and Peggy Browning; Contributing Editor, Homer A. Jack.

Entered as second-class matter, July 11, 1935, at the U. S. Post office at Woods Hole, Massachusetts, under the Act of March 3, 1879, and re-entered, July 23, 1938.

Introducing

DR. CHESTER ITTNER BLISS, Guest Investigator of the United States Fish and Wildlife Service; Consulting Biometrician for various institutions.

This is Dr. Bliss' second summer at Woods Hole. He spent his first summer here in 1925, when he conducted experiments as a student of T. H. Morgan on the effect of temperature upon the rate of prepupal development in Drosophila, work which led to a Ph.D. from Columbia.

Between his first and second summers at Woods Hole, Dr. Bliss has led an interesting and varied life. From 1926 to 1933 he was associate entomologist and later entomologist in the Tropical Fruit Insect Division of the United States Bureau of Entomology. From 1933 to 1935 he continued his research at the Galton Laboratory of University College, London, where he studied under R. A. Fisher, the noted statistician. During this period he visited many European capitals. In December, 1935, Dr. Bliss went to the U.S.S.R. as a foreign specialist in the Institute for Plant Protection and spent two years at Leningrad and in other parts of the Soviet Union lecturing, organising research and holding conferences upon various research problems. Since his return to the United States, he has been consultant in statistics for a number of institutions.

Dr. Bliss' work has been primarily concerned with statistical methods in experimental biology, particularly toxicology and related fields. His main contributions have been in adapting statistical methods developed for agricultural field experiments to laboratory work in pharmacology, physiology and applied entomology. Some of his more recent papers have dealt with fly spray testing, the biological assay of insulin, parathyroid extract and digitalis, and the toxicity of poisons applied jointly.

At Woods Hole this summer Dr. Bliss plans to complete several biometrical papers, especially one which still requires some experimental work on the interrelations of reaction time, concentration and toxicity. He is expected to deliver a lecture at the Marine Biological Laboratory on quantitative biology later in the season.

THE SEMINAR ON CELLULAR PHYSIOLOGY

DR. ROBERT CHAMBERS

The seminar on Tuesday evening covered a rather wide scope in cellular physiology but the substance of the three papers given can be summed up in the word "structure'. The first paper on the starfish egg dealt with the appearance of the sperm-aster as affected by varying conditions of the egg cytoplasm, egg-nucleus and the polar bodies.

The second paper presented an experimental analysis of chromosome structure in terms of its protein and nucleic acid constituents.

The third paper dealt with a method of rapid extraction of egg cytoplasmic proteins and the use of micro oil drops as a modification of the Langmuir trough method.

The discussion following Mr. Chambers' paper brought out the fact known from the early experiment of E. B. Wilson and Yatsu that the fertilizability of the egg cytoplasm depends upon an intimate mixture of the fluid contents of the germinal vesicle with the cytoplasm. The cytoplasm of the mature egg should thus be given the distinctive term of nucleo-cytoplasm. For the starfish egg, Mr. Chambers showed that a relatively long period is necessary for the combination of the nucleoplasm with the cytoplasm to come to completion before the sperm aster, which is an expression of egg maturity, can appear.

Dr. Mazia's paper emphasized the value of determining the chemical constitution of the chromosome by differential digestion methods. It is hoped that this method will be extended to chromosomes other than the highly specialized structures in the salivary gland cells of insects. Trained cytologists will do well to incorporate the digestion technique with their elaborate fixing and staining methods.

Dr. Kopac presented a method of extracting cytoplasmic proteins with less risk of drastic breakdown of the chemical components than has hitherto been possible. We may be on the track of being able to determine the physico-chemical properties of proteins as they actually exist in the living cell.

CURRENTS IN THE HOLE

At the following hours (Daylight Saving Time) the current in the Hole turns to run from Buzzards Bay to Vineyard Sound:

Date	A. M.	P. M.
July 14	12:03	12:24
July 15	12:44	1:02
July 16	1:48	1:57
July 17	2:39	2:53
July 18	3:31	3:45
July 19	4:17	4:38
July 20	5:01	5:16

ITEMS OF INTEREST

DR. DUGALD E. S. BROWN, assistant professor of physiology at the New York University College of Medicine has been appointed professor and head of the department of physiology at the College of Dentistry in the same institution.

DR. FERDINAND J. M. SICHEL has been promoted from instructor to assistant professor of physiology at the University of Vermont Medical College. Dr. Sichel is on the staff of instruction of the physiology course at the Marine Biological Laboratory.

MR. MAC V. EDDS, assistant in biology at Amherst College, received his M. A. degree at the commencement exercises there in June. Mr. Edds, who will continue his post graduate studies at Yale, worked at the Marine Biological Laboratory last summer.

DR. GEORGE B. JENKINS, professor and head of the department of anatomy at George Washington University, retired this June after twenty years of service. No successor has as yet been appointed to his position. Dr. and Mrs. Jenkins will continue to make their winter home in Washington for the present.

DR. GERALD W. PRESCOTT, associate professor of botany at Albion College, has been added to the staff of the University of Michigan Biological Station at Douglas Lake, Cheboygan County, Michigan. Dr. Prescott was for several years on the staff of instruction of the botany course at the Marine Biological Laboratory.

DR. JOHN A. KITCHING, who was an investigator at Woods Hole last summer, is now working at the Department of Banting Medical Research of the University of Toronto. Dr. Allan C. Burton, who worked at Woods Hole in 1938 and who was a Johnson Foundation fellow until last March, is also working at the same institution.

At the commencement exercises of the University of Pennsylvania held on June 12, the honorary degree of Doctor of Science was conferred by the University upon Dr. Clarence E. McClung, professor of zoology and director of the Zoological Laboratory at the University of Pennsylvania. The following citation was read:

"Professor of Zoology, administrator, forceful and inspiring teacher. He is an internationally accredited investigator of the factors of sex-determination and heredity, and has promoted goodwill and cooperative research among biologists, through the Marine Biological Laboratory, the National Research Council, and other scientific agencies."

DR. FRANK BLAIR HANSON, associate director of the Rockefeller Institute for Medical Research, arrived in Woods Hole on Wednesday with Mrs. Hanson and their son, Frank, Jr. They will spend the remainder of the summer here. Their daughter, Blair, will join them later.

DR. G. KINGSLEY NOBLE, curator of the department of experimental biology at the American Museum of Natural History, was a visitor at Woods Hole last week. He was in this region studying colonies of terns.

DR. FRANK HIDES of the University of Michigan Biological Laboratory, has been visiting Woods Hole for the past few days.

DR. DAVID GREEN, who took courses at the Marine Biological Laboratory several years ago, visited Woods Hole on Saturday and Sunday. He has recently been a Beit Memorial Fellow at Cambridge University, England, and is now working under the same Fellowship with Dr. A. B. Hastings at Harvard University.

DR. A. EMERSON WARREN, associate professor of biology at McMaster University, attended the recent Growth Symposium at Salsbury Cove and afterwards visited the Marine Biological Laboratory.

DR. C. G. ROSSBY, assistant chief of the Weather Bureau at Washington, D. C., is at the Woods Hole Oceanographic Institution for a short stay.

DR. CLIFFORD BARNES and MR. FLOYD SOULE returned to the Woods Hole Oceanographic Institution on July 9 after a three and a half month trip to St. Johns, Newfoundland, on the *U. S. C. G. General Greene*, which sailed from Woods Hole on March 21. Dr. Barnes and Mr. Soule were with the International Ice Patrol engaged in making current maps which are used to predict the drift of the icebergs.

DR. CLEMENTE ESTABLE, professor of biological sciences at the University of Montevideo and Director of the Laboratory of Biological Sciences of the Ministry of Public Health in Uruguay, is visiting Woods Hole for a few days. After attending the American Scientific Congress in Washington, he was a guest of Professor C. E. McClung at the University of Pennsylvania. He also visited Princeton, Harvard and New York Universities. Dr. Estable, whose work is in the field of histophysiology and biomicroscopy, has devised a number of methods for rendering microscopically visible tissues in living amphibians and mammals.

EXTRA-CURRICULAR ACTIVITIES AT THE M. B. L.

M. B. L. CLUB

The Music Committee of the M.B.L. Club regrets the defect in the amplifying system which interfered with the Phonograph Concert on July 8. Thanks to the expert help of Ed Brill, the loose connection has been found and resoldered, and we can expect good reception at the concert Monday night, July 15. The program follows: Ballet music from "Rosamunde", Schubert; Concerto no. 1 in E minor, Chopin; Symphony no. 4 in E minor, Brahms. —*Music Committee*

REFUGEE WORK AT WOODS HOLE

An exhibit was staged at the Brick Dormitory last Tuesday evening by a group of wives of Woods Hole investigators who are engaged in sewing and knitting for the benefit of war refugees. This work is being carried out under the direction of an organization founded during the last war under the name of The Little House of Saint Pantaleon.

This non-sectarian organization, which comprises about twenty chapters in the United States, is engaged in supplying clothing to evacuated civilian populations and medical supplies for the wounded in France. The group in Woods Hole is headed by Dr. Alice Russell, Mrs. H. B. Goodrich, and Mrs. W. Gardner Lynn. This group meets almost every morning in the Brick Dormitory and so far has prepared three boxes of dresses and medical supplies which will be sent to France as soon as arrangements can be made with the proper authorities. The organization in France is entirely in the hands of native French administrators.

During the month of May some ten thousand pounds of clothing, bandages, and other supplies were sent to France by the organization throughout the United States.

Any women connected with the Laboratory are cordially invited to help in the work of this organization.

CHORAL CLUB

The second and third rehearsals of the Woods Hole Choral Club were held on Tuesday evening at the estate of Mrs. James P. Warbasse, to which the Club adjourned after the lighting arrangements at the Coast Guard Canteen had broken down. Substantial progress was made in preparing the program for the presentation of the Club's concert towards the end of August.

The following is a tentative program for the concert, as it was drawn up by Professor Ivan T. Gorokhoff, director of the Club:

Part One

O Rejoice, ye Christians, Loudly — Bach
O Praise the Lord, my Soul — M. M. Ippolitov-Ivanov
Triumph! Thanksgiving — S. Rachmaninoff
We Praise Thee — Tschaikovsky
Choral, from "Die Meistersinger" — Wagner
Ye Watchers and ye Holy Ones — 17th Century German Melody

Part Two

Swansea Town — Hampshire Folksong
I Love my Love — Cornish Folksong
When Allen-A-Dale Went A-hunting — R. L. De Pearsall
The Cobbler's Jig — 17th Century English Air
Oh, if Mother Volga — S. W. Pantchenko
The Gipsy — W. Zolotarieff

CHILDREN'S SCHOOL OF SCIENCE

The annual Children's School of Science and Junior Laboratory has opened for the summer at the Woods Hole Schoolhouse. Registrations are still being accepted for the six courses and the Junior Laboratory, which are offered each for a different age group. These classes, which will conclude Friday, August 9, will be held out of doors as often as possible except for the Junior Laboratory. Seventy-four children are enrolled at the school this summer.

For beginners, seven and eight years, a general introductory nature study course is offered based on observations made in the field. Studies will be made of animals and plants, their associations, adaptations and habits.

Water life, teaching field acquaintance with common plants and animals of salt and fresh water, will be offered the eight to nine year group.

The nine to ten year class will take a more advanced nature study course treating bird life, winds and tides as well as fuller information on the material covered in the two elementary courses. Insect study for the ten to eleven year group will include collecting, classifying, mounting, labelling and a study of insect anatomy and developing stages.

Ecology, a study of the relationship between organisms and their environments, will be given the twelve to thirteen year class. This will consist of a field course in collection and study of typical forms of marine life of the region. Elementary biology for the thirteen to fourteen year students will include an introduction to the structure and functions of plants and animals, and to some of the more important biological principles.

Experiments and dissection of interesting forms will be undertaken.

For those fifteen years and over the school offers a junior laboratory course aiming to make studies which cannot be undertaken in winter classes, such as preparation of microscope slides, culturing of simple animals and a variety of experiments.

This year's teaching staff is comprised of Miss Helen Smith of Kingswood School, Cranbrook, Bloomfield Hills, Michigan, *Chief of Staff*; Reginald MacHaffie, of Avon Old Farms School, Avon, Connecticut; and Mr. and Mrs. George C. Lower of Westtown Friends School, Westtown, Pennsylvania.

The Children's School of Science executive committee includes Mrs. Edward A. Norman of New York City, *President*; Mrs. C. Luther Fry of Rochester, New York, *Vice-President*; Mrs. Truman S. Potter of Chicago, *Secretary*; Mrs. Henry C. Stetson of Belmont, *Treasurer*; Mrs. Wm. Randolph Taylor of Ann Arbor, Michigan, *Science Chairman*; Mrs. Alfred C. Redfield of Cambridge, *Membership Chairman*; and a science committee, Mrs. Frank E. Bailey of South Hadley; Mrs. Archie D. Carr of St. Louis, Missouri; Mrs. Alvern P. Clough of Woods Hole; Mrs. James D. Graham of Haddonfield, New Jersey; Mrs. J. W. Mavor of Schenectady; Mrs. Walter Root of New York City; and Mrs. Edmund E. Watson of Kingston, Ontario.

—*Mrs. Wm. Randolph Taylor, Science Chairman*

PROTOZOOLOGY CLASS NOTES

The Protozoologists are overjoyed to report that they survived the Fourth with no other than a glorious victory in the "Battle of the Labs." This accomplishment was the result of a strong resistance to a fiery attack from below via the spiral stairway. All day the battle raged with ammunition more than plentiful. The "Protos" working in shifts were able to hold their ground and carried on a record amount of work under fire in spite of the spirit of independence expressed by the active "Physios." No casualties were reported with the exception of "the bomb in a box" episode. After setting off several firecrackers in a big wooden box a certain particularly brilliant Physiologist discovered that the box contained cats. Luckily the cats had died previously!

With several similar interruptions this past week has been most eventful. Saturday morning, while the Embryologists were dancing around on the sunny beaches, the Protozoologists had the opportunity of hearing Dr. Summers speak on certain aspects of regeneration in protozoa. He discussed various experiments on conditions which affect regeneration with special reference to his work on the colonial protozoan, Zoothamnium. Among the experiments mentioned was that on Difflugia, a test dwelling Rhizopod, in which pieces of pseudopodia were removed and left on the same slide. These homesick fragments, it seems, just plain get too lonely and soon find their way home to mama and again become part of the original animal. Oh, to always have a roof over one's head and be able to keep the bacteria from the door!

Other lectures of the week that are especially worthy of mention are Dr. Calkins' lecture on "Reproduction by Budding in Sarcodina" and Dr. Kidder's on the "Neuromotor Apparatus in Ciliates." At last the protos know who Dr. Kidder is! Especially interesting is his work on *Concophtherius mytili*, a ciliate living on the common mussel Mytilus.

Termites! Rather than bring an axe to the lab at midnight, it was a pleasure for two especially energetic members of the class to beg, borrow or steal two bicycles and puff up hill for four miles to the region of the Sippiwissett road where the wicked white "ants" are to be found in materials other than foundations. In the heat of the hot day, after hearing the life histories of several of the local talent, they pumped up hill all the way back with some *six* termites in their possession. High mortality of the inner inhabitants of these weird creatures required the use of the accomplishments of a girl in the class who knows "man with car" and the supply was replenished.

It is the sincere hope of all that few organisms (including you and they) have as many internal companions as the termite. In the array of socially important names of those present was that of dwarfed Microspirotrichonympha. Imagine the feelings of a termite with one of those inside!

Forms of the week included Opalina, Trichonympha, Dinenympha, Holomastigotes. Among those on the independent ticket were Folliculina and Difflugia competing for first place in popularity and the complicated, jerking Uronychia for the booby prize.

Recent reports have drifted up from nether regions occupied (so we hear) by the Embryologists and the Physiologists. It is said that the Embryologists were told that they ought to compete with Physios as to time spent in the lab. Was it just chance that the latter took the other afternoon off?

At least the Protozoologists can maintain their superiority in this case. They don't need the Physiologists as an example. In fact—vice versa!

—*Doris Marchand*

BOTANY CLASS NOTES

The half-way mark has been reached! Less than three weeks remain for the ten of us to acquire professional standing as competent algologists. Yet everything is not as blissful as one might think. It seems that our two blond mermaids are very much distressed over the prospect of dark days without afternoons for swimming, for the number of genera for class study has been increased twofold. Yet in spite of the increased work, Dr. Runk, that handsome gentleman from Virginia, still insists that we haven't seen anything yet. Mr. Bill Gilbert, collector extraordinary, who in part is responsible for our mermaids' predicament, backs up Dr. Runk by saying, "You bet!"

Our custom of ten P. M. tea has already attracted two physiologists—Davies and Norman—who are of the opinion that botany isn't bad at all. We might mention three embryologists who are attracted to our lab not so much by tea as by the scenery. However we'll let the embryology professor find out for himself. Speaking of tea, it has been remarked that for the past two nights our tea has had an unusual flavor. I'll bet Mr. Thompson knows why—he's been boiling snails of late.

Last Saturday we had our first marine field trip. We were towed out in three rowboats to Nonamesset beach where we proceeded to stumble over rocks. There is a unique technique in collecting algae. You wade out into the water between tidal zones, carrying your bucket on your arm, shoulder, or head depending on how you've been brought up. When you have reached a favorable location, you search on the submerged rocks for various colored filaments. When you spot one that looks good, you thrust your hand quickly down through the water, grab hold of the plant by the holdfast, and pull. Lo and behold, there is your specimen. This is repeated several hundred times, at different places, of course, until your bucket is full. However the collecting of the algae is only half the story—the better half. The mounting of the algae that has been collected takes anywhere from three to an infinite number of hours, depending upon how much of the stuff you throw away when nobody is looking. The results of your mounting will either be aesthetic or pathetic, depending upon the type of syringe you use. This instrument, consisting of a rubber bulb and a piece of glass tubing, is very handy in more ways than one—as Miss Campbell can very readily testify.

To speak of more intellectual things—our Thursday night seminar for example—Mr. Rufus Thompson, Professor Taylor's learned assistant, delivered a talk on the development of a rare genus—Riella—a member of the Jungermanniales. The drawings which accompanied the lecture, and which will be included in a subsequent paper to be published by Mr. Thompson, were admired by most of us algologists who have not as yet developed our potential artistic talents. The week before, Dr. Taylor gave a very interesting and somewhat humorous account of his experiences on expeditions to tropical waters. It is generally agreed among us that Dr. Taylor gets around.

Perhaps it would be in order to introduce the members of our class and staff to you readers so that our human qualities will become apparent to all zoologists. The members of the class:

"Big Boy" Joe Anderson:—who arrived late for the course, but who has since made his presence felt. Joe never stays late for tea. He goes in for strong drinks like malted milk.

Del Morgan, Jr.:—the roommate of the above gentleman. Del is quite an expert on breeding dahlias, and will be at Columbia this Fall.

Nat Buchanan:—who is very fond of classical music and quiet boys. Nat has generously supplied us with delicious cookies.

Ruth Ciu:—who is one of our more diligent phycologists. She was the first to get poison ivy, but has not felt any the worse.

Hank MacCosbe:—algologist from Pennsylvania. Hank is our seminar hostess and puts on a dress for great occasions.

Donald ("Ducky") Brown:—who at present is learning how to type between algal mountings. Ducky is a great rower even against a strong current.

Jo Sanders:—who is one of the mermaids mentioned previously. Jo thinks that some algae are not so hot, and has great sympathy for hard working embryologists.

"Toots" Campbell:—who plays a sister act with Jo. This young lady is a hard worker although Dr. Runk has his doubts.

Dorothy Brown:—who loves to look at the "little beasts" under the microscope. Dorothy is a hardy collector, but thinks that there is a limit to what one can endure.

Samuel Silver:—who as the writer of this article will modestly refrain from boosting himself.

The staff:

Professor Wm. Randolph Taylor:—who discovered *Acrothrix novae-angliae* much to the chagrin of Jo and Toots.

Dr. B. F. D. Runk:—whose corn cob pipe and snappy clothes give him great dignity.

Mr. R. H. Thompson:—who also has a pipe and is fond of red Euglenas.

Mr. B. Gilbert:—who has graciously lent me the typewriter on which this is being written, and who supplies the class with everlasting species of Algae.

Looking at my watch I notice that it is one A. M. and the lab is very quiet except for the typewriter which is keeping me awake. It won't any more. —*Samuel Silver*

EMBRYOLOGY CLASS NOTES

The Battle of Jutland, Dewey's Battle of Manila and the Battle of the Monitor and the Merrimac had nothing to compare with the valiant, dauntless, courageous and intrepid defense and offense of the Battle of Eel Pond which took place the evening of the Fourth of July. The embattled defenders of the *Shalom* carried on nobly (with Fifth Column assistance) despite frequent efforts by the offensive to scuttle the vessel by planting flash salutes in the exhaust pipes of the General's boat. The General and his respected cohort Ernie (of the strong right arm and good aim) were the admitted victors in the fray with the boys in the row boats. They managed to outsabotage any attempts at sabotage made by the wild-eyed boys who had contributed their money to help storm the undaunted defenders of that neat little craft that ordinarily lies calmly at anchor off the shore. Urged on by the shouts of fellow members of the lab the offensive continued to fire on the *Shalom* until they ran out of firecrackers. The outstanding heroes of the battle were, of course, the General and Ernie, commendable for their gentlemanly efforts to keep the war on a gentleman's basis. Of questionable heroism were Popeye-the-Sailor Atkinson and Robinson-Crusoe Hopper who made an effort at being brave although they were all wet. Miller and Metcalf were also examples of manhood's best. They went to the aid of the defenders of the *Shalom* despite any remarks in the ranks on shore of their being traitors. The day after the battle was profitably (?) spent in dissecting the "secret weapons" dreamed up by both sides for defense but which had failed, for some reason or other, to go off.

Dr. Schotté began his series of lectures on Echinoderms the same day. The series contains lectures on the development of echinoderm eggs, the parthenogenetic growth of echinoderms and two discussions of experimental work with echinoderms.

On Saturday the class held the annual picnic at Tarpaulin Cove where the emphasis was on lobster with corn and lobster without corn, lobster with onions and lobster without, lobster with potatoes and lobster without. The same thing for chicken and clams. Not being members of the local Rotary Club, we were not bashful about admitting that that was the first day that we people of brains (and not brawn) had found it warm enough to whip around in anything less than our famous long underwear and six sweaters. Contrary to the opinions of the editor of the *Falmouth Enterprise,* we Embryologists are not timid but smart enough to use common sense and wear sufficient clothing when it is cold. It is a simple case of brains over the elements, not of mass submission to the styles of the season despite the temperature—*WHICH WAS COLD.*

On Monday Dr. Hamburger gave us an insight into his work on neuro-embryology and showed us some of the pictures and diagrams of the neural development in the chick.

The laboratory work this week has consisted of the work on echinoderm development and experiments on parthenogenesis. The experiments in parthenogenesis have proven (almost) to ye reporter that men are unnecessary (more or less) and have caused her to contemplate an erudite and philosophical volume on "Why Man, Yes, Why?" —*Margie Jolly*

PHYSIOLOGY CLASS NOTES

We are suddenly realizing that our golden hours of instruction are practically over. Now for those ten days of individual research, to really show our stuff.

The organization of Höber and Shannon units has brought comparative peace and quiet once more. One of the more cynical Protozoologists above was heard to remark that the Physiologists really seem to be doing some work for a change.

The kidney cannulations have proved the undoing of many of us. It is a pathetic sight to see strong men, frustrated and shaken, with every nerve quivering, trying to cannulate the ureter of a frog. One or two cases of complete mental collapse were averted in the nick of time.

The glorious Fourth was celebrated quite, quite sanely. The majority of us presented ourselves at the laboratory and spent the day here in body if not in spirit, with a doleful eye at the murky weather.

About four or five ambitious souls collected about forty-five foot-loose individuals on Sunday for an impromptu excursion to Quicks' Hole. The trip was highlighted by much hiking, ball playing (warming up for that pending clash with Embryology), a spot of hop-scotch, and much corny singing. They even remembered salt for hamburg. —*R. P. F.*

THE COLLECTING NET

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URETHANE AND THE RESPIRATION OF YEAST CELLS

DR. KENNETH C. FISHER

Assistant Professor of Experimental Biology, University of Toronto

The use of inhibitors of various kinds in the examination of the activities of living cells seems to be well established as an experimental technique. Ultimately work of this sort will perhaps enable us to determine the relations between definite chemical reactions and the particular cellular function made possible by the energy derived from them. Beginnings in this direction have already been made of course, and as an example, I need only draw to your attention the use of cyanide in connection with studies on oxidation-reduction reactions in cells.

Such experiments reveal, however, that the mere division of the respiration or function into inhibitor sensitive and inhibitor insensitive fractions is not sufficient. Stannard finds that there is reason to consider the completely cyanide sensitive respiration of active frog muscle to be composed of two discrete portions. (*Continued on page 73*)

M. B. L. Calendar

TUESDAY, July 23, 8:00 P. M.

Seminar: Mr. Nelson T. Spratt, Jr.: "An in vitro Analysis of the Organisation of the Eye Forming Area in the Chick Blastoderm."

Dr. Ernst Scharrer: "On the Determination of the Vascular Pattern of the Brain of the Opossum."

Dr. Paul A. Weiss: "Functional Properties of Transplanted and Deranged Parts of the Central Nervous System of Amphibians."

FRIDAY, July 26, 8:00 P. M.

Lecture: Dr. D. H. Wenrich: "Chromosomes in Protozoa."

HORMONES AND THE PHYSIOLOGY OF GROWTH IN PLANTS

DR. KENNETH V. THIMANN

Associate Professor of Plant Physiology, Harvard University

The problems I am going to discuss tonight are specifically concerned with plants. If most of the workers at this Laboratory are mainly concerned with animals, I can only hope that the many parallels between the physiology of growth in plants and that in animals may prove suggestive enough to be worth your consideration.

The first idea that special substances might control the growth of plants came out of the work of Charles Darwin, who was greatly attracted by the coleoptiles of the grasses. These delicate first shoots of the cereals are extremely sensitive to light and gravity, and Darwin showed that the sensitivity, or tropism, was lost if the tip were cut off. He concluded that the tip transmits some influence to the part below, causing it to react. Just thirty years ago, Boysen Jensen, in Fitting's laboratory, found that these plants which had lost their tropism to light by having their tips cut off

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ONE OF THE TIDE-FILLED TANKS AT MILFORD

Used in shellfish culture experiments.

TEMPORARY FIELD LABORATORY AT MILFORD, CONNECTICUT

For the study of shellfish culture and the control of oyster pests. Facilities have been increased recently by the construction of a two-story brick building.

could regain it if the tip were stuck on again. This was not all, for Páal in Hungary brought the significance of the whole matter out by the following simple experiment.

The plant is decapitated and the tip is replaced asymmetrically; the result is that growth is accelerated only on the side on which the tip rests. The plant therefore curves. This experiment could be done in the dark, and so here for the first time we get away from the complexities of tropisms and come towards the mechanism of ordinary growth. Since the tip has no organic connection with the base, the growth of the base must be controlled by a substance diffusing from the tip. In normal, straight growth, this diffuses equally on all sides, as shown directly by Söding with straight growth measurements. Since we have to deal with a substance, it must be possible to separate it from the tip and this was done by Went, by placing the tips upon agar so that the substance could diffuse into the agar. When the agar was applied to one side of the decapitated test plants they curved as before.

Now in tropisms, shoots curve towards weak light and away from gravity. One might expect that the curvatures caused by asymmetric application of the growth substance would be related to those caused by light and gravity. Indeed, Cholodny put forward a general theory of tropisms according to which all such curvatures are due to an asymmetric distribution of growth substance in the plant. This theory was confirmed almost as soon as it had been propounded by Went and by Dolk in the Utrecht laboratory. When the tip is illuminated from one side more growth substance was found to diffuse into agar from the dark side than from the light side. Similarly when the tip was placed horizontally, more was found to diffuse from the lower side than from the upper. The increased growth in each case on one side of the plant is therefore due to an increased amount of growth substance on that side.

This shows that in these plants growth is proportional to the amount of growth substance present. That is, the relation between growth and the growth substance is a quantitative one. Hence it is possible to use such curvatures as an assay method for the active substance. Under standard conditions curvatures, or straight growth, are proportional to concentration over a certain range. The active substances have been called auxins. A number of other tests have been developed. That using slit stems is interesting because it brings out an important property of growing plant parts. The stems, coleoptiles or other elongating organs, are slit in two and placed in the solution. In water the halves curve outward, away from one another. In auxin solution they curve inward and the inward curvature varies roughly as the logarithm of the concentration. A polemic has raged for some time on the explanation of this reaction. The outward curvature in water is apparently due to tension in the outer layers which is released on slitting. The inward curvature cannot be due to wounding, since if two wounds are made parallel to one another curvature still results, although the influence of the wound has no component in the direction of curvature. Another possibility suggested was that the auxin could not enter the inside, wounded, tissue but entered only the intact tissue on the outside. This was disproved by showing that application of the auxin to the wounded side only still caused inward curvature. Evidently the substance must have entered and penetrated through the tissue to the outer layers. The only conclusion can be that the inner and outer layers of tissue have different sensitivities to auxin. The inner grows in response to the auxin for a short time only, the outer continues its growth for much longer. This can be shown by following the progress of curvature with time.

The curvature is complicated by the mechanical rigidity of these halved cylinders. We found that if the material is quartered the sensitivity is correspondingly increased and that in concentrations too low to cause curvature of the halves, excellent responses are obtained with quarters. The explanation for this can be readily seen by comparing the difficulty of bending rubber tubing slit in half with that slit in four. This test enables concentrations of 0.0008 milligrams per liter to be detected.

These curvatures bring out the important fact that sensitivity to applied auxin varies within different tissues of the same plant. This conclusion is important for understanding other responses to auxin. Thus, while the growth of coleoptiles and of stems is promoted, the elongation of roots is inhibited. Similarly the development of buds is inhibited. In nature lateral buds are inhibited

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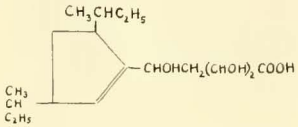
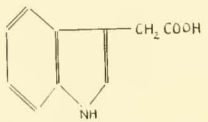
by the influence of the growing terminal bud. When this bud is removed the laterals begin to grow. If, after removal, its place is taken by a supply of auxin the lateral buds are again inhibited. Lastly, there is one case where new organs may be formed in response to auxin treatment. This is the formation of roots on stem cuttings. It takes place in a very wide variety of plants and has been in the last few years adopted by many horticulturists as a regular procedure for the rooting of cuttings.

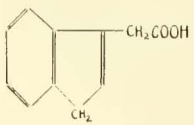
All this later work was made possible by the isolation and chemical study of the active compounds, and this in turn has depended on the use of the various assay methods. Kögl and Haagen Smit isolated from urine and from corn oil the substance auxin *a*.



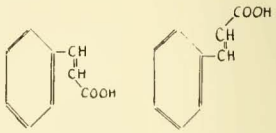
On the other hand I obtained from certain fungi and the Dutch workers from yeast and from urine indole-acetic acid,



and most of the work since then has been done with the latter, whose physiological activity quantitatively and qualitatively resembles that of auxin *a* and its relatives. A comparison of the formulae shows that substances of apparently very different structure may have activity. The differences are in some cases very important, however. Indene-acetic acid,



which differs from the indole acid by only one carbon atom, produces curvatures which are very local in extent, that is, they do not spread out down the plant. Also, it produces roots locally at the point of application but not at a distance. Hence it is an active substance but is not readily transported through plant tissue. When the double bonds in the rings of these compounds are hydrogenated, activity disappears, so that we can deduce that a double bond is essential. Also, a double bond in the side chain cannot substitute for one in the ring. With the cinnamic acids, the cis- derivatives are active, the trans- derivatives are not.



This suggests that a particular arrangement in space is necessary for activity. Such an idea is supported by numerous substances of related structure but in which the distance between the acid group of the side chain and the double bond in the ring is varied.

Taking the results as a whole it is clear that some relation in space between these two groups is more important than any one particular radical. This recalls the experiments of Ehrlich on immunity which he explained in terms of the fitting together of the antigen with its antibody in the manner of a lock and key. The simile is helpful because it is clear that the action of auxin could be analyzed through a consideration of the structure of the substance, i.e., of the key, and through a consideration of the reactions which auxin causes in the plant, i.e. of the lock. The latter comprises many final results, viz., a growth response which differs quantitatively from one tissue to another, formation of roots, inhibition of buds, activation of cell division in the cambium, etc. It seems reasonable to conclude that these different responses are secondary effects resulting from one primary, fundamental reaction. We have therefore sought for some very fundamental process which when influenced by auxin might have a number of different effects depending upon the plant tissue reacting. Such a process was found first of all in protoplasmic streaming. In the cell of the coleoptile the protoplasm streams steadily around the outside and the rate can be followed easily if one observes the number of the finest particles. It can be measured by timing a particle over a fixed distance with a stop watch or better still with the semi-automatic recording device which Mrs. Sweney and I have recently developed. By either method the records show

that immediately after auxin is supplied there is an increase in the rate of streaming and the extent of this increase is a function of the auxin concentration. The rise takes place long before any effect on growth can be detected and therefore it precedes the growth response. However, after thirty minutes the streaming rate returns to normal while on the other hand growth acceleration continues for many hours. The reason for this puzzling difference was found by removing the auxin and applying it again after varying lapses of time. After about twenty minutes the coleoptile has recovered and can again give a rise in streaming rate. This shows that some factor necessary to the response is temporarily exhausted. A further analysis showed that the missing factor is sugar. When auxin is applied together with fructose the acceleration of streaming rate is maintained for an indefinite period. This corresponds with the fact that growth also is dependent on the sugar supply and when auxin is applied together with sugar the acceleration of growth produced is greater and is maintained for a much longer time.

It follows that the streaming process, which is promoted by auxin, involves the oxidation of sugar. We know that streaming is highly dependent upon oxygen supply and slows down as soon as the tissue becomes oxygen-deficient. If the plant is treated with dinitrophenol the increase of respiration which this substance causes rapidly renders the tissue oxygen-deficient and the streaming slows down. On removal of the stimulant the normal streaming rate quickly returns. Thus the action of auxin on streaming, and therefore presumably on growth, is dependent upon carbohydrate oxidation.

Now we know that in a general way growth is related to oxidation. Plants will not grow in nitrogen and Bonner showed that when coleoptiles are treated with cyanide the respiration and growth are reduced in strict parallel. In the old days respiration was considered a "primary necessity" for growth, i.e., plants must be respiring in order to grow; but the connection was not thought to be a direct one. However, by studying respiration and growth in parallel, Commoner and I have found that there is indeed a direct connection. It is not a simple one. The mere addition of auxin to coleoptiles does not increase their respiration. Since cyanide, which poisons the oxidase, reduces growth and respiration together, it is evident that the two processes can only be separated by studying the dehydrogenase end of the respiration system. Dehydrogenase inhibitors strongly inhibit growth. Iodo-acetate is very active in this connection and it can prevent growth completely while lowering the respiration only some 10%. Thus if there is a respiration involved in growth it can be only a small fraction of the whole. The nature of the process sensitive to iodo-acetate has been elucidated by studying the effect of various substrates. The inhibition is removed completely by succinic, fumaric and malic acids, and also by pyruvic acid. No other substances have been found effective, so that the process must involve these four-carbon acids. Now these acids have been shown by Szent-Györgyi and others to be active as hydrogen carriers in respiration. The coleoptile has its respiration increased by malate, and this effect depends upon the presence of auxin. In the absence of auxin malate has no effect on the oxygen uptake of starved coleoptiles, but in presence of auxin, M/1000 malate increases respiration greatly. Fumarate behaves similarly. Thus the auxin is here acting as a respiratory substance.

Since malate, which is itself a respiratory substance, can control growth in presence of auxin, it seemed possible that auxin, which is a growth substance, could control respiration in presence of malate. This turned out to be the case. By using coleoptile sections previously soaked in malate, it was found that the addition of auxin produces a marked rise in respiration. The concentrations active in this reaction closely parallel those active in accelerating growth.

Hence the dependence of growth on respiration is due to the participation of a respiratory system, viz., that of the four-carbon acids, in the growth process. Auxin must play the part of a catalyst or a co-enzyme in this reaction. It is interesting to note in this connection that we have recently found that auxin is apparently linked to protein in plant tissues. The linkage to protein is very characteristic of co-enzymes. Also the relationship between activity and molecular shape may be explained as due to the necessity for the auxin to become adsorbed on a protein or some other surface before acting.

In conclusion, it is a characteristic of plants that they are always growing; plants do not commonly reach constancy of size as do animals. Thus the study of the auxins and their action, in giving a new tool for the study of growth, may also allow a new insight into many other aspects of the physiology of plants.

(This article is based upon a lecture delivered at the Marine Biological Laboratory on July 12.)

THE BIOLOGICAL FIELD STATIONS OF SWITZERLAND AND THE LOW COUNTRIES

Mr. Homer A. Jack
Cornell University

The immediate environment of the biological field stations in Switzerland and the Low Countries varies from sea-level to an elevation of more than eleven hundred feet in the Alps. The Zoological Station of the Netherlands Zoological Society is located on a dike of the Zuider Zee while the Jungfraujoch Scientific Station is situated on a high mountain ridge near the largest glacier in Europe. Other important field stations in this area are those at Zurich and Bourg St. Pierre in Switzerland, at Ostend and Sourbrodt in Belgium, and at Wijster in Holland. Smaller stations in this portion of Europe include the hydrobiological laboratories at Kastanienbaum and Davos in Switzerland, the Laboratory of Freshwater Biology at Rouge-Cloitre in Belgium, and the Laboratory of the Hugo de Vries Foundation at Abcoude, Holland.

The Jungfraujoch Scientific Station (*Hochalpine Forschungsstation Jungfraujoch*) is as fine an example of international cooperation in science as the present war is one of international competition in science. Realizing the need for "research work . . . under the best possible conditions in a high mountain region," a committee of representatives from Switzerland, Germany, France, Belgium, and England decided to establish a research institute on the top of a mountain ridge on Jungfraujoch, about three hours by train from Berne, Switzerland. Although a cog-wheel railroad for tourists and skiers had already been tunneled up this mountain, laboratory and living quarters for scientists still had to be built. In time a five-story building was constructed out of solid rock and this was opened to investigators in 1931. The first floor of this remarkable edifice contains six individual laboratories, a darkroom, cages for experimental animals, a storeroom, and a workshop. Ten bedrooms, a dining room, kitchen, and administrative office are situated on the second floor. The caretaker's apartment is on the third floor and the fourth is devoted to a library and lecture room. The fifth floor contains a partially-covered observation terrace and all floors are supplied with running water and several types of direct and alternate electricity. About 367 feet above this building is the institute's annex, containing a dark room, meteorological and astro-physical laboratories, living quarters, and several open terraces.

The Jungfraujoch station is equipped to receive throughout the year investigators in the fields of physiology, pharmacy, botany, zoology, biochemistry, meteorology, and physics. Persons desiring to work at the station must apply through one of the participating societies. For investigators residing in the United States, this would be the Rockefeller Foundation. Accepted investigators pay no laboratory fees and may obtain a reduction in railroad fares to Jungfraujoch and exemptions from customs duty on consignments of scientific apparatus entering Switzerland. There are lodging accommodations for fourteen persons at the institution and the cost of lodging for persons coming from the "founding countries" (*Cf. ante*) is seven Swiss francs a week (about $1.57). Investigators may prepare their own meals in the station's kitchen or obtain board in an adjacent tourist hotel for sixty-nine Swiss francs a week (about $15.50).

The Linnaea Alpine Garden and Laboratory (*La Linnaea - Jardin et Laboratoire Alpine*) is located in Valais, some four hours by train and bus southeast of Geneva and about eight miles from Great St. Bernard Pass. At an elevation of about fifty-five hundred feet and in a region containing a mixture of both an arctic and Mediterranean flora, this institution is dedicated to research and instruction in alpine botany. The instruction includes both advanced course-work and popular education, the latter by means of a well-labeled alpine garden containing about two thousand species of alpine plants from many parts of the world. A six-week course in the Botany of the Alps is given by Professor Fernand Chodat in either the French or English languages and the instruction consists of lectures, assigned research problems, ecological field trips, and botanical excursions to Mount Blanc and Great St. Bernard. The course begins in the middle of July and may accommodate ten students, the tuition being twenty-five Swiss francs (about $5.60). The laboratory is also open to research workers in both botany and zoology during July and August. There are no living accommodations at the laboratory, but board and lodging may be obtained at nearby hotels for forty-two Swiss francs a week (about $9.41).

The Marine Institute of Belgium (*Institut Maritime de Belgique*) at Ostend is of interest in being approximately on the site of the first permanent biological station to be founded anywhere in the world. Ninety-seven years ago Professor P.-J. van Beneden of the University of Louvain established a seaside station in this locality. The laboratory had an irregular existence, however,

and was abandoned. In 1900 the present station at Ostend was founded and in 1935 it was completely reorganized. A new building was to have been constructed, but it is not known whether conditions in recent years have prevented its completion.

The Scientific Station of the Fagnes (*Station Scientifique des Fagnes*) was established in 1928 by the University of Liége for the study of the biology of swamps and peat bogs. It is located in the bog area of the Belgian Ardennes near Sourbrodt, at an altitude of about two thousand feet. The station is housed in a one-story building which contains two laboratories and six living rooms. Advanced students in biology, ecology, and meterology are welcomed at the station from June to October, the season when the station is normally in operation. There are no fees for lodging or laboratory accommodations. Board may either be prepared by the investigator or obtained at a nearby hotel. Professor Ray Bouillenne, director of the station, has written a number of papers on the ecology of the region.

Another field station largely devoted to a study of the biology of swamps and bogs is the Biological Station of Wijster (*Biologisch Station te Wijster*). This institution is located in the most extensive health- and moor-land district of the Netherlands, being about seventy-five miles northeast of Amsterdam, in Drenthe. Founded in 1927 by Dr. W. Beijerinck and united with the Netherlands Biological Station Foundation in 1933, this station contains a small brick dwelling, an arboretum, and is adjacent to several bog ponds. The brick house contains the director's residence, several guest rooms, a library, one laboratory, plant and insect collections, and a greenhouse. The station is especially prepared for researches in limnology, entomology, and plant ecology and occasionally informal courses are given in hydrobiology and vegetation. Students and investigators may obtain board and lodging from the director for about seventeen florins a week (about $9.00) and laboratory fees amount to fifty-four florins a month (about $16.00). The most recent scientific contribution from this station is a monograph on *Calluna* by Dr. Beijerinck.

The largest biological station in the Low Countries is the Zoological Station of the Netherlands Zoological Society (*Zoölogisch Station der Nederlandsche Dierkundige Vereeniging*). Located on a dike at Helder in northwestern Holland, this institution was founded in 1876 by the Netherlands Zoological Society. It is now financed by the Netherlands Ministry of Education, Arts and Sciences and is concerned with "marine biological investigations in the widest sense, including university extension instruction."

The main building of the station at Helder contains a small aquarium for the public, a biological supply department, a study-museum, a library, three research laboratories, classroom, darkroom, chemical laboratory, and the office of Dr. J. Verwey, the director. A recently-constructed second building contains dining and lodging quarters for twelve persons. The laboratories are supplied with running fresh- and sea-water and electricity, while the library contains sixty current scientific periodicals and about six thousand bound volumes, among which are many of unusual historical interest. The station also owns a 13-meter research vessel, *Max Weber*.

Instruction at Helder consists of two fortnightly courses, one for university students in July and the other for teachers in August. The station is open to investigators throughout the year and there are no laboratory fees for foreigners. Board and lodging may be obtained at the station for about thirteen florins a week (about $7.00). In addition to offering opportunities for instruction and research to students and investigators, the station pursues its own year-round research program with a staff of three resident scientists and an annual budget of 12,700 florins (about $6,858). Since 1934 a large portion of the scientific work of the station has been published in *Archives Néerlandaises de Zoologie*.

THE USE OF RADIOACTIVE TRACERS IN THE DETERMINATION OF IRRECIPROCAL PERMEABILITY OF BIOLOGICAL MEMBRANES

DR. LEONARD I. KATZIN
Research Worker, Department of Physiology, University of California

One of the characteristics of living membranes is the performance of osmotic work in building up or maintaining a thermodynamically improbable system. This is characteristically exhibited in the case of electrolyte passage across the membrane; a high degree of selection may occur in the type of ion allowed across the membrane, and the rate of passage in the two directions may be different. The combination of these factors gives differences in the electrolyte composition on the two sides of such a membrane.

To get an understanding of the fundamental processes underlying this phenomenon it is first necessary to obtain an accurate quantitative description of what actually takes place. For a number of technical reasons frog skin has been an active membrane much used in investigation of this problem of "irreciprocal permeability." Due

in the main to its rather low salt permeability, indirect methods of often questionable reliability may be resorted to in order to obtain data. As a result, there is considerable controversy as to whether irreciprocal passage of materials is even manifested.

It is possible to overcome the technical difficulties of low salt permeability and determination of small changes in the ionic content of solutions bathing the skin by the use of "labelled" atoms such as the radioactive isotopes Na^{24} and K^{42}, for which very delicate physical methods of analysis are available. Knowing the number of radioactive explosions per minute in a given amount of starting material, the total amount of salt represented by a given radioactivity is readily calculated.

The actual experimental manipulations are simple. Skin samples from a frog are mounted over the ends of glass tubes. A small volume of radioactive solution is placed in the tube, and the membrane immersed in a salt solution of the same chemical composition as the internal fluid (all solutions are 0.12 N in chloride). The amount of radioactivity that has passed into the outer solution is measured at the end of two hours. Pairs of skins are used, one with the morphological outer face in the inactive solution, and one with the inner face in the inactive solution. The difference in the amount of labelled salt passing through the skin in the two cases measures the amount of "irreciprocal permeability."

A summary of the results of a series of such experiments is given in Table I. The solutions with different percentages of sodium are made by mixing proper volumes of 0.12 N potassium chloride with the same concentration of sodium chloride. Thus a 50% sodium solution is a mixture of equal parts of sodium and potassium chlorides. Each value given is the average of six or more membranes, and has been reduced to rates per hour per square centimeter membrane surface.

As can be readily seen, the rate of inward passage of sodium ("turned" position) is markedly greater than rate of passage in the opposite direction ("normal" position). This difference extends in very marked fashion even to potassium values as high as 80%, falling off above this figure.

Potassium, on the other hand, seems to pass outwards through the skin at a somewhat higher rate than inwards, although the difference in the two directions is not as marked as in the case of sodium ion. It is possible that even this difference may be illusory, however. The amount of radioactive salt retained by the skin when the labelled solution is in contact with the outer face is approximately equal to the difference between the rates of potassium passage in the two directions. If this skin retention is interpreted as retention of salt in the dermal region, after it has already passed through the diffusion-limiting epidermis, then we must say that no difference in the passage of potassium ion in the two directions can be found.

As can be seen from the above example, radioactive tracer ions are a very useful tool for the study of work done by living systems on ions. Quantitative results can be obtained under conditions in which chemical methods would at best yield ambiguous qualitative information. In the case of the living frog skin membrane, these labelled atoms have been used to demonstrate conclusively the existence of a differential and irreciprocal ionic permeability, and to show its variation with change in chemical make-up of the solutions bathing the skin.

(This article is based upon a seminar report presented at the Marine Biological Laboratory on July 16.)

Table I.

(Gram ions per hour per sq. cm. $\times 10^8$)

	% Na Cl	0	9	20	50	67	80	91	100
Sodium	Normal position	—	1.4	6.6	9.4	—	—	—	20.4
	Turned position	—	5.0	29.	26.	—	—	—	32.2
Potassium	Normal position	31.	—	—	—	12.	4.4	5.0	—
	Turned position	30.	—	—	—	6.	3.4	2.2	—

In general it seems to be apparent in a wide variety of observations now recorded in the literature, that the entire oxygen consumption of a cell is not of uniform significance to the cell. It seems to be established, therefore, that the division of respiration into inhibitor sensitive and inhibitor insensitive fractions is actually too gross a division to distinguish the reactions supplying energy for specific function, from those others which may be required to supply energy for the maintenance of structure, to rid the cells of waste products and so on.

One may then inquire as to the method by means of which a subdivision could be accomplished. Let us imagine the inhibitor to be operative at more than one point. It is then apparent, that given appropriate relations between the affinities of these different systems for the inhibitor, the heterogeneity of the effect of the inhibitor might be demonstrable from a careful examination of the relation between inhibitor concentration and its effect. With this possibility in mind, we determined in detail the effect of different concentrations of urethane on the oxygen consumption of yeast cells.

If, as is generally held to be the case, the inhibitor operates by combining with an essential catalyst,

$$E + aUr \rightleftharpoons E(Ur)a$$

in such a way that the enzyme-inhibitor complex is catalytically inert, so that the observed respiration or function is proportional to the free [E], then the principle of mass action predicts that

$$\frac{U}{I} - [Ur]^a = K$$

U and I refer to uninhibited and inhibited respiration respectively, [Ur] is the urethane concentration and a and K are constants. Plotting log U/I against log [Ur] will give a straight line if the postulations made are adequate. Over much of the range of inhibition in yeast a straight line is obtained. The points corresponding to the initial degrees of the inhibition are however definitely off that line, and in fact a second line could be drawn through them. Thus two separate systems seem to be affected.

A discontinuity in the effect of urethane on O_2 uptake exists therefore and we may next inquire whether this fact is related in any way to function in the cells concerned. The ability of this same inhibitor to interfere with the function of multiplication in these cells was therefore determined. It appears that the concentration of urethane at which the discontinuity occurs is just about capable of stopping multiplication. It is difficult to escape the implication that the energy for reproduction is flowing through the first of the two systems.

Van Schouwenberg has determined the effect of urethane on light production and oxygen consumption in luminous bacteria. Calculated as indicated above, the completely urethane sensitive respiration seems to be made up of two fractions, the ability to produce light being associated with the first of the two.

Thus in these two types of cell the effects of urethane suggest that in each, two discrete systems are combined to make up the normal respiration. Moreover there is a close parallelism between the inhibitor concentration necessary to completely eliminate the first of these, and that necessary to stop reproduction in one cell and light production in the other. It seems possible that in these cells at least, the portion of the total respiration which is concerned with activity metabolism can be identified as a discrete portion of the total oxygen consumption from the quantitative effects of the narcotic, urethane.

(This article is based upon a seminar report presented at the Marine Biological Laboratory on July 16.)

M. B. L. CLUB

Mr. C. Lloyd Claff was elected President of the M. B. L. Club at its annual meeting at the Clubhouse on Monday evening. Dr. A. A. Abramowitz was made Vice-President and Dr. Sears Crowell was re-elected Secretary-Treasurer. Dr. Charles Packard was elected a member of the board of trustees of the Club.

Dr. Crowell made a report at the meeting on the finances of the Club. This stated that there was a balance of $187 at the beginning of 1939. Membership fees for last year totaled $405, and admissions to entertainments and guest fees $169, making a total income of $762. The general expenses of the club for last year, which include repairs, music, magazines, etc., totaled $547, leaving a balance of $215 at the beginning of the season for 1940, about $30 more than that of a year ago.

251 persons have joined the M.B.L. Club so far this season, Mrs. Dorothy Bosworth, chairman of the House Committee, reported. This figure is nine less than that at the corresponding time last year, and is attributed to the late arrival of many investigators at Woods Hole. She further reported that the exterior of the Clubhouse was repainted during the past year.

Miss M. Lucille Nason, chairman of the social committee, outlined plans for a "Poverty Dance" to be held at the M.B.L. Clubhouse tonight. All attending are requested to wear rags; an amateur floor show will be presented by members of the Club.

The Collecting Net

A weekly publication devoted to the scientific work at marine biological laboratories.

Edited by Ware Cattell and Robert Chambers with the assistance of Boris I. Gorokhoff and Peggy Browning; Contributing Editor, Homer A. Jack.

Entered as second-class matter, July 11, 1935, at the U. S. Post office at Woods Hole, Massachusetts, under the Act of March 3, 1879, and re-entered, July 23, 1938.

Introducing

DR. OTTO LOEWI, Research Professor of Pharmacology at the New York University, College of Medicine; Nobel Laureate in Physiology and Medicine, 1936.

Born in Frankfurt-am-Main, Dr. Loewi was educated at the Universities of Strassburg and Munich, and received a doctorate of medicine at the former institution in 1896. After receiving his degree he was an assistant to Professor von Noorden at Frankfurt for two years and then assistant to Professor Hans Horst Meyer at Marburg until 1904. After five years as Associate Professor of Pharmacology in Vienna, he became Professor of Pharmacology at the University of Graz, Austria, and director of the Institute of Pharmacology there, positions which he held for nearly thirty years. In 1938 he left for England, where he worked for a short time at the National Institute for Medical Research. Then he received an appointment as Franqui Professor of medicine at the University of Brussels for eight months. Since, he has conducted research at the Nuffield Research Institute at Oxford, where he remained until May, 1940.

Dr. Loewi's scientific work has covered many fields. He has dealt with the physiology and pharmacology of the metabolism, of the ions, the hormones, the kidney, the heart and the autonomic nervous system. In 1921 he discovered the humoral transmission of nervous impulses, and he has devoted most of his work to this subject since then. His fundamental experiments were made on frog hearts, in which he found that the stimulation of their nerves liberated from their endings chemical substances, acetylcholine and adrenaline, respectively, and that these substances are responsible for the transmission of the nervous impulse to the effective organ. It was this work that brought him the award of the Nobel Prize in Physiology and Medicine, which he shared with Sir Henry H. Dale of London.

Dr. Loewi arrived at Woods Hole on Tuesday of this week. He had left England on May 22 upon learning of his appointment at the New York University College of Medicine, where he will conduct research this fall. This summer he plans to complete papers started by him at Brussels and Oxford on the chemical transmission of impulses in sensory nerves.

This is Dr. Loewi's third visit to the United States. In 1929 he attended the Thirteenth International Physiological Congress, and in 1933 he returned to America as Dunham lecturer at Harvard Medical School.

Primary among Dr. Loewi's interests, aside from biology, are philosophy and the science of art.

ADDITIONAL INVESTIGATORS

De Liee, Elvira fel. med. New York Med. Br 304.
Egan, R. W. undergrad. asst. biol. Canisius (Buffalo, N. Y.). OM 39. Dr 15.
Gettemans, J. F. lab. asst. Rockefeller Inst. (Princeton). Br 209. Dr 6.
Herget, C. M. res. fel. phys. Russell Sage. Br 317.
Herskowitz, I. grad. biol. Brooklyn. Br 110.
Hibbard, Hope prof. biol. Oberlin. Br 218.
Hiestand, W. A. assoc. prof. physiol. Purdue. Br 223.
Klein, Ethel res. asst. zool. Pennsylvania. Rock 2.
Loewi, O. res. prof. pharmacol. New York Med. L 30.
Meglitsch, P. A. instr. Wright Jr. Coll. (Chicago). Br 222.
Morgan, Isabel M. invest. Rockefeller Inst. Br 320.
O'Brien, F. D. Canisius. OM 39. Dr 15.
Root, C. W. asst. prof. zool. Syracuse. OM 43.
Schaeffer, Olive K. res. asst. biol. Temple. Br 214.
Williams, J. L. grad. asst. biol. New York. Br 232. Ki 7.

ACADEMIC RANK OF M. B. L. INVESTIGATORS

The number of investigators in each academic rank registered at the Marine Biological Laboratory:

Professors	63
Associate Professors	19
Assistant Professors	60
Instructors	46
Research Associates	10
Assistants	71
Fellows	22
Graduate Students (not listed elsewhere)	27
Medical Students	8
Undergraduate Students	7
Preparatory Students	3
Miscellaneous	22

The four institutions leading in providing investigators at the Marine Biological Laboratory are:

Pennsylvania	34
Columbia	20
New York University	16
Chicago	11

The entry for the University of Chicago was accidently omitted from the tabulation last week.

CURRENTS IN THE HOLE

At the following hours (Daylight Saving Time) the current in the Hole turns to run from Buzzards Bay to Vineyard Sound:

July 21	5:47	6:00
July 22	6:24	6:50
July 23	7:10	7:28
July 24	7:48	8:13
July 25	8:31	9:01

ITEMS OF INTEREST

DR. J. RICHARD WEISSENBERG, formerly professor extraordinarius of anatomy at the University of Berlin, Germany, then in 1937 Visiting Professor of Cytology at Washington University, St. Louis, Mo., and in 1939 Member of the Wistar Institute, Philadelphia, Pa., has been appointed professor of histology and embryology at the School of Medicine, Middlesex University, Waltham, Mass.

DR. ERIC BALL has been appointed assistant professor of biological chemistry at Harvard Medical School. Dr. Ball was an associate in biological chemistry at Johns Hopkins University School of Medicine.

DR. VICTOR SCHECHTER has been promoted from instructor to assistant professor of biology at the College of the City of New York. This appointment takes effect on January 1, 1941.

A daughter, HELEN BELL JONES, was born on June 26th to Dr. and Mrs. E. Ruffin Jones, Jr. Dr. Jones is professor of zoology at William and Mary College and will be an instructor in the invertebrate course this summer.

MISS LAURA N. HUNTER, who has spent several summers at Woods Hole, was married on June 15 to Dr. Arthur C. Colwin, instructor in biology at Queens University, Long Island, New York. Mrs. Colwin, who has been on the faculty of the Pennsylvania College for Women, has been appointed instructor in zoology at Vassar College.

DR. CURT STERN, associate professor of zoology at the University of Rochester, visited Woods Hole on Tuesday and Wednesday to deliver a lecture before the embryology class on "Genetics and Development." Dr. Stern will spend most of the summer working at the Marine Experimental Station of the Lankenau Hospital at North Truro, Massachusetts.

PROFESSOR C. L. TURNER, of Northwestern University, delivered an evening lecture at the Marine Biological Laboratory on July 18 under the auspices of the staff of the embryology course. The title of his lecture was, "Evolution of Nutritive and Respiratory Devices in Embryos of Viviparous Fishes."

Among the members of the Marine Biological Laboratory to attend the Spectroscopy Conference at the Massachusetts Institute of Technology this week were: Drs. Kurt Stern, Kurt Salomon, Kenneth Fisher, A. E. Navez, Titus Evans, O. M. Ray, Carl Smith, F. J. M. Sichel, and E. P. Little.

The program of the phonograph record concert at the M. B. L. Club Monday night: Brandenburg Concerto No. 2, Bach; Symphony No. 40 in G minor, Mozart; Symphony in D minor, Franck.

A seminar in botany has been held by members of the Marine Biological Laboratory each Thursday night for the past four weeks. The first three were illustrated discussions of various biological stations. Last Thursday Dr. Taylor presented movies of the Hancock Expedition of 1939.

The second staff meeting of the Woods Hole Oceanographic Institution was held on Thursday in the lounge of the Institution. Mr. Iselin spoke on "Developments in Oceanography and their Effect on our General Program."

The Woods Hole Oceanographic Institution's ketch *Atlantis* returned on Wednesday to Woods Hole after an eight-day trip. It will sail again on Monday for a five-day cruise. Professor Maurice Ewing of Lehigh University will be on board with equipment to determine the thickness of the sediment on the ocean bottom.

Twelve lady members of the library, administration office, supply department and chemical room held their annual outing last Sunday. The group went to Cuttyhunk on the supply department's power boat *Nereis*, and enjoyed a shore dinner there.

On Monday afternoon, the *Nereis*, piloted by Mr. W. E. Kahler and Mr. Armas Kyllonen, rescued the crew of Morris Frost's sailboat, the *Jolly Roger*, which capsized during a race at the entrance to the Hole. The *Nereis* took the occupants of the boat, and the boat itself, back to Little Harbor.

DR. FRANK A. HARTMAN, professor of physiology at Ohio State University, is leaving tomorrow for a ten-day fishing trip in Maine.

APPEAL TO BIOLOGISTS

The research work at the U. S. Bureau of Fisheries Laboratory at Milford, Connecticut, is handicapped at present by lack of library facilities. It will be greatly appreciated if the biologists interested in marine research contribute their reprints to this institution. Papers on aquatic biology and those dealing with the life histories, embryology, anatomy, and physiology of marine fishes, invertebrates, and algae are especially needed. Those desiring to donate their reprints may mail them directly to U. S. Fisheries Laboratory, Milford, Connecticut, or leave them with Dr. Paul S. Galtsoff, Acting Director, U. S. Fisheries Laboratory at Woods Hole, room 118.

NEW MARINE LABORATORY AT MILFORD, CONNECTICUT

Dr. Paul S. Galtsoff

In charge of Shellfisheries Investigations, U. S. Fish and Wildlife Service

For nearly twenty years the U. S. Bureau of Fisheries has conducted oyster investigations in Long Island Sound from headquarters at Milford, situated first on the premises of a private oyster company and later on moved into a small temporary wooden building erected on a shore lot donated for this purpose by the State of Connecticut. Last May the staff of the laboratory was busy moving the equipment and furniture into a just completed new two-story brick building. Construction of a new laboratory was carried out as a Public Work Administration Project with funds allocated for this purpose by the Secretary of the Interior, Harold L. Ickes.

Preparatory to the construction work the low marsh ground received from the State was raised about 10 feet above its original level and the part of the bay adjacent to the property was dredged to provide a minimum depth of 10 feet. The new laboratory occupies a fireproof building 70 by 35 feet, which rests on 96 yellow-pine piling driven 35 to 40 feet into the ground. The first floor contains the Director's office and laboratory, one laboratory room 21 by 16 feet, two small rooms for investigators, a room for meetings, lectures, and displays, 22.7 by 22 feet, rooms for the heating plant and mechanical equipment, lavatories, and a carpenter shop.

Chemical, physiological, and biological laboratories, each about 23 by 16 feet are located on the second floor, together with the chemical stock room, balance room, photographic room, and library. All the laboratories are provided with standard equipment, i.e., gas, electricity, cold and hot fresh water, sea water, compressed air, and the necessary furniture. The chemical room is equipped with standard chemical tables and two large fume hoods with forced draft. The sea-water system consists of a noncorrosive rubber pump of suitable capacity, a 5,000 gallon cypress storage tank located in the attic, and lead pipes delivering the sea water to drain tables placed in each of the laboratory rooms.

A unique feature of the new station is a series of large concrete out-door tidal tanks, about 8 feet deep, built along the water line. Each tank is individually filled with sea water through tidal gates and the depth of the water can be maintained at three different levels. An 80-foot dock provides ample facilities for the laboratory's boats.

Before designing the laboratory and selecting its equipment, a careful study was made of existing biological stations, and efforts were made to introduce the necessary up-to-date facilities, yet at the same time to avoid expensive structural features. Many of the architectural features proving useful in the Marine Biological Laboratory and the Oceanographic Institution at Woods Hole were incorporated in the plans of the Bureau's new station. To conform with its surroundings, the Milford Laboratory is of simple design and colonial in style of architecture.

The program of research to be conducted in the new laboratory comprises two distinct phases: (a) Studies of the life histories, ecology, and physiology of principal edible mollusks and of their enemies; and (b) Applications of scientific knowledge to the practical problems of conservation and cultivation of shellfish. At present the following investigations are being carried on at the laboratory: (1) Development, growth, and metamorphosis of oyster larvae; (2) Factors controlling the distribution and attachment of the oyster larvae; (3) Carbohydrate metabolism of the oyster in relation to its growth and gonad development; and (4) Propagation of starfish, *Asterias forbesi.*

Permanent staff of the laboratory consists of Dr. V. L. Loosanoff, director; Dr. Walter Chipman, Jr., physiologist; James B. Engle, oyster culturist; and Joseph Lucash, foreman. The position of a secretary has not yet been filled.

Two other laboratories of the Bureau engaged in shellfisheries investigations are located at Beaufort, North Carolina, and at Santa Rosa Island near Pensacola, Florida. During the past two years the buildings of these institutions were repaired and their equipment modernized to meet the present needs of biological research.

PHYSIOLOGY CLASS NOTES

This week has been marked by a series of visiting lecturers. On Friday Dr. Ball discussed the chemical nature of various catalysts taking part in biological oxidations, bringing us right up to date as to the significance of several members of that vitamin B complex. Following this, Dr. Stern on Saturday engaged in a discussion of some of the differences between the metabolism of normal and malignant tissues. Dr. Nachmansohn's lecture on choline esterase in the electric organ of the torpedo brought back memories of that Saturday morning demonstration which Dr. Prosser arranged for us, down on the wharf, during which a torpedo was excited and caused to ring a door bell. The torpedo was rather a slug-

gish beast but after much twisting and slamming would finally "discharge" for us.

The annual Physiology picnic at Tarpaulin Cove was, needless to say, a success. Embracing students, staff, wives and blood relations (but not heart-beats) it got under way about 9:30 aboard the *Winifred*. Just before casting off, Dr. Irving appeared with an organ grinder out of nowhere, who accompanied us for the day. After several of our number had tried their hand at organ grinding, it was unanimously agreed that they stick to physiology. There was more to it than met the eye.

The traditional lobsters were served along with clams, corn, potatoes ,and liquid refreshment of various orders; and of course the watermelon.

At one point when comparative quiet prevailed, someone noticed that one of our huskier colleagues had not been near the water. After a moment or two of shrewd calculation, an appropriate amount of man power was accumulated and the struggle was on. It was successful in that the victim was dunked after just the right amount of resistance to the overpowering brute force.

A hike to a fresh-water lake was undertaken by some few of our crew, but the rest spent a lazy afternoon on the beach.

At about 4:30, the *Winifred* started back with some, while a party set off to hike across country to the end of Nonamesset Island. This took two hours and the reactions to this excursion were somewhat varied. There were those who felt stimulated and invigorated; and again there were those who were quite definitely done in, who staggered down the last stretch in a somewhat punch-drunk condition. There were those who took the hike with mighty strides, and those who seemed rather to be sauntering. Supper was waiting, however, and all spirits were restored. The *Nereis* came for us at about 9:00, and found us huddled around the fire, quite out-doing ourselves in "Red River Valley" et al. with sound effects.

Thursday was a typical "day-after", with as much work done as could be expected.

Saturday the Physiologists and Embryologists played a baseball game. The Embryologists won. It is our humble opinion that our unceasing application to academic work was a contributing factor to our defeat. Witness the deep coats of tan worn by so many of our opponents. Those were not acquired underneath a desk lamp! We suspect many long secret hours of practice while our boys toiled away in the laboratory. At any rate, we think the first inning was pretty swell.

—*R. P. F.*

EMBRYOLOGY CLASS NOTES

Four Embryologists, only slightly hampered by six Physiologists, won the soft ball game between the Physiologists and the Investigators for the Physiologists. Such an example of Christian charity and kindness should go down in the annals of history. We bear no envy towards our models of diligence and of true investigative spirit whom we have been instructed to emulate in an attempt to reach the acme of intellectual attainment. The fact that the Physiologists spend more time in the lab is not caused by the fact that they work any harder or produce any more or better results. Rather, the reason should be fairly obviously one of a lack of not only brawn (see above) but also of you know what. And so, despite frequent injunctions to rival the Physiologists in scientific interest we take great pleasure in extending to them some of our excess brawn produced in excess time produced by more brains so that we can have the time to develop the brawn.

The Investigators, however, we will have to admit, really must have something. In a five-inning game they emerged the victors over the Embryologists with the official score standing at 14-13. In an extra sixth inning the Embryologists took the lead again but, then, it wasn't significant.

For the benefit of those who haven't been in the laboratory this last week I would like to give some of the details concerning the lab work. The experiments on echinoderms which Dr. Schotté had started us on the previous week were continued. We repeated the parthenogenetic experiments outlined by Loeb and also used the simpler parthenogenetic technique of immersion of eggs in hypertonic sea water. Other experiments were tried to show the influence of lithium chloride on developing echinoderm eggs and also to show the effects of cross-fertilization on development. The Harvey technique for the parthenogenesis of centrifuged merogones was also repeated. The experiments produced a state of consternation as well as millions (more or less) of echinoderm plutei in an otherwise happy lab.

Dr. Hamburger began his second series of lectures late this week on the development of annelida and molluscs with emphasis on some of the more important experimental work that has been done. The laboratory work has consisted of observations of Nereis and Crepidula trachaphores.

Lost and found department:—

1. Where is Ollie Halstead?
2. Anyone knowing the whereabouts of an Amherst football player during the recent baseball games will keep quiet or will Sweeney's face be red.

3. Found: At the Embryology picnic—what takes Ken Steele's mind off his work.
4. Where is Ollie Halstead?
5. Flash! Where was Sawyer Saturday night?
6. Whose battle cry on what night in the forward cockpit of what boat was "Wolf, Wolf!"?
7. Where is Ollie Halstead?
8. Has Ed Robinson at last bridged the gap between plants and animals?
9. J. Van Raalte K. objects to the claim that her theme song is "Double Trouble." That's no trouble—it's a pleasure.
10. Where is Ollie Halstead?
11. "I just came along to DRIVE the boat," unquote you know whom.
12. Haven't they heard in Oklahoma that the day of etching exhibits is past?
13. Where is Ollie Halstead?

—*Margie Jolly*

BOTANY CLASS NOTES

ALGOLOWOCKY

'Twas Algae and because of this
The class cut sections by the score:
All Axel was the *Nereis,*
And the embryos next door.

"Beware the barnacles, oh Rufe!
The rock that slips, the stone that skins.
Beware the shores and stay aloof
To guard those lanky shins."

To plumb the bottom of the sea
Sans Mrs. Sills we went to dredge,
And then rocked we in misery
(While Bill stayed near the edge).

The fog rolled in, a misty screen,
Miss Ciu discovered algae rare;
Our stalwart Sam turned slightly green,
Began to gasp for air.

Jo saw that we were pickle-fed,
Hank dived for dainty algal snack.
With skins burned red we left Gay Head,
Came seminaring back.

"And hast thou seen an algal slide?
Come to my arms, my darling Toots!"
"Oh, No," she cried, and turned aside
To see Don's bandaged boots.

"It's bunk to dunk," said Dr. Runk,
"Please pass the Ritz and peanut butter.
We'll work all night, no use to funk;
Miss Campbell, please don't mutter."

'Twas Algae and because of this
The class cut sections by the score:
All Axel was the *Nereis,*
And the embryos next door.

—*Algernon Algy*

PROTOZOOLOGY CLASS NOTES

This last week, in a calm sort of way, has marked the beginning and the end of various of the multiple activities of the busy Protozoologists. The days of hay tea and isolation cultures are over and the beloved Glaucoma need no longer find shelter from pipette raids from their watery sky.

The beginning of slide making marks a new era in vocabulary control. The chief difficulty occurs in the coverslip. Only after long hours of work does one view the beauties of an empty slide skillfully stained with Heidenhain's Iron Heamotoxylin method. Then there are more rapid methods in which, only after a few minutes, does one behold the same view stained with Feulgen's or the relief stain Negrosin. A few victims, however, have resigned themselves to sticky funerals and are colorfully fixed for posterity in their glass mausoleums.

Collecting took on new forms this week. Two Protos spent a profitable morning on hands and knees at Nobska hopping around after sand fleas. Another member wallowed in the Falmouth dump and returned with a veritable menagerie.

Drawings are being produced at a tremendous rate as the deadline for all sixty approaches "on little cat feet" with next Saturday.

The "pros and cons" of a picnic are seriously debated with the probability of the event taking place decreasing from hour to hour. It has been suggested that microscopes be taken along and the picnic be combined with a deep sea fishing expedition with beer, lobsters and Radiolaria.

On Saturday morning, Dr. Austin Phelps, of the University of Texas, spoke on "Certain Aspects of Protozoan Growth" with emphasis on population and growth curves. Other lectures of the week, given by Dr. Calkins and Dr. Kidder, included those on nuclear organization and development.

Judging from the comparative calm of the nearby labs, an industrious week was in order for all. As the middle of next week marks the close of the Physiology and Embryology courses, is there a possibility that they are making up for lost time? Then, too, the more than successful Physiology "get acquainted" picnic accounts for one day of complete quiet and advancement of science. So ends the fourth week for the Protozoologists.

—*Doris Marchand*

BOOKS IN THE BIOLOGICAL SCIENCES PUBLISHED SINCE SEPTEMBER 1, 1939

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THE COLLECTING NET

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FUNCTIONAL PROPERTIES OF TRANSPLANTED AND DERANGED PARTS OF THE AMPHIBIAN NERVOUS SYSTEM

DR. PAUL A. WEISS
Associate Professor of Zoology, University of Chicago

In an attempt to determine functional properties of nerve centers which might not depend for their execution upon the integrity of the typical neurone patterns, a method of "deplanting" fragments of developed nervous system was devised by which a breakdown of the normal structural patterns could be obtained while at the same time enough nervous matter could survive to exhibit functional activity. The method consists of the following.

Fragments of spinal cord measuring from four to twelve segments are excised from salamander larvae (two to four centimeters in length) and inserted into the gelatinous connective tissue of the fin extending along the dorsal mid-line of a host animal of similar age. At this stage the central nervous system is essentially differentiated and has been in functional activity for several weeks or months. After deplantation it becomes (*Continued on page* 91)

M. B. L. Calendar

TUESDAY, July 30, 8:00 P. M.

Seminar: Dr. B. H. Willier: "A Study of Feather Color Patterns Produced by Grafting Melanophores During Embryonic Development."

Dr. G. H. Parker: "The Melanophore Neurohumors in the Catfish."

Dr. H. B. Goodrich: "The Cellular Basis of the Color Pattern in Some Bermuda Coral Reef Fish."

FRIDAY, August 2, 8:00 P. M.

Lecture: Dr. Eric G. Ball: "Catalysts of Biological Oxidation, Their Composition and Mode of Action."

ELECTRICAL PROPERTIES OF CELL MEMBRANES

DR. K. S. COLE
Associate Professor of Physiology, Columbia University

By far the largest part of our knowledge of living cells has been acquired from observations and measurements made with visible light and indeed we most often think of cells, tissues and organisms in terms of their visible appearance. We habitually associate an object directly with its optical image because long familiarity permits us to overlook the intervening steps, such as refraction and absorption, which create this image. And so when we must turn to other and less familiar methods of observation it may be difficult to recognize what we see and to have confidence in the image which they create. We shall seek now to describe the living cell membrane in electrical terms—to present its electrical picture. The electrical methods are used, not because of any belief that they are necessarily fundamental, but because they certainly see things in a different and perhaps simpler light, and (*Continued on page* 87)

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THE SITE OF THE WOODS HOLE OCEANOGRAPHIC INSTITUTION PIER IN 1870

A painting from memory by the late Franklin L. Gifford. The location of the berth of the *Atlantis* is just to the right of the stage coach; the site of the engine house and a portion of the yard of the Woods Hole Oceanographic Institution appear in the picture.

The painting portrays the steamer *Monohansett* landing at Bar Neck Wharf in August, 1870, with over 900 passengers aboard on their way to Vineyard Haven camp meeting. The vessel often towed whaling vessels into Woods Hole when they were unable to proceed under their own sails.

The building on Bar Neck Wharf was first used as a freight shed by the Steamboat Company, and was originally on the present site of the library. After the railroad wharf was built, the building was purchased by William Studley who rebuilt it as a residence for himself. The house is now on North Street.

The stage coach on the wharf met all the boats, and brought passengers to Woods Hole, bound for New Bedford and the Vineyard. It had a regular route between Falmouth and Woods Hole.

The land in the distance is Naushon Island, while the low tide in the foreground exposes the sand bar on Grew's Clam Flats. Dyer's dock now covers the flats, and the Penzance Garage is located on the old Bar Neck Wharf.

Two lightships can be seen in the distant harbor. The "square-rigger" came from Italy loaded with brimstone for the Pacific Guano Company which was established on Penzance Point in 1863. This chemical laboratory and manufacturing plant was for thirty years the principal industry of Woods Hole. Crude guano from distant islands was combined with bone scrap to produce a superior type of fertilizer. The Guano Company was in operation from 1863 to 1895, employing regularly from 150 to 200 men.

ELECTRICAL PROPERTIES OF CELL MEMBRANES

(Continued from page 85)

because the machinery is available for making rapid and accurate measurements with little or no detectable effect on either the living membrane or the cell as a whole.

Ion Permeability

First let us investigate the permeability of the cell membrane to ions. This should be an ideal application for electrical methods because the outstanding characteristic of an ion is its electrical charge. When such charges are in an electric field between two electrodes, they are forced towards one or the other of the electrodes and if some of the ions are able to cross an intervening membrane, they constitute an electrical current. The permeability of the membrane may then be measured by the ratio of the current to the driving force, which is the potential difference between the electrodes. This ratio of current to potential difference is none other than the electrical conductance, or the reciprocal of the electrical *resistance,* commonly measured in ohms.

We cannot easily insert an electrode inside of a cell to measure the membrane resistance directly but current may be sent in one side of the cell and out the other. The cytoplasm is a good electrical conductor and we could obtain the membrane resistance in this manner except for the difficulty of estimating the current leakage around the cell. If, however, we have a uniform suspension of cells in a conducting medium it is possible to calculate the paths of current flow. This has been done by Clerk Maxwell for a suspension of spherical particles and his equation may be used for marine egg suspensions, although it is very unlikely that he foresaw this application. Measurements of the resistances of the suspension and the suspending medium, and the volume concentration made on Hipponoë and Arbacia egg suspensions of various concentrations, show that within the error of the concentration measurements the plasma membranes are perfectly nonconducting in both the fertilized and unfertilized egg. It is not necessary, however, to confine ourselves to spherical cells for the Maxwell equation is easily modified for use on fibrous tissues such as muscle and nerve when the current flow is transverse, i.e., at right angles to the fiber axes. It is not an easy matter to vary the volume concentration of fibers in muscle but instead the resistance of the intercellular medium may be varied by mixture with iso-osmotic sugar solution. These measurements of the frog sartorius muscle also fail to prove an ion permeability as do the data on nerve, Nitella and the squid giant axon. The first extensive and accurate measurements of cell suspensions were made with red blood cells but these could not be explained by the Maxwell equation. The equation was modified by Fricke to apply to oblate spheroids and excellent agreement was then obtained on the assumption that the membrane was impermeable to ions.

Before concluding that these membranes are not permeable to ions, we must consider the effect of experimental errors. The necessary accuracy in the volume concentration measurements is found to be directly proportional to the resistance of the medium and to the diameter of the individual cell, and inversely proportional to the membrane resistance. In the experiments already considered, it is estimated that this accuracy would have to be better than 1/10 per cent and so we must look for more favorable conditions. It is not yet permissible to alter the membrane resistance and so we must seek larger cells and higher resistance media. By external measurements on so large a marine cell as Valonia, Blinks was unable to demonstrate a membrane conductivity. He did, however, obtain the first estimate of a membrane resistance, 5000 ohms for a square centimeter, for impaled Valonia. Recent preliminary measurements on the frog egg in pond water give a value of about 400 ohms. It is not necessary that the cells be large in all dimensions, if we are willing to desert our relatively simple mathematical analysis and undertake to interpret longitudinal measurements made between two electrodes along the length of a fiber. In this way, Blinks obtained a value of 250,000 ohms for a square centimeter in Nitella. More extensive longitudinal measurements of the squid axon and single fibers from lobster and crab nerves give approximately 1000 ohms for a square centimeter of membrane.

It is now found that for favorable material in which the geometrical measurements can be made with sufficient accuracy, a permeability of the membranes to ions as such can be detected and measured. We may then assume that a similar permeability exists in other cell membranes but that it will be more difficult to measure. There

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is as yet no basis for deciding that this ion permeability is large or small. It is difficult to measure and seems quite small in the units we have used to express it, but we do well to remember that the cell has adjusted the permeability to its requirements and not to our convenience. We may however reach a compromise if we ask about not only the permeating ions but also the ions which do not get through the membrane—either because they are refused admittance or because of the crowds at the gates.

Ion Impermeability

We shall again put the electrical driving force on the ions but now confine our attention to those ions that do not cross the membrane. At the instant the potential difference is applied all ions will start to move quite as they do when there is no membrane present, but soon some are stopped by the membrane and an accumulation of anions on one side of the membrane and cations on the other starts in. This accumulation proceeds at a slower and slower rate as the ions already present prevent more of the same kind from approaching. Finally the excess charge on each side becomes constant and is proportional to the applied potential difference. This is a familiar characteristic of non-conductors and the ratio of charge to potential difference, known as the *capacity*, is measured in farads. Although this capacity is measured by means of the ions which cannot cross the membrane, it is a characteristic of the membrane which depends upon its composition, structure and thickness. The capacity can be measured by the rate at which the ions assemble after the application of a constant potential difference or, more conveniently at the present time, by the use of alternating potential differences. If the potential difference swings rapidly back and forth from one direction to the other, the ions will only have time to travel so short a distance that they all move quite as if the membrane were not present. There will then be current flow through as well as around the cells in a suspension. For very low frequencies of alternating potential difference, the ions will have ample time to accumulate on each side of the membrane and practically prevent current flow in this direction. The current flow in a suspension will then be around and between the cells for low frequency alternating current.

Now as to the evidence that a living cell membrane has such an ion impermeable structure. Höber found the current flow was entirely intercellular in red cell suspensions and muscle at one thousand cycles and that at nearly ten million cycles the current also flowed through the cytoplasm just as it would if there were no membranes. These observations clearly demonstrate a membrane capacity, but it was not until some years later that Fricke showed that the membrane capacity could be calculated from measurements on a suspension and obtained an approximate value of 0.8 microfarad per square centimeter for the red cell membrane. We may now put the theory in more complete form by returning to the Maxwell equation and modifying it again. Alternating current measurements on suspensions of unfertilized Hipponoë, Asterias and Arbacia eggs agree very well with the theoretical picture, except for the effect of an unidentified structure at the highest frequencies, and give us membrane capacities between 0.7 and 1.1 microfarads per square centimeter. Red cell suspensions give nearly one microfarad but show a slight systematic deviation from the theory. For frog muscle, we obtain again a microfarad per square centimeter but the deviations are far too large to ignore and we must ask what is wrong with our theoretical picture. The observations could be explained by a variation of membrane capacity and diameter from fiber to fiber but there is also the possibility that this deviation may be a characteristic of each individual fiber membrane. This can be only decided by measurements of single cells. Both the Nitella and squid axon data again give a membrane capacity of a microfarad per square centimeter but also present ample evidence that this membrane capacity is not so perfect as we have pictured it. It has the well-known characteristic found in many non-living insulators which is called dielectric loss.

A summary of the data for nearly thirty different cells gives an average membrane capacity of about one microfarad per square centimeter with varying amounts of dielectric loss for all but the marine egg cell membranes. We may now make a comparison between the ion impermeable and the ion permeable aspects of the membrane as measured by the capacity and resistance. When a potential difference is applied to the membrane, the permeating ions give a steady current flow which is proportional to the excess non-permeating ions piled up on each side of the membrane. A resistance of 500 ohms and a capacity of one microfarad for a square centimeter of membrane tells us that two thousand ions per second pass through the membrane for each pair of impermeable ions separated by the membrane. Stated in these terms the membrane permeability seems quite considerable, but we are again without an adequate basis for this conclusion.

Membrane Inductance

With these ion permeable and ion impermeable characteristics of the membrane represented by resistance and capacity we now turn with some confidence to prediction. With paper, pencil and differential equations we calculate the longitudinal

alternating current characteristics of the squid axon to be measured between large electrodes a centimeter or so apart, and then we turn to the axon for confirmation, as was done two summers ago. The measurements at the high frequencies were quite as expected but low frequencies gave an apparently "negative" capacity which was entirely unanticipated. This anomoly is not only real and a property of the axon but the structure responsible for it is located in the membrane. A "negative" capacity is only a descriptive term but from conventional electricity and magnetism we find that the measurements can be explained by —and only by—the well-known electrical element of *inductance* which is measured in henries.

This inductance must now be put into our electrical picture of the cell membrane along with the resistance and capacity. The simplest possible picture is not perfect but it is sufficiently good to give us an estimate of one-fifth henry for a square centimeter of membrane.

Membrane Function

A preliminary sketch of the cell membrane, as seen electrically, has now been completed and we should pause to question its value, to ask what it tells us of the structure and function of the membrane. We may turn first to the processes of injury and death. These have been extensively investigated in Laminara by Osterhout and there are certainly changes of ion permeability but we may ask what happens to the ion impermeability. As a single example let us measure the resting frog sartorius muscle and then follow the changes of the alternating current characteristics during exposure to chloroform. These changes are approximately those which we expect if the ion permeability alone increases. Although they do not follow the predicted course exactly, and there is an apparent alteration of membrane capacity, the data indicate that the changes of ion permeability are many hundred fold greater than the changes of the ion impermeable aspect of the membrane. This suggests that the two aspects may be relatively independent.

It is commonly accepted, apparently without extensive proof, that during current flow the ion permeability of a membrane is increased at the cathode and decreased under the anode. Our membrane picture however, gives an ion permeability independent of current flow and we must measure the effect of current flow through a real membrane. This has been done by transverse measurements of the squid giant axon; there was practically no change of the ion impermeable structure, and the permeability was found to increase at the cathode and decrease at the anode. This result is quite satisfactory from a physiological point of view, but it means that the electrical picture must be modified. We can no longer represent the ion permeability by a conventional resistance and shall turn to a different type of experiment to suggest its successor.

Last summer techniques were developed independently at Plymouth by Hodgkin and Huxley and at this laboratory by Curtis for inserting a micropipette about a centimeter into the axoplasm from one end of the squid axon. Using the tip of this pipette as an electrode we can now measure directly the potential difference across the membrane during current flow. After the current is applied, the potential rises at the anode and falls at the cathode until it reaches a constant level after the membrane capacity has been charged. These changes of potential would be equal and proportional to the current if the membrane permeability were represented by resistance. But at the anode the potential rises more slowly to higher levels than anticipated as the current is increased. At the cathode the potential rises more rapidly and oscillates before settling down to a lower level than for a simple resistance as the current is increased.

Considering now only the final level, this means that the current flows more easily in one direction than the other and as a result also spreads much farther along the axon from the anode than the cathode. Taking into account the spreading effect we find that the membrane is actually an excellent rectifier, having a hundred times greater resistance at the anode than at the cathode. The spread of current is an explanation of the spatial difference of anelectrotonus and catelectrotonus first found by Pflüger and the rectification will probably also explain several summation effects found by Gildemeister and Katz.

Our membrane has both capacity and inductance which are analogous to elasticity and mass in mechanical systems. As we know, a spring and a weight or a stretched wire can vibrate freely if there is not too much friction. From the data which produced the membrane inductance we can predict that the membrane potential will oscillate under favorable conditions and that the frequency will be about 250 cycles—middle C on the musical scale. The membrane may be "struck" electrically with a cathode current and the calculated oscillations agree quite well with those described above. At the anode the motion should be overdamped, as has been found. Arvanitaki has found similar oscillations of about the same frequency in the Sepia axon. When the calcium was lowered sufficiently, the oscillations started spontaneously and built up until the threshold was reached and repetitive discharge took place. Oscillations of excitability at about 200 cycles have been found

by Erlanger and Blair, and Monnier and Coppée for the frog sciatic nerve.

It has long been postulated that an increase of ion permeability was an essential part of the initiation and propagation of a nerve impulse. Measurements on the squid axon at the cathode show this increase when the threshold is reached and we may make similar observations during the passage of a distantly initiated impulse. The action potential rises smoothly to the point of inflection with no measurable change of the alternating current characteristics. At this point, however, a sudden increase of ion permeability takes place which returns to the resting level somewhat more slowly than the action potential. The maximum permeability is about forty times the resting value but this takes place with little if any change of the membrane capacity and similar results are found for Nitella. An analysis of the local circuit current flow in the rising phase of the action potential shows that this current is outward, or cathodal up until the point of inflection. There should then be an increase of ion permeability, but none was found. When we invoke the inductance this is quite easily explained. The membrane potential is falling quite rapidly in this region of the action potential and a considerable portion of the current tends naturally to flow into the membrane capacity. An inductance however is fundamentally opposed to any change of the *status quo* and resists it so vigorously as to force nearly all of the current into the condenser and so protect the rectifier or ion permeability element from change until the actual excitation takes place at the inflection point of the potential.

In all of these phenomena we have found that the membrane capacity is singularly unaffected but this is not always the case. The capacities of the Arbacia and Hipponoë egg membranes are several times larger after fertilization than before. There are however preliminary data to indicate that this change does not occur in several other forms and it may be that these two, the first investigated, are anomalous.

These few examples indicate that the elements of our electrical membrane picture may have functional significance and it becomes even more interesting to investigate the suggestions which it can make as to the structure of the membrane under various conditions.

Membrane Structure

As has been mentioned, the capacity, or ion impermeable aspect, and the dielectric loss depend upon the composition, structure and thickness of the membrane. If we assume that the membrane has the properties of a lipoid in bulk, the thickness corresponding to a microfarad per square centimeter is about one or two molecules, as was pointed out by Fricke. Measurements of the properties of surface films do not seriously modify this estimate. It is not necessary that the film be lipoid so far as the capacity and dielectric loss are concerned, for the double tanned protein films of Dean provide an excellent model in both respects. The origin and nature of dielectric loss in non-living materials is not yet known and engineering has long been waiting on physics and chemistry for an answer to these questions. Furthermore, until they can be answered we must not be too confident of our concepts of perfect dielectrics. There are however indications that highly condensed structures, in which the inter-molecular forces are particularly strong, are responsible for the type of dielectric loss observed in the living cell membrane. Such structures may also have a large dielectric constant which suggests that the membrane may after all be rather thick.

The singularly small changes of this ion impermeable part of the cell membrane in injury, death, current flow and excitation—where the ion permability may change ten or a thousand fold—leads us to picture the ion impermeable structure as a massive, inert and durable framework occupying almost the entire bulk of the membrane, with the ion permeability represented by at most a small percentage of the membrane volume.

In contrast to the ion impermeability, the ion permeability as measured electrically has considerable functional significance and its changes reflect—or perhaps, cause—a variety of physiological and pathological phenomena. The outstanding difficulty is that as yet we have no objective indications of the ions involved and until these can be identified the number of possible mechanisms for the ion permeability characteristic is almost unlimited. For example, we may assume a membrane permeability to potassium ions alone. With an inward current flow, an external medium of low potassium concentration could only supply a few ions to the membrane and its electrical resistance would be high. An outward current flow might draw on the high internal potassium concentration to increase the number of carriers in the membrane and so decrease the resistance. It may not be too optimistic to predict that an explanation of this membrane characteristic will be a rather complete molecular picture of the membrane and correlation of ionic membrane phenomena.

From the purely electrical point of view, this cell membrane compares very favorably with the copper oxide and selenium rectifiers so widely used at the present time. It is interesting to note that while these rectifiers have been quite difficult to explain and their action has been a center of considerable theoretical interest, there are prob-

ably fewer of them in use than there are biological rectifiers in a few cubic centimeters of living cells.

Our information on the origin of the inductive element in the membrane is very meager as yet, but it is difficult to deny its importance in nerve phenomena. The constancy of the membrane capacity and the prevalence of the 250 cycle frequency in nerve fibers leads us to suspect that the inductance may be as constant and indestructible as the capacity. It may be intimately associated with the capacity and present in all cell membranes, but it could also be the structure which makes a nerve fiber what it is.

The concept of a capacity finds a ready application in the cell membrane but those of us who associate inductance with massive coils of copper wire on heavy iron cores find it difficult to place such a structure in the cell membrane. Fundamentally, a capacity represents a storage of energy by virtue of the position of electrical charges and in these terms an inductance represents a storage of energy associated with the motion of electrical charges. A magnetic field is but one way in which an electrical current can be made to store energy. A quartz crystal can do this because of its mass and an ability to change shape in an electrical field and a small quartz plate a millimeter thick may have an inductance of about 1/10 henry—half that of a similar area of cell membrane. Another example is a bead of uranium oxide a millimeter in diameter on two fine platinum wires. The thermal properties and a negative temperature coefficient of resistance give this structure an inductance of several hundred henries. Recent x-ray observations on the myelin sheath and electro-optical studies of bentonite suspensions strongly suggest that the membrane inductance may be of the type found in the quartz crystal and arise from a highly organized, quasi-crystaline membrane structure.

This then is the cell membrane as seen through the eyes of electricity. It is quite apparent, from our discussion of its origins and relations to structure and function, that the picture is far from being complete and accurate. We can see that the real and difficult problems lie ahead, for only the simple and elementary steps have been taken. Yet these steps were easy only because of the able and enthusiastic cooperation of Dr. Curtis, Mr. Spencer, Dr. Baker, Miss Guttman and Mr. Hodgkin.

(This article is based upon a lecture delivered at the Marine Biological Laboratory on July 19.)

FUNCTIONAL PROPERTIES OF TRANSPLANTED AND DERANGED PARTS OF THE AMPHIBIAN NERVOUS SYSTEM

(Continued from page 85)

quickly revascularized from blood vessels of the host but remains otherwise independent. It undergoes a certain amount of involution and its intimate structure becomes considerably reduced and deranged.

As a test organ for its functional manifestations, a limb was transplanted at some distance from the grafted center. Nerve fibers issuing from the latter soon effected functional connections with this limb graft, supplying both musculature and skin in fairly normal fashion.

Towards the end of the second week after transplantation signs of function appear. They consist of fibrillar twitches which within a few days increase in strength and frequency until, by the third week, the limb exhibits almost continuous automatic clonic contractions. Individual seizures may last for many minutes and upon subsiding can be provoked again by slight pressure against the site of the grafted center. The activity of the C.N.S. at this time is marked by its rhythmicity and tendency of the discharges to become synchronized so that the limb musculature displays strong beats at a fairly regular rhythm of the order of one to several seconds.

This endogenous discharge occurs while the host animal may be completely at rest, but it is augmented by previous activity of the host body, indicating that metabolites appearing in the blood during activity raise the excitability of the grafted unit. Pithing the host animal or excising the grafted unit does not suppress the activity of the latter. Anaesthesia as well as cutting the nerve cable between the grafted center and limb abolish the response.

Some days or weeks after endogenous activity has appeared reflexes can also be obtained by stimulating the grafted limb or the skin in the vicinity of the spinal graft. These reflexes are mass reactions of the limb musculature and consist of a quick twitch followed by a drawn-out repetitive after-discharge. The fact that both the endogenous automatic discharge and the reflex discharge involve the grafted center as a whole rather than any particular component neurone chain, is best demonstrated by cases in which two limbs were transplanted, one to the anterior, the other to the posterior end of the spinal cord graft. Although innervated from opposite parts of the center, both limbs contract in unison. This synchronism is immediately abolished by dividing the grafted center so that each limb now possesses an independent center of its own. All reflexes have shown evidence of spatial and temporal sum-

mation. The observed phenomena of endogenous and reflex activity may continue for as long as five months, although there seems to be a gradual decline in the excitability of the grafted units.

If a limb is transplanted with its spinal centers and nerve connections left intact, reflexes can be obtained immediately after the transplantation. These reflexes are as differentiated as they were in the intact animal. However, during the two weeks following the operation one observes a gradual deterioration of the reflex and breakdown of its organization, with a concomitant appearance of automatic activity of the same type as that occurring in secondarily innervated limbs. Thus the degradation of the spinal center can be followed directly by observation.

If the nerve centers, instead of being transplanted as such, are minced and then injected so that the fragments reaggregate, the functional phenomena are essentially the same as those following the deplantation of the intact centers.

Different parts of the nervous system seem to differ specifically in their performances, but this point is still under investigation. Thus far, spinal cord from any level behaves as described above; hind brain produces well-synchronized rhythmic activity, but thus far has not yielded reflex action; thalamus has not yet been seen to give rise to either activity.

In conclusion, these experiments demonstrate that certain fundamental functional properties of nerve centers persist after the typical anatomical structure has been deranged, and the described method points a way to an analytical study of those properties. It furthermore permits the experimental complantation of different nerve centers in arbitrary combinations, thus creating a kind of "synthetic neurology." Potentially the method can render a similar service to the study of physiological function as tissue culture has rendered in the study of morphological problems.

(This article is based upon a seminar report presented at the Marine Biological Laboratory on July 23.)

PHYSIOLOGY CLASS NOTES

At the beginning of the season we wondered at the necessity of the painted signs outside the building designating the various labs. Now they seem altogether futile because with the waxing of the moon there has been an ever increasing migration of students—more predictable even than Nereis itself. Certain Embryologists find pretext to use our Bunsen burner, we dash upstairs to use the Protos' centrifuge or do a little collaborating over at Rockefeller; more recently the Protos have gained courage to visit us but more often fire salutes down the spiral staircase with empty beer cans—they were beer cans weren't they, Phil?

Rumors are that Holton and Woodward have been called up before the Woods Hole division of the F.B.I. to explain the disappearance of large quantities of rubber tubing. As a matter of fact they have merely been turning their investigative minds to the development of a better long-range water gun. Improvements are remarkable. Syringes soon replaced pipettes and now a thoroughly distended piece of tubing has the advantages of both capacity and range. So effective are they that to date the Protos, while often hit poring unsuspectingly over their scopes, have never once spotted the snipers.

This week's lectures offered a change in diet from the usual fare of cell respiration and transmission in nerve fibers. Dr. George L. Clarke came over from the Oceanographic and made us ardent supporters of Maine's crystal-clear lakes think we had only been swimming in mud holes after all. Our hats are off to him for his charm, his sense of humor, and his outstanding ability to present his material clearly and simply.

Monday there was standing room only in the Old Lecture Hall when Dr. Loewi summarized the discovery of drugs and how their action depended both on the kind of organism and its state of health. He got a good rise out of the scions of physiology by putting forward the theory that man had found plant drugs by instinct. Dr. Loewi however fended off all blows with his subtle wit which many of us were better able to appreciate at the tea which the Chambers gave for us that afternoon. — *A. W. S.*

PROTOZOOLOGY CLASS NOTES

With corrections on last week's pessimistic note in regard to the annual picnic, the Protozoologists are still here to report that with a bang and without microscopes the picnic was a great success. Thursday, one of those hot and "sun through mist" types of days, saw the seven Protozoologists, their instructors and twenty guests on the beach of Tarpaulin Cove throwing each other in the water, swamping and stealing boats, clambering over rocks, sunbathing, playing volleyball, listening to the radio, (take a breath), eyeing lighthouses, playing water polo, diving off boats, eating lobsters, taking subtle snapshots and all "beering" up under the strain. Some were just "settin'"! May they add that certain members of the expedition are still moulting as a result. Special mention is to be made of Kathie and Mary for the superb board, well planned and distributed.

Delayed by the above event, the deadline for drawings arrived with Monday instead of Saturday and each artist hopefully surrendered his creations with the prayer that somewhere in each of the sixty was a clue to the species.

Drawings in and whoof! off went the Protos with the speed of lightning into the realm of slides. Slides by the hundreds. Good slides, bad slides, full slides, and empty slides!

Now, while the instructors decide their fates on the above matters, the Protos enter the most interesting phase of the whole course. Having passed through the stages of artist and technician, they are now ambitious investigators and have started work on their problems.

Amid these events the lectures have continued. On Saturday, Dr. W. L. Doyle of Bryn Mawr College spoke on "Hydrolytic Enzymes in Protozoa" in which he described various methods of studying these and discussed the work of several men in this field. Dr. Calkins spoke on "Cyclical Differentiation in Protozoa" and Dr. Kidder spoke on "Culture Methods in Protozoa" preparatory to the work on the problems.

As a postcript, for further reference to the extra-curricular activities of the Protozoologists, you are referred to the janitor crew and inhabitants of the Eel pond and vicinity.

—Doris Marchand

BOTANY CLASS NOTES

ALGOLOGICAL ALPHABET

A is for Algae, red, green, and blue,
And rarer kinds that are found by Miss Ciu.

B is for Brown—you'll find him right "he-ah"—
Our finder supreme of algal forms "quee-ah".

C is for cookies, Cuttyhunk, class
We go to all three, always *en masse*.

D is for Delbert and Dorothy, too
Who never miss breakfast, whatever they do.

E is for Embryos—through with their work—
When they departed not once did we shirk.

F is for food we consumed at the teas—
Ritz, and Mytili caught in the seas.

G is for Gilbert, collector of note,
A few more cookies, and he'll sink the boat.

H is for Hank who sits on the rocks,
Confers with the Coast Guard and walks on their docks.

I is for ignorance we all profess,
Though our ignorance of algae is growing much less.

J is for Jo, our blond missing link,
Who fills a forementioned gap—so we think.*

K is for Kylin, authority on reds,
Whose facts are rapidly filling our heads.

L is for lab where we spend all our days,
Cutting up algae and learning their ways.

M is for moon that has shone at night—
Hank knows the view from the Nobska Light.

N is for Natalie who can't say too much,
Since an embryologist has her in clutch!

O is for Ollie who is heaven knows where,
Unless, of course, he is still in our hair.

P's for Platoma of '89 fame.
Since Doc Taylor re-found it, he's not been the same.

Q is for Quahogs. If they don't make you sick,
You chew them to kill them, then swallow them quick.

R is for Runk—Ben Franklin De Wees,
"Chief," "Papa", or "D"—call him any of these.

S is for Suffolk Downs—a bad gambling place.
Anderson can tell you. Ask him—watch his face.

T is for Thompson of Riella fame
(But we call him "Rufe"—he answers just the same!)

U is unique, what Sam Silver is,
With that limitless store of knowledge of his.

V is Virginia. Need I say more?

W is for what will we do with our time,
When not searching the carpospore and sweet trichogyne.

X is the unknown—Don Brown's best gal.
She's a raving brunette, so stick around, pal!

Y is for yellow—a glorious hue
That algae don't come in. We like it, we do!

Z is the end. The class is dismissed.

And—after we have gone far away, and no longer grace the mess hall, and no longer sneak upstairs in the brick dorms to take a hot shower, and no longer have seminars and refreshments on Thursday, and no longer go collecting smelly algae with Axel, and no longer pester investigators, and students and professors—

I ask you, my friend, do you think we'll be missed?

— Algernon and Alergicto Algy.

* See Embryology Class notes in **The Collecting Net of July 20, 1940.**

The Collecting Net

A weekly publication devoted to the scientific work at marine biological laboratories.

Edited by Ware Cattell and Robert Chambers with the assistance of Boris I. Gorokhoff and Peggy Browning; Contributing Editor, Homer A. Jack.

Entered as second-class matter, July 11, 1935, at the U. S. Post office at Woods Hole, Massachusetts, under the Act of March 3, 1879, and re-entered, July 23, 1938.

Introducing

Dr. Maurice Henri Pirenne, Fellow of the Belgian American Educational Foundation at Columbia University.

Dr. Pirenne received his doctorate in the physico-chemical sciences at the University of Liège in 1937, having concentrated upon training in physical chemistry with the hope of later applying this training to biological problems. He worked particularly with Dr. Peter Debye, who was at that time Visiting Professor at the University of Liège; during the following year he worked with Dr. Debye at the Kaiser Wilhelm Institut für Physik at Berlin under a fellowship granted by the Belgian government.

In 1938 he arrived in America under a Belgian American Foundation Fellowship and received training in biophysics at Princeton University with Dr. E. N. Harvey. During this period he conducted research with Dr. J. A. Kitching on the influence of low tensions of oxygen on the protoplasmic streaming of myxomycetes.

After working at Woods Hole last summer, Dr. Pirenne determined to conduct research in the field of vision, a subject for which his training in physics had particularly prepared him.

This work was conducted during the past academic year, under the Belgian American Foundation, with Dr. Selig Hecht at Columbia University. One of the problems upon which he concentrated was that of the vision of nocturnal birds. He found that the vision of the long-eared owl is homologous to that of man at low illuminations, corresponding to the predominantly rod structure of the retina of the owl. Any theory that the owl sees by infra-red light has therefore to be discarded. He also worked with Dr. S. Schlaer on the absolute threshold of the human eye, a research which should at the same time give information as to the possible limit of the sensibility of any animal's eye.

During his second summer at Woods Hole, Dr. Pirenne plans to continue his work on vision, particularly studies on visual purple with Dr. George Wald. Dr. Pierenne is filled with admiration for the opportunities for contacts at Woods Hole. His hobby, aside from swimming and other Woods Hole recreations, is sketching.

THE INVERTEBRATE COURSE

The invertebrate course of the Marine Biological Laboratory was initiated at eight o'clock on Thursday evening by Dr. T. Hume Bissonnette who gave a general talk on the conduct of the course, duty of team members, dangers from tides, poison ivy, etc.

On Friday the class began its study of protozoa with Dr. Waterman giving the lectures. The first excursion is scheduled to take place to Stony Beach on Tuesday. Seven other trips are scheduled during the season in addition to the annual picnic.

As usual the course is crowded to capacity, there being fifty-five members registered. When members of the class were selected on May 1, there were about thirty more applicants than could be accomodated. The staff is substantially the same as last year although there have been two or three changes. Dr. F. R. Kille has resigned as instructor and he has been succeeded by Dr. Walter E. Martin, who was a junior instructor last year. He is in charge of arthropods. Dr. E. Ruffin Jones has been added to the staff as junior instructor. Dr. Hannah T. Croasdale succeeds John Wightman as laboratory assistant.

The program for the summer meeting of the Genetics Society of America has recently been drawn up. On Thursday morning, August 29, short papers will be presented in the M. B. L. Auditorium. In the afternoon there will be a boat trip on the *Winifred*, followed by a clam-bake at Tarpaulin Cove. Friday morning and afternoon will be given over to demonstrations in Old Lecture Hall; in the evening Dr. Curt Stern of the University of Rochester will present a lecture. Abstracts and titles of papers to be delivered at this meeting should be given to Dr. P. W. Whiting, local representative, by August 12.

Immediately following the meeting some of the geneticists will remain for informal discussions on the gene problem.

CURRENTS IN THE HOLE

At the following hours (Daylight Saving Time) the current in the Hole turns to run from Buzzards Bay to Vineyard Sound:

Date	A. M.	P. M.
July 27	10:10	10:39
July 28	11:01	11:34
July 29	11:54	
July 30	12:33	12:34
July 31	1:27	1:36
August 1	2:14	2:33
August 2	3:03	3:20

ITEMS OF INTEREST

DR. C. W. METZ, member of the staff of the Department of Embryology (Baltimore) of the Carnegie Institution of Washington has been appointed professor and head of the department of zoology, succeeding Dr. C. E. McClung, who has retired.

DR. A. B. DAWSON and his family visited Woods Hole on Tuesday. Dr. Dawson is director of the Biological Laboratories at Harvard University and has worked several years at the Marine Biological Laboratory.

DR. LANCELOT HOGBEN, professor of Natural History at the University of Aberdeen, Scotland, is scheduled to arrive in Woods Hole today. He will be the guest of Dr. Chambers for a couple of days. Dr. Hogben, who worked at the laboratory a number of years ago, has been lecturing in Norway; war conditions made it necessary for him to return to England by way of America. He made his way to Japan, sailing from there to San Francisco, arriving in New York on July 22. Dr. Hogben is the author of "Mathematics for the Million." He has received many honors including election as a fellow of the Royal Society of London and a gold medal from the Royal Society of Edinburgh for his publications on the mathematical theory of genetics.

The construction of a new U.S.B.F. Laboratory on the campus of the University of Maryland at College Park, Maryland, to cost $18,000, will be undertaken in the near future. The new building will house the laboratories of the Division of Scientific Inquiry and the technological and bacteriological laboratory of the Division of Fishing Industry, which are now in office buildings in Washington.

A new instrument, the Continuous Plankton Recorder, was received this week by the Woods Hole Oceanographic Institution, which will have the recorder on loan from Professor A. C. Hardy of University College, Hull, England, for the duration of the war. The instrument will be used to record the density of living matter in the ocean, and has the advantage over other forms of collecting apparatus in that it does not have to be periodically removed from the water. It can be towed by a ship and will record the fluctuation in density of living matter along the course. Shaped like a torpedo, the recorder contains a spool of gauze which unwinds as the plankton is caught at the rate of about an inch for every mile that the ship travels. About twenty of these recorders are now in existence and the two at the Oceanographic Institution, which will be used by the *Atlantis,* are the only ones outside of England.

The embryology course at the Marine Biological Laboratory held its final session on Monday, and the physiology course ended the following day. The botany course ends today, but the protozoology course will continue until next Wednesday.

The annual convention of the National Shell Fisheries Association will be held July 31 to August 2 at New Haven and Milford, Connecticut, under the presidency of Dr. Paul S. Galtsoff, acting director of the U. S. Fish and Wildlife Service at Woods Hole. The Association comprises primarily the federal and state officers engaged in research work on various edible molluscs, and also includes state and U. S. Public Health officers in control of shell fish sanitation, as well as some independent investigators working on life histories and the physiology of molluscs. Founded about a quarter of a century ago, the association now has about 65 members.

MISS PRICILLA DRISCOLL was married at Christmas to Dr. J. P. Wooley. Dr. and Mrs. Wooley have been research workers at Woods Hole and are now at Columbia University where Dr. Wooley is an assistant in zoology.

At the staff meeting of the Woods Hole Oceanographic Institution on Thursday, Dr. Phelps talked on "Aspects of the Problem of Attachment of Organisms to Submerged Surfaces."

DR. CHESTER I. BLISS is conducting an informal seminar in statistics for research workers each Wednesday from 7:15 until 8:15 at the residence building of the Bureau of Fisheries. The first meeting was held on July 17.

Photographs of local marine life in color were shown by Mr. George G. Lower on Thursday at the Fisheries residence.

The program of the Monday night phonograph record concert at the M.B.L. Club: Concerto in D minor for two violins, Bach; Symphony No. 8 in B minor ("Unfinished"), Schubert; Symphony No. 4 in F minor, Tschaikowsky.

The entry chart for the M.B.L. Tennis Club tournament was posted Wednesday on the Mess Court bulletin board. It will consist of men's singles, women's singles, men's doubles, women's doubles, mixed doubles and children's singles. The tournament, which is open to all members of the Tennis Club, will get under way on August 1. Entries will close on Tuesday, July 30. A silver cup will be presented to winners in each tournament. Information in regard to the tournament may be obtained from the committee in charge, Mrs. Eric G. Ball and Mrs. C. C. Speidel.

M. B. L. CLUB

The Poverty Ball at the M.B.L. Club last Saturday night included the following in its entertainment: A skit, played by Margie Jolly, Philip Trinkhaus, and John Milford a lecture by Dr. A. Shlaifer; a dance by Helen Goulding and Dick Ormsbee; a harmonica solo by Teru Hayashi; and songs by the Mess Hall Quintet composed of Teru Hayashi, Dick Lee, Dick Ormsbee, Myron Nichols, and George Edwards. Teru Hayashi was toast-master. Square dancing followed the entertainment. Old clothes were obligatory for those dancing; prizes were awarded for the most original and best costumes to Mary Chamberlain and Carl Smith, Dr. and Mrs. Goodrich and Dr. Irving being the judges.

THE SEMINAR ON EXPERIMENTAL MORPHOLOGY

Dr. Lester Barth
Assistant Professor of Zoology, Columbia University

Three papers were presented at the seminar on Tuesday evening for criticism and discussion.

Dr. Nelson T. Spratt, Jr., of the University of Rochester presented new experiments in which explants of the anterior primitive streak region of the chick embryo were made to plasma clots and their differentiation followed. The region used regularly differentiated into forebrain and eye and other structures. When the donor of such explants was also cultured the wound healed and complete regeneration of the lost parts took place. However when the blastoderm was separated into two parts one differentiating into eye and the other forming posterior structures the posterior part was not able to regenerate an eye. Similarly when the eye forming region was cut in the median line only right or left eyes formed—no regeneration took place. The difficulties of considering the explants as mosaics or organ specific areas was discussed. Likewise it was pointed out that the ectoderm which formed the eye in the case of explants was not the same ectoderm which would form eye in the intact blastoderm. This meant that the eye structures were induced probably by mesoderm.

Dr. Ernst Scharrer of the Rockefeller Institute showed that the patterns formed by the blood capillaries in the brains of rats and opossums were different and that the different patterns could not be modified by his particular experiments. These experiments consisted in replacing parts of the brain of the opossum with dead masses of rat brain and the capillaries which grew into the dead rat brain were of the opossum type. Criticism brought out that live rat brains should be tried on opossum to see whether the pattern might be changed by living tissues as opposed to dead.

The marvelous opportunity of using the capillaries of the opossum brain for physiological work was pointed out by Dr. Höber. The conclusion was that, although opossum capillaries in parts of the body other than the brain resemble those of the rat, the brain capillary pattern is fixed and unalterable.

Dr. Paul Weiss of the University of Chicago presented a new technique for studying the relationship between the end organ and the central nervous system. Transplants of the cord without the spinal ganglia of axolotls were made to the dorsal fin together with a limb transplant. The transplanted cord became somewhat disorganized but sent out fibers to the limb and adjacent skin. This produces an isolated spinal cord-nerve-limb preparation which can be studied for months. Spontaneous activity of the cord sets in and the limb undergoes contraction which seems to be brought on by conditions in the host such as fatigue and possibly low oxygen. Various interpretations of the nature of the activity were discussed. The problem of the nature of the neurones supplying the limb and connecting with the skin could not be settled. The spontaneous activity of the entire explant of the cord is exhibited when two limbs are innervated by the same explant and simultaneous activity of the two limbs is exhibited. A suggestion that this activity might be caused by one neurone supplying both limbs was made.

(The paper by Dr. Weiss is published in this issue. The other two will be published next week.)

THE BIOLOGICAL FIELD STATIONS OF SCANDINAVIA AND FINLAND

Homer A. Jack
Cornell University

One of the first seaside colonies of biologists sprang up at Kristineberg, Sweden more than one hundred years ago. It was in 1835 that Professor Bengt Fries first visited this site at the mouth of Gullmar Fiord and found a wide range of environmental conditions in the vicinity. Two years later he brought another biologist with him to study and collect specimens for the State Museum of Sweden. In 1839 Sven Lovén paid a visit to this area and in subsequent years he trained local

fishermen to collect specimens and manage the dredges. Soon a number of Scandinavian biologists took advantage of these collecting opportunities and a summer colony of scientists arose, although there was not sufficient organization to justify calling the assemblage a biological field station. In 1877, however, Professor Lovén was able to establish a marine station at Kristineberg, with financial assistance from the Swedish Academy of Sciences and a bequest from a Swedish physician in Brazil. At first the buildings and grounds of the captain who had long served as boatman and collector were purchased and used. Then in 1884 the first building was constructed and at last seaside biology in Scandinavia had its own headquarters.

This was the beginning of the biological station movement in Scandinavia and Finland which today encompasses fifteen of these laboratories from the North Sea to the Arctic Ocean and from the Kattegat to the Gulf of Finland. The important stations in Denmark are located at Charlottenlund and Hillerød, while others may be found at Frederikshavn (*Universitetes Havbiologisk Laboratorium*) and Skalling (*Skalling Laboratoriet*). In addition to the station at Kristineberg, there is an important Swedish station in Göteborg. Other field stations in Sweden include the Marine Biological Station at Barsebäckshamn near Lund, the Limnological Laboratory of the University of Lund at Aneboda, the Klubbans Biological Station located only one mile from the Kristineberg station at Fiskebäckskil, and the arctic biological station at Abisko, near Narvik, Norway. The larger Norwegian stations are at Drøbak and Herdla, while others exist at Trondheims (*Trondheims Biologiske Stasjon*) and at northernly Tromsø. The sole biological station in Finland is at Tvärminne, although an important station existed at Esbo-Lofo near Helsingfors during the last decade of the nineteenth century.

The Danish Biological Station (*Dansk Biologisk Station*) is housed in an old castle at Charlottenlund, about five miles from the center of Copenhagen. Attached to the Ministry of Agriculture and Fisheries, this station is concerned with "marine and freshwater investigations with special regard to fisheries." At Nyborg and at Frederiksdal the station has auxiliary field laboratories, but the greatest extension of its scientific work is accomplished by means of its 143-ton research steamer, *Biologen*. This vessel with its eight-man crew operates from April first to October twentieth and occasionally foreign investigators may accompany its expeditions. The work of the Charlottenlund station is summarized annually in the *Report of the Danish Biological Station*.

To limnologists, Hillerød brings to mind the name of Professor Wesenberg-Lund whose laboratory has been in this Danish village since 1911. It was in 1897 that Wesenberg-Lund first established a small field headquarters at Fure Lake. Nine years later the station was taken over by the University of Copenhagen and in 1911 the laboratory was moved to Hillerød which is about twenty miles northwest of Copenhagen. Today the Freshwater Biological Laboratory of the University of Copenhagen (*Universitetets Ferskvansbiologiske Laboratorium*) is housed in a two-story building on the shore of Frederiksborg Castle Lake. The building, which was donated by the Carlsberg Foundation, contains a workshop, equipment room, aquarium room, storeroom, chemical laboratory, experimental laboratory, darkroom, and library. There are no living accommodations at the station, but board and lodging may be obtained at nearby boarding houses for forty kronor a week (about $8.36). The work of the station includes a year round research program and a three-week course in freshwater biology, both being under the direction of Dr. Kaj Berg since the recent retirement of Professor Wesenberg-Lund. Independent investigators are also invited to work at the station. There are no laboratory fees and it is open throughout the year.

Within the city of Göteborg, Sweden, stands the recently-constructed building of the Oceanographic Institute of Göteborg (*Oceanografiska Institutionen vid Göteborgs*). This three-story edifice is equipped with laboratories for physical oceanography, a hydrodynamics tank, and three bedrooms for investigators. Of interest to biologists is its plankton shaft which is twelve meters in height and two meters in diameter. It has been filled periodically with seawater carried by freighters from the Bay of Biscay. The station does not have its own boat, but it occasionally makes use of the state-owned research vessel, *Skagerak*, for plankton hauls.

The research program of the institution at Göteborg is under the direction of Dr. Hans Pettersson who is also professor in the Oceanographic Institute of the *Göteborg Högskola*. While the work of this station is mainly concerned with the research of its staff members in physical oceanography and related sciences, a limited number of outside investigators may be permitted to make use of the station's facilities. For such workers there are no laboratory fees and lodgings may be obtained at the station for four kroner a week (about $.96). Board is procurable at nearby hotels or boarding houses for thirty-five kronor a week (about $8.40). The laboratory is open throughout the year, except during the months of July and August.

About one hundred miles north of Göteborg lies the Kristineberg Zoological Station (*Kristinebergs Zoologiska Station*). It is on the island of Skaftö in Gullmar Fiord, near the village of Fiskebäckskil. Walking less than a mile west of this tiny fishing village, one soon beholds several buildings and private dwellings on the rocky shore. This is Kristineberg. The building by the water's edge contains a sorting room, experimental aquariums, storerooms, and laboratories. The three-story building a few feet away contains the research laboratories, darkroom, and library. The dormitory contains lodging accommodations for twenty persons and a dining room with kitchen. The station makes no charge for lodging and good Swedish food is obtainable for 24.50 kronor a week (about $5.98).

Foreign investigators are admitted at Kristineberg and are not required to pay laboratory fees. Throughout the year they are supplied with the facilities of the laboratory (including 110- and 220-volt A.C. electricity and running fresh- and sea-water) and biological specimens collected by the laboratory's 42-foot motorboat, *Sven Lovén*. University students and school teachers usually come to Kristineberg for a course in marine biology, the cost of this and the general maintenance of the station being absorbed by the Royal Swedish Academy of Science.

In nearby Norway is located the University Biological Station (*Universitetets Biologiska Stasjon*) at Drøbak. Sponsored by the University of Oslo which is less than twenty miles north, the station offers facilities for both instruction and research in marine biology in the Oslofiord (formerly Kristianiafiord). There are three tables for foreign investigators who are invited to work at the station between July first and August thirty-first.

Polluted waters have caused the abandonment of more than one biological field station. Although disturbed by civilization for this reason, the Bergen Museum Biological Station (*Bergens Museums Biologiske Stasjon*) has been more fortunate. Founded in 1891 at Puddefiord, Norway, the station found that the waters surrounding it became too contaminated for the usual uses in biological research. In 1920, therefore, the station was moved to Herdla, its present site, which is seventeen miles north of Bergen. Here there are opportunities for research in relatively uncontaminated waters from the surface down to about two thousand feet. The station now contains one large building and several boats, including the 47-foot research vessel, *Herman Friele*. The basement of the building contains a controlled temperature room, darkroom, sorting room, and workshops. The first floor includes a classroom, four research laboratories, kitchen, dining room, and the laboratory of Professor Brinkmann, the director. The second floor consists of the caretaker's apartment, living rooms for fifteen investigators, and the library which is supplemented by one-day service from Bergen.

Both research and instruction in marine biology are the aims of the station in Herdla which is sponsored by the Bergen Museum. Instruction is given only to Norwegian students, but investigators from all countries are invited to work at the station and are not charged any laboratory fees. The station is open throughout the year, for the fiords and the sea in the vicinity never freeze in winter. Investigators may obtain board and lodging at the station for 38.50 kroner a week (about $9.06). Research work at the station is often published in the *Bergens Museums Arbok*.

On the shores of a long fiord-like bay off the Gulf of Finland lies Tvärminne. At this village which is about sixty miles southwest of Helsingfors (and therefore *not* in territory recently occupied by the U.S.S.R.) the Zoological Station of the University of Helsingfors is located. Founded in 1902 by Professor J. A. Palmén and now directed by Professor Alexander Luther, this laboratory is equipped for both instruction and research. Instruction is conducted in aquatic zoology, hydrology, and plant physiology for three-week periods. Research facilities are available to outside investigators from May fifteenth to September tenth. Laboratory fees amount to seventy-five markka a month (about $1.54) while board and lodging may be obtained at the station for 950 markka a month (about $19.48).

SUPPLEMENTARY DIRECTORY FOR 1940

INVESTIGATORS

Baker, L. A. res. asst. Eli Lilly & Co. Br 319.
Bowser, E. R., Jr. Pittsburgh. Rock 7.
Brink, F., Jr. res. asst. biophys. Pennsylvania. Br 115.
Brown, D. E. S. asst. prof. phys. New York. Br 304.
Bush, J. J. Amarillo H. S. (Texas). OM Base.
Butler, P. A. asst. zool. Northwestern. Br 225. K 15.
Calabrisi, P. instr. anat. George Washington Med. OM 46.
Cardiff, Margaret asst. phys. Swarthmore. OM 2.
Catherine Francis instr. Hallahan H. S. (Pa.). Rock 3.
Commoner, B. tutor biol. Queens (Long Island). Br 305.

Crampton, H. E. prof. zool. Columbia. Br 340.
De Liee, Elvira fel. med. New York Med. Br 304.
Dressler, Elsie L. grad. genetics. Pittsburgh. Rock 7.
Egan, R. W. undergrad. asst. biol. Canisius (Buffalo, N. Y.) OM 39. Dr 15.
Evans, Gertrude instr. biol. Beliot. Br 332.
Ferguson, F. P. grad. asst. zool. Minnesota. Br 210. K 6.
Finkel, A. J. res. asst. zool. Chicago. Br 332.
Gettemans, J. F. lab. asst. Rockefeller Inst. (Princeton). Br 209. Dr 6.
Glancy, Ethel tutor biol. Queen's (N. Y.). OM Base.
Graham, Judith grad. phys. Chicago. OM 4.
Griffiths, R. B. instr. biol. Ariz. Br 127. Dr 10.
Hauguard, G. asst. Carlsberg Lab. (Denmark). Br 207.
Hayashi, T. grad. asst. zool. Missouri. Br 310. Ka 21.
Hemstead, G. W. Union. Br 312. Ho 7.
Herget, C. M. res. fel. phys. Russell Sage. Br 317.
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THE COLLECTING NET

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CELLULAR BASIS OF COLOR PATTERN IN SOME BERMUDA CORAL REEF FISH

Dr. H. B. Goodrich
Professor of Biology, Wesleyan University

The observations presented were made in Bermuda during the summer of 1939 on parrot fish of the families Sparisomidae and Scaridae and on the "Bluehead", one of the wrasses of the family Labridae. Most of the parrot fish are fairly large fish, 18 to 24 inches in length, and the color producing cells are located in a thick fleshy portion of the dermis overlying the scales. The relationship of the various cell layers of four species of parrot fish was shown by a series of stereograms. The first of these was *Sparisoma viride*, the dark green parrot fish. Beneath the stratified epithelium of the epidermis there is first a basement membrane and then successive layers containing the chromatophores, the iridocytes and finally a thick stratum of loose connective tissue overlying the scale. A striking feature is the presence of intercellular blue pigment bodies. The blue color of most fish is due to the (*Continued on page* 112)

M. B. L. Calendar

TUESDAY, August 6, 8:00 P. M.

Seminar: Dr. Albert E. Oxford: "Nitrogenous Metabolism of Molds: Isolation of a Substance Related to Tyrosine from Penicillium."

Dr. Kurt Salomon: "Studies on Erythrocruorin (Invertebrate Hemoglobin)."

Dr. Kurt G. Stern, Dr. Joseph L. Melnick and Dr. Delafield DuBois: "Photochemical Spectrum of the Pasteur Enzyme."

FRIDAY, August 9, 8:00 P. M.

Lecture: Dr. Francis O. Schmitt: "Modern Concepts of Protoplasmic Organization."

CHROMOSOMES IN PROTOZOA

Dr. D. H. Wenrich
Professor of Zoology, University of Pennsylvania

Up to a relatively recent period there has been a wide-spread belief that nuclear division in Protozoa is simple and direct rather than indirect or mitotic. Three possible reasons for this belief may be mentioned: (1) The great diversity of nuclear structure and division behavior in Protozoa and the inherent difficulties in their interpretation have interfered with the accumulation of knowledge in this field. (2) The evolutionary concept called for a simple condition in the Protozoa as a starting point for the evolutionary series "from amoeba to man". (3) Textbook authors have extensively used an illustration of division in amoeba first published by F. E. Schulze in 1875 showing simple direct nuclear division and have offered this as typical for amoebae, or even for the Protozoa as a group. The use of this illustration and its over-simple interpretation have probably had an important influence in perpetuating the idea of

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THE LIBRARY BUILDING, MOUNTAIN LAKE BIOLOGICAL STATION, MOUNTAIN LAKE, VIRGINIA.

CATESBY COTTAGE, MOUNTAIN LAKE BIOLOGICAL STATION.

amitotic nuclear division for Protozoa. One wonders what difference it might have made had the text-book writers selected instead the figures showing mitotic divisions of micronuclei published by Bütschli in 1876.

One of the striking facts about nuclear structure and nuclear division in the Protozoa is the great diversity shown, in contrast to the relatively uniform conditions in the Metazoa. Nuclear structures and division processes in the Protozoa range from the obviously very simple to the surprisingly complex. Chromosome numbers are likewise diverse with counts ranging from 2 in some flagellates up to an estimated 1500 to 1600 in some Radiolaria. In many cases the chromosomes are so small or so numerous or so crowded that authors have failed even to make an estimate of their number; some authors have even hesitated to employ the term chromosome for the chromatin granules which have appeared in the spindles during mitosis in many Protozoa. At the present time, however, it seems reasonable to state that, with the exception of the macronuclei of the Ciliata and Suctoria, the nuclei of Protozoa generally divide by some form of mitosis.

The nuclei of Protozoa show a surprising range of diversity of structure. The text-books tell us that there are two general types of nuclear organization: (1) the vesicular, in which there is a central nucleolus-like chromatic mass called the karyosome or endosome, surrounded by a space which may appear to be devoid of chromatin, or which may contain more or less definite chromatin elements in the form of finer or coarser granules, strands, or a reticulum; and (2) the compact type in which the chromatin is rather uniformly distributed through the nuclear space usually in the form of very fine granules, at least as seen in fixed and stained preparations. The macronuclei of ciliates are usually of this compact type. Naturally there are many conditions which are intermediate between these two types. It is often stated that protozoan nuclei may, in addition to the achromatic substances, contain three kinds of chromatin. These are: (1) the generative, or idiochromatin, from which the chromosomes develop during mitosis; (2) the vegetative or trophochromatin which is supposed to control vegetative processes; and (3) the kinetochromatin from which arise the deeply staining division centers and desmoses found in many nuclei during mitosis.

In the "resting" nuclei the distribution of these three components varies greatly. In the vesicular nuclei of many of the Mastigophora, Sarcodina and Sporozoa, the endosome may contain all the trophochromatin as well as the kinetochromatin and the surrounding nuclear space will contain the idiochromatin. In other vesicular nuclei, especially in some of the amoebae and flagellates, the central endosome will contain only a part of the trophochromatin, the remainder being distributed in a peripheral zone or layer which may or may not become adherent to the inner surface of the nuclear membrane. Again all the trophochromatin may appear in the peripheral zone leaving a small centriole in the center surrounded by the idiochromatin, or the centriole may not be apparent. On the other hand in the vesicular micronuclei of many ciliates all of the idiochromatin seems to be located in the central endosome.

The staining reactions of these components may vary greatly. The endosomes and other nucleolus-like bodies may stain intensely with basic dyes or the reverse. The same may be said for the idiochromatin. As a rule the trophochromatin, represented by the nucleolus-like bodies, or by peripheral masses and granules, does not give a positive Feulgen reaction, and the idiochromatin may or may not give a positive reaction. Generally the fully formed chromosomes give a positive Feulgen reaction and the kinetochromatin may also.

In the opalinid ciliates, the so-called "macrochromosomes" have been shown by Chen to be nucleolus-like bodies, each attached to an individual chromosome and dividing when the chromosome divides. In *Entamoeba muris* there are two sets of chromosome-like bodies in equal numbers which form in the spindle and divide successively. One set gives a positive Feulgen reaction and is therefore thought to consist of idiochromatin, while the other set does not give a positive reaction and is thought to consist of trophochromatin.

The mitotic processes in Protozoa may take place in a manner quite similar to that characteristic for the Metazoa; with an extranuclear division center which divides and forms the spindle asters, with the formation of chromosomes out of a nuclear net and an intermediate spireme stage, and with the break-down of the nuclear membrane in the prophase and its reformation in the telophase; as, for example, in the gregarine, *Monocystis magna*. On the other hand, mitosis may occur entirely within the confines of the nuclear membrane which persist throughout division

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except when severed by the telophase constriction into two daughter nuclei, as in *Entamoeba muris*. Such intranuclear mitoses may or may not be accompanied by division centers. In many flagellates there is an intermediate condition in which the division centers are extra-nuclear and associated with the basal granules or blepharoplasts of the flagella. Usually the desmose is extra-nuclear and the nuclear membrane persists so that the total spindle is made up of some intra- and some extra-nuclear components. In the hypermastigote flagellates, according to Cleveland and his associates, the chromosomes are attached to the nuclear membrane by fibers which join the fibers from the extranuclear centrosome, and thus the strands which connect the chromosomes with the centrosome have a double origin.

In many Protozoa, as in the Metazoa, the chromosomes show "individuality" in the sense that the numbers are constant for the species and that there are constant differences in size or shape or both among the chromosomes in the same complex. In the coccidian, *Aggregata eberthi*, for example, there are six chromosomes in the haploid series and each differs in length from the others. In the diploid series there is a pair of each kind.

In meiosis, synapsis or pairing of chromosomes and the subsequent appearance of tetrads in the first meiotic division and of dyads in the second meiotic division have been reported for some Protozoa. Belar has described details of meiosis in the heliozoon, *Actinophrys sol*, that are quite parallel to those found in the Metazoa. On the other hand, zygotic meiosis, as seen in the gregarines and coccidia, is apparently accomplished by a single "reducing" division.

Telophase splitting of chromosomes has been reported for a number of Protozoa and in the prophase the daughter chromatids may separate precociously, making chromosome counts difficult. Commonly these chromatids reassociate before the chromosomes enter the metaphase stage and are then separated in the anaphases in the usual manner, although in some cases the reassociation does not occur. Spiral structure of chromosomes has also been reported for a number of different kinds of Protozoa.

Although there is a wide range of chromosome numbers there is a tendency for related Protozoa to have similar numbers. In the Sporozoa, the numbers so far reported are small, not over 16 for the diploid number. For the Myxosporidia the diploid numbers reported are from 4 to 6, in gregarines from 4 to 12 and in coccidia from 8 to 16. In each of the other classes of Protozoa the recorded numbers range rather widely. In the plant-like Phytomonad flagellates, which live a haploid existence except for the single zygote generation, the haploid numbers are mostly 8, 10 and 12 although a species with 32 has been reported. In the euglenoid flagellates the numbers range high, up to an estimated 200, and in the dinoflagellates they range still higher up to nearly 300. Most of the parasitic trichomonad flagellates have from 3 to 12 chromosomes, although one very large species from termites is said to have over 100. In the complicated hypermastigote flagellates the family Holomastigotidae shows numbers from 2 to 8, while recorded numbers for the Hoplonymphidae are from 8 to 50. Most of the smaller free-living amoebae and most of the known parasitic amoebae have relatively small numbers, from 4 to 20, while the larger amoebae of the *A. proteus* group have several hundred. In the few Heliozoa studied the diploid numbers have been reported from 24 to 150, and in the Radiolaria estimates from 1500 to 1600 have been made for certain species. In these Radiolaria there are difficulties since such animals are said to form flagellispores having 4 or 5 chromosomes. It is still uncertain whether these small flagellates are a part of the life cycle of the radiolarians or are parasitic dinoflagellates as claimed by Chatton. Among the ciliates the reported numbers are quite diverse, ranging from 4 in the genus *Chilodonella* to several hundred in the genus *Paramecium*.

There are some cases of polyploidy. MacDougall found 4 to be the diploid number in four species of *Chilodonella*, but in *C. uncinata* she found two tetraploid races with 8 chromosomes, one of these after treatment with ultra-violet light; she also found a triploid race with 6 chromosomes after ultra-violet treatment. Chen has recently reported different numbers of chromosomes in different races of the same mating type in *Paramecium bursaria*. He has also shown that anamolies may occur during conjugation, such as the coalescence of three or four gamete nuclei, which would be expected to give rise to polyploidy. Chromosome numbers suggestive of polyploidy also occur in other groups, for example in the hypermastigote flagellates, where three species of *Holomastigotoides* are reported to have 2, 4, and 8 chromosomes, respectively, and two species of *Barbulanympha* have 16 and 32. Two other species of this latter genus, however, have 40 and 50, numbers which do not fit into a polyploid series so well. It is to be expected that more cases of polyploidy will be found in the Protozoa.

So far as is known, all Protozoa reproduce by one or more of the asexual methods, binary fission, multiple fission or budding. Certain groups also reproduce by syngamy. This method has definitely been established for the Ciliophora and the Sporozoa. Among the ciliates meiosis is pregametic and is usually accomplished by two "ma-

turation" divisions. These animals live diploid lives. Most of the Gregarinida and Coccidia apparently live haploid lives except for the single zygote generation and meiosis takes place at the first division of the zygote. In the Myxosporidia the vegetative stage is diploid, meiosis usually taking place in preparation for the complicated process of spore formation. Among the Mastigophora, syngamy is well established for the plant-like Phytomonadida, which are haploid in the vegetative stages. Among the Sarcodina, syngamy is well authenticated for the Foraminifera and Heliozoa; in both groups the vegetative stages are diploid and meiosis is pregametic. Phenomena interpreted as syngamy have been reported for some representatives of nearly every other order of Protozoa not named above, but the evidence is too incomplete or too insufficiently substantiated to be credited.

Adequate cytological studies have been made of relatively few Protozoa, so that an extensive undeveloped field for investigation is offered. The great variety of nuclear conditions and the inherent difficulties of interpretation offer a challenge to students with a well-developed scientific curiosity and an ability to accomplish worth-while results.

(This article is based upon a lecture presented at the Marine Biological Laboratory on July 26.)

ON THE DETERMINATION OF THE VASCULAR PATTERN OF THE BRAIN OF THE OPOSSUM

Dr. Ernst Scharrer

The Rockefeller Institute for Medical Research, New York

In mammals there exist two types of cerebral vascular patterns: In the one, found thus far in all Placentalia, the capillaries form an unending network; in the other, discovered by Wislocki and Campbell ('37) in the opossum, an artery and a vein are always associated in a pair and the capillaries do not anastomose but end in hairpin-like loops. The question to be studied concerns the factors that determine the type of vascular pattern. These factors can be sought in peculiarities of the chemical or physical constitution of the living brain (Wislocki '39), or they may be regarded as inherent in the cerebral vascular system. The influence exerted by the living brain on the angioblastic tissue was tested in experiments in which pieces of dead, formol-fixed brains from rats and guinea pigs whose brains are vascularized by networks, were implanted into living opossum's brain which is supplied by terminal arteries ending in capillary loops. After 3 to 4 months the dead brain tissue is invaded by blood-vessels regenerating from the surrounding brain tissue and the pia. The vessels penetrating rat's or guinea pig's brain are of the opossum type. Accordingly in the reverse experiment, when dead opossum's brain is implanted into living rat's or guinea pig's brain, no capillary loops are induced, but a network grows from the host's brain into the implanted dead tissue. From these observations it is concluded that under the conditions of regeneration the characteristic vascular pattern of the opossum brain is not forced upon the angioblastic tissue by the peculiar chemical or structural constitution of the living nervous tissue of the opossum's brain, but appears to be determined by factors inherent in the cerebral vascular system.

(This article is based upon a seminar report presented at the Marine Biological Laboratory on July 23.)

AN *IN VITRO* ANALYSIS OF THE ORGANIZATION OF THE EYE-FORMING AREA IN THE EARLY CHICK BLASTODERM

Nelson T. Spratt, Jr.

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Rudnick ('32), Willier and Rawles ('35), Rawles ('36), and others have shown that the chick blastoderm at the head-process stage of development is composed of organ-specific areas or districts occupying definite positions. Each of these has the capacity to produce specific tissues in choric-allantoic grafts. Clarke ('36) found that one of these areas which has the capacity to produce eye tissues occupies a definite position at the anterior end of the primitive streak in definitive primitive streak blastoderms and at the anterior end of the notochord in head-process blastoderms. This area, designated the "eye-forming area" by Clarke, is elliptical in shape and exhibits a gradient in eye-forming potency which is highest in the median portion and which falls off abruptly to the right and gradually to the left. The present investigation is concerned with the development of this area as it takes place in isolates cultivated on the surface of a blood plasma clot *in vitro*. By means of this technique, which seems to be more favorable for the occurrence of morphogenesis

than the chorio-allantoic method, it seemed probable that some additional light might be thrown upon the nature of the organization of the eye-specific area.

When a piece containing the entire eye-forming area is isolated from a blastoderm at either the definitive streak, head-process, head-fold, or early somite stage of development, it forms, as a rule, a fore-brain with optic vesicles or cups of rather normal structure. The isolate is thus shown to have the capacity for developing a morphologically organized structure of a specific sort. Furthermore, it was found that isolates from older blastoderms gave this result more frequently than did comparable isolates from younger ones. Also, the shape of the fore-brain was more nearly normal in the former. This is indicative of a change in organization of the eye-specific area.

This result initiated next a study of the morphogenetic potency of pieces containing parts of the eye area. Is each piece capable of producing a complete or only a part of the fore-brain? Isolates containing anterior and posterior parts, right and left halves, and fourths of the area were tested. In general, isolates of these types produced corresponding parts of the fore-brain, e.g., either an anterior or a posterior portion, or a right or a left half. Such an isolate from a younger blastoderm showed a greater tendency to regulate the form of that part of the fore-brain arising from it than the same kind of isolate from an older blastoderm. The development of these isolates indicates, thus, a regional localization or specification within the area which becomes progressively more stable during development.

Since each of the isolates consists of the three germ layers of the blastoderm it must be realized that the mesodermal and endodermal layers of tissue which lie beneath the eye-forming area in the ectoderm may play a role. In other words, the development of the fore-brain from the isolate is probably not a case of independent differentiation of an already specifically organized ectoderm. There is some evidence which indicates that the mesoderm in particular plays an important role.

Lastly, a study was made of the power of a blastoderm from which a piece containing the eye-forming area had been removed to regenerate eye material. This problem had its origin in experiments designed to determine whether such a blastoderm could form all organ primordia except those arising from the eye-forming area. When the blastoderm minus its eye-forming area was explanted on the surface of a clot it was found that not only do many organ primordia develop, but a complete and remarkably normal fore-brain forms in many cases. The first step in this regeneration is the replacement of the excised area by endodermal, mesodermal, and ectodermal cells surrounding it. The latter normally do not contribute to eye-formation and do not show eye-forming potencies when tested on the chorio-allantoic membrane. In some cases a node-like structure and primitive pit may then arise in the regenerated region. Subsequently, medullary plate and neural folds develop in a fashion comparable to that found in unoperated blastoderms. Regenerative capacity is greatest during primitive streak stages, is markedly decreased in head-process stages, and is apparently lost as the somites begin to form. Since the regenerated region undergoes the same kind of morphogenesis that a normal eye-forming area undergoes, it is inferred that an eye-forming area has been reconstituted. In other words, the regenerated region has acquired an eye-specific organization. This has probably come about as the result of the spacial relationship of the regenerated region to the whole blastoderm, and especially to the anterior end of the primitive streak, a structure known to possess organizing powers.

(This article is based upon a seminar report presented at the Marine Biological Laboratory on July 23.)

ION INTAKE BY LIVING CELLS

Dr. S. C. Brooks
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The present work is in marked contrast with the previously accepted conclusions as to the rate of movement of ions through the plasma membrane and the cytoplasm. These older conclusions were based on measurements of the total amount of ions in cells. Radioactive ions tell another story. When ions are transformed into heavier isotopes, e.g. Na^{24}_{12} instead of Na^{23}_{11}, they disintegrate and emit radiation, beta and gamma, which can be detected by very sensitive devices such as the Geiger-Müller counter. To obtain salts with activities high enough to be read and too low to injure cells, it is necessary to activate only one-billionth of the ions in the preparation. Under these conditions, it is considered that the concentration of the salt is essentially proportional to this radioactivity.

Cells are put into an excess of a dilute solution

(0.0005M for Na_2HPO_4 to 0.033M for RbCl) in fresh sea water or other normal habitat, according to the material. If the plasma membrane were rather impermeable to ions, it would be expected that active ions would be excluded. But these ions distribute themselves in a statistical equilibrium within an hour or two or in seconds, involving inorganic ion exchange. Nitella cells adjust themselves in about one minute for Na^+, K^+, Rb^+, and B^+; Spirogyra in less than 15 seconds, *Amoeba proteus* is less than 7 minutes. Arbacia eggs in 3-10 minutes for HPO_4 and Na^+, and other marine eggs and sperm, and a yeast were tried with essentially similar results. This means that these cells are very permeable to ions, the rates observed being about 10^{-7} to 10^{-4} G.M. cm.$^{-2}$ sec.$^{-1}$, in contrast with 10^{-9} to 10^{-8}, the earlier supposition.

Change in salt concentration of the immersion fluid produces results in accord with the ideas that: (1) equilibrium is attained with salts present free and ions occupying attachment points in intracellular consituents; (2) the entering ions replace all protoplasmic ions in proportion to their own concentration and the replaceability of the intracellular ions.

Freshwater cells, e.g. Nitella, do not easily give up active ions to distilled water, but do lose them in a few minutes to inactive salt solutions. This sems to show that ions enter independently, cations in relation to acidic groups in the protoplasm and anions in relation to basic groups. These groups constitute an effective mosaic membrane as suggested by earlier workers.

Later stages in ion intake are complicated with losses of salts, and primary accumulation. These are shown in cells sacrificed for each observation, and in cells kept intact through a series of observations. In the case of Nitella, the latter is possible since the sap does not participate in this ion exchange, thus showing low permeability of the vacuolar membrane. These losses of salts, thought of as loss of ion pairs, rather than by ion exchange, and primary accumulation, are connected with metabolism. This may mean that metabolically produced organic ions are normally exchanged for entering inorganic ions.

(This article is based upon a seminar report presented at the Marine Biological Laboratory on July 16.)

SPECTROPHOTOMETRIC DETERMINATIONS ON HEMOGLOBIN AND ITS DERIVATIVES

DR. MATILDA M. BROOKS
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In these experiments I have tried to show what the mechanism of methylene blue action is when injected into the blood stream, and what the action of cyanide is when added to blood in concentrations found in cyanide poisoning. The essential point is whether methemoglobin (the ferric form of Fe) enters into the picture.

When fresh whole blood is used, or when methylene blue is injected intravenously, no methemoglobin can be demonstrated either in the visible range (Brooks, 1932, 1935*) of the spectrum or in the infra-red region by means of the spectrophotometer and the microphotometer. The reason for this is shown in Table I, in which different systems and their relative position on the oxidation-reduction scale are shown. One system can only reduce another one above it or oxidize one below it. Only at the extreme ends of the curve where overlapping occurs would it be possible for methylene blue to produce an appreciable concentration of methemoglobin. In the living body this does not occur, owing to the presence of glucose and other reductants which keep the redox potential at a relatively negative level. When crystallized hemoglobin, or old blood or hemolyzed blood is used, then the potential becomes more positive because the reductants have been used up and some methemoglobin can be demonstrated. If, therefore, methemoglobin is not present when methylene blue is injected, it cannot be used to explain the theory of cyanide poisoning and recovery by therapeutic methods.

What is the action of $NaNO_2$ and methylene blue in the case of cyanide poisoning? The action appears to be solely upon the respiratory enzyme (now known as cytochrome oxidase). This enzyme contains a reversible system composed of a heme group containing Fe, which changes from Fe^{++} to Fe^{+++} and back. This reversibility is destroyed by cyanide, not because the cyanide unites with the Fe^{+++} as is generally assumed, but rather because the cyanide produces a low redox potential (see Table I) poising the system at this level so that the most of the Fe remains in the bivalent form and can no longer be oxidized. The respiratory enzyme can only function at a definite positive potential and ceases

* Wendel (1937) repeated my experiments and reversed his former conclusions that methemoglobin was produced by injections of methylene blue.

Table I.

Showing relative E'_o values of different systems.

Oxidizes systems below ↓ Reduces systems above ↑

System	E'_o at pH 7.0	Reference
$NO_2 + H_2O + e' \rightleftharpoons NO + 2OH$	+0.34	Latimer (1938)
Methemoglobin reduced hemoglobin	+0.211	Schmidt (1938)
Methylene blue ⇌ leuco methylene blue	+0.011	Michaelis
Hemoglobin + cyanide	−0.252	Schmidt (1938)
Glucose ⇌ oxidant (?)	−0.400*	Aubel, Genevois and Wuhmser (1927)

* At pH 8.2 at 80° C.

to function when this potential becomes sufficiently negative and respiration stops. This appears to be the mechanism of inactivation by cyanide, by analogy with the experiments on hemoglobin.

To produce recovery it is only necessary to add a substance producing a positive potential. $NaNO_2$ or methemoglobin itself added will do this because from Table I it is evident that both of these systems have their E'_o in the positive range of the scale. They neutralize the negative potential produced by cyanide so that the Fe of the enzyme can again function at its proper potential. The production of *methemoglobin by $NaNO_2$ is a by-product and does not enter into the mechanism.* When methylene blue is used, not only is the potential poised at a high level, but the dye can take the place of the respiratory enzymes by virtue of its catalytic property as stated by the writer in 1932.

Finally it has been reported by some investigators that a shift in the absorption band of hemoglobin occurs when KCN is added to methemoglobin in certain concentrations as evidenced by the band spectroscope. In this case an absorption maximum at wave length 555 mμ appears. This absorption maximum is identical with that for reduced hemoglobin and indicates that it is the same substance rather than a new substance known in the literature as "cyanmethemoglobin", (presumably caused by a combination of cyanide with the ferric form of the Fe in the hemoglobin.)

Finally, summarizing, the conclusion is that the action of cyanide is upon the respiratory enzymes of the tissues, concerned with oxidation-reductions; the action of $NaNO_2$ or methemoglobin or any other non-poisonous oxidant is upon the redox potential of the enzyme shifting it back to its normal positive value from the negative value set up by the cyanide. Methylene blue also poises the potential at a higher value and because of its catalytic properties is able to substitute for the poisoned enzyme by transferring hydrogen. This is the antidotal action of these substances. Hemoglobin or methemoglobin is not concerned with the process of recovery from cyanide poisoning. No methemoglobin is produced by methylene blue when injected into the blood stream because of the presence of reductants which keep the redox potential at a range where methemoglobin is not appreciably formed.

(This article is based upon a seminar report presented at the Marine Biological Laboratory on July 16.)

CELLULAR BASIS OF COLOR PATTERN IN SOME BERMUDA CORAL REEF FISH

(Continued from page 105)

refraction of light and not as in the parrot fish to the presence of an actual pigment. A second fish examined was *Sparisoma abildgaardi*, the red parrot fish. The under side of this fish can change from a light pink color to a rose red within a few minutes. Tissue from this region showed an especial abundance of the erythrophores. There were also some extraordinary inter-cellular inclusions designated as opalescent bodies. Other parrot fish studied were *Sparisoma squalidum*, *Scarus vetula* and *Scarus caeruleus*. The last two named species also showed an abundant blue pigment in some cases diffusely distributed.

The Bluehead, *Thalassoma bifasciatum*, carries brilliant vertical bands or areas of blue, black and green. No blue pigment, however, is present.

The blue effect is produced by an association of very numerous iridocytes with melanophores. The presence of xanthophores with blue producing complex gives the green color.

Slides were also shown of a few other fish among which were the Squirrel fish, *Holocentrus ascensionis* and *Atherina harringtoniensis*. The former in addition to the usual color producing elements carries a dense underlying layer of guanin crystals which give a metallic effect. Atherina possesses some extraordinary melano-iridosomes which show shifting colors.

The paper was illustrated with about fifty kodochrome lanternslides of which most were photomicrographs. These latter were made in large part from fresh tissue on recently removed scales and some photographed by reflected light and others by transmitted light. Some pictures were made from gelatine mounts. Various magnifications were used including some taken with an oil-immersion lens.

(This article is based upon a seminar report, illustrated with kodachrome photomicrographs, presented at the Marine Biological Laboratory on July 30.)

INVERTEBRATE CLASS NOTES

Most of us arrived at Woods Hole Thursday, July 25—some by car, some by boat and others by train; but the important thing is that we arrived. Immediately we visited the laboratory and were completely put at ease by reading on the bulletin board that, "The instructors are present to help, not drive you."

Dr. Bissonnette welcomed us officially at 8:00 in the evening, and introduced our instructors to us. He then proceeded to explain our field trip duties as "angels," "archangels" and carriers of the "wg - fb" which turned out to be only a watch glass and finger bowl combination. The great dangers of Woods Hole tides, currents, poison ivy, ticks and sunburn were properly impressed and then, overcome, we travelled thru the fog to our new homes.

Early next morning we dove into the invertebrates, starting with a lecture on protozoa by Dr. Waterman. Immediately after, we began lab work, and spent two full days on this great group. Friday we were concerned with attached and free living protozoa, pursuing Euplotes and others all about the slides. On Saturday, symbiotic, commensal and parasitic protozoa were studied.

Saturday evening found us all at the M. B. L. Club Mixer, meeting many interesting and friendly people and generally being introduced to the Woods Hole spirit. All enjoyed the punch, cookies and dancing and we must take this opportunity to say—many thanks. Most of us are proud to say that we are now members.

After a Sunday of basking in the sun, exploring the "Hole," and burning the midnight oil in lab, we were more than ready for the porifera. Being limited to only two hours we went to work immediately after Dr. Lucas' lecture.

Exhausted by our visit with Sycon, Microciona and other sponges, we handed in our laboratory reports and settled down to our first lecture about coelenterates given by Dr. Crowell. He first warned us of the strength of the tides in this vicinity and explained, as a matter of interest, that when the tides turned the incoming body of water met the outward moving body with such force that a loud report like a pistol or a cannon shot resulted. At the appointed time everyone listened intently, and many confirmed Dr. Crowell's story. (P. S. It was a shot starting boat races at that exact moment). After having bitten on this piece of professional wit we began a study of Obelia, Bougainvillia, Clava, etc.

Tuesday morning found us starting for Stony Beach at 8:30 with numerous pieces of equipment and slacks and longsleeved shirts to protect us from the overcast sky and rough rocks. During the collecting of about 50 invertebrates by each team, excitement came in the form of fallen "angels," an unexpected swim by Dr. Matthews and several students when they slipped into the salty sea, and exercises on the beach to keep up body temperature. We are all looking forward to the next field trip. —*Grace Coe*

The Collecting Net

A weekly publication devoted to the scientific work at marine biological laboratories.

Edited by Ware Cattell and Robert Chambers with the assistance of Boris I. Gorokhoff and Peggy Browning; Contributing Editor, Homer A. Jack.

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Introducing

Dr. G. Haugaard, Research Worker at the Carlsberg Laboratory, Copenhagen; Fellow at the Rockefeller Institute of Medical Research, New York City.

A native of Copenhagen, Dr. Haugaard attended schools in that city and graduated from the Danish School of Engineering. After working in the chemical industry for two years, he joined the staff of the world-famous Carlsberg Laboratory in Copenhagen and has been associated with it since.

He has conducted research on a variety of subjects at the laboratory. One of his early investigations was carried out in collaboration with Dr. R. Koefoed on the composition of water from various parts of the Dead Sea with samples obtained during Dr. Ludwig Brühl's expedition to Palestine in 1911-1912.

In 1927 he worked with Dr. Arnold H. Johnson (then Rockefeller Fellow at the Carlsberg Laboratory and now working in Baltimore) on the fractionation of gliadin, the alcohol-soluble protein in wheat. Later he worked with Mrs. Margarethe Sørensen, wife of the then Director of the Carlsberg Laboratory, on the determination and identification of carbohydrates by the use of orcenol, the employment of which they found to be very satisfactory.

More recently he has been working on applications of glass electrodes in pH measurements of biological fluids.

In September of last year Dr. Haugaard arrived in the United States under a Rockefeller Foundation Fellowship and worked under Dr. Max Bergmann at the Rockefeller Institute of Medical Research.

At Woods Hole this summer Dr. Haugaard is concerned primarily with bibliographical research on various phases of his work. This fall he will work in the Biochemical Laboratory of Dr. A. Baird Hastings at Harvard University.

Dr. Haugaard is accompanied in his trip to America by his wife Karen and his three sons, Niels, Erik and Dan.

GOVERNMENT ZOOLOGY IN BRAZIL

To the Editor:

The Department of Zoology of the Agricultural Secretariat originated the first of last year when it separated from the Section of Zoology of the Paulista Museum. The staff, which is still very small, is composed of two executives who had formed part of the above-mentioned Section, and new members.

Their goals are among others:

a) Study of the fauna of the State of São Paulo and of Brazil with a systematic approach and any other considered necessary for the scientific, cultural and economic development of the State and the Country.

b) The organization and maintenance in the capital of the State of a Zoological Museum on the model of the large European and United States museums for the purpose of studying, teaching, and exhibiting our rich fauna. . . .

d) The foundation, at various localities in the State, of zoological stations, designed not only for study, but also to collect and prepare specimens of our salt-water, fresh-water, and insular fauna.

e) The organization and maintenance of a Zoological Library, containing publications on Brazilian fauna.

f) Publication, with the help of national and foreign specialists now connected with the Department of Zoology, of "Brazilian Fauna," an illustrated work containing a description of all species known in our fauna, their geographical distribution, habits and biology.

g) Publication of the "Arquivos de Zoologia do Estado de São Paulo" to review all the scientific original works about zoology pertaining to Brazilian fauna. . . .

n) Promotion of scientific trips abroad for members of the scientific staff, for further study, organization and reform of departments.

o) Organization of scientific expeditions in the country or abroad in order to study and collect zoological material or introduce exotic species considered useful to the national economy.

The staff is composed of: Dr. Oliverio Mario de Oliveira Pinto, Frederico Lane, Carlos Amadeu de Camargo Andrade, Lindodlpho Rocha Guimarães, Romualdo Ferreira de Almeida, Lauro Travassos Filho, José Kretz, Carlos Octaviano de Cunha Vieira, Da. Antonio Amaral Campos and José Leonardo Lima.

Additional information will be found in Volume I, Arquivos do Departamento de Zoologia, which will be published soon.

Sincerely yours,
Dr. Oliverio Mario de Oliveira Pinto,
Director.

CURRENTS IN THE HOLE

At the following hours (Daylight Saving Time) the current in the Hole turns to run from Buzzards Bay to Vineyard Sound:

August 3	3:51	4:19
August 4	4:42	4:54
August 5	5:28	5:43
August 6	6:17	6:33
August 7	7:03	7:35
August 8	7:54	8:19
August 9	8:46	9:19

ITEMS OF INTEREST

NEW ADDITION TO BRICK BUILDING

A new wing to the main brick building of the Marine Biological Laboratory will be constructed in the near future, it was announced this week. Work in sampling the underlying soil has already begun and it is expected that construction will be started this fall.

Built with funds granted by the Rockefeller Foundation, the new wing will be fifty-eight feet long and fifty-one feet wide, and will have the same height as the brick building. It will join the north wing to the east of the entrance of the latter so as to be continuous with the stack space of the present library.

The addition will be used primarily to house part of the library of the Marine Biological Laboratory. There will be five floors, corresponding to the floors in the present library. The basement floor will be used in part as additional space for sterilizers and other types of laboratory apparatus. The library has long felt the need for additional space for its rapidly growing collection of periodicals, and ample space will be provided by the new wing.

The east and west sides of the wing will contain windows, and there will be rows of tables along these sides, thus increasing the available space for readers. The style of architecture will harmonize with the present building. The architects are Coolidge, Shepley, Bulfinch and Abbott, of Boston, who have designed several other buildings of the laboratory.

Professor A. B. Dawson, who has been director of the Biological Laboratories at Harvard University for the past five years, has been appointed chairman of the department of biology to succeed Professor F. L. Hisaw, who recently resigned.

Dr. Charlotte Haywood, associate professor of physiology at Mount Holyoke College, has been appointed head of the department of physiology, succeeding Miss Abby Turner, who has retired.

Dr. Robert Chambers, research professor of biology at New York University, delivered a lecture under the auspices of the Invertebrate Zoology course Wednesday afternoon on "Various Aspects of Micro-manipulation, Technique and Results."

The last botany seminar at the Marine Biological Laboratory was held on Thursday, July 25. Dr. Runk showed pictures of the Mountain Lake Biological Station in Virginia and Miss Ruth Patrick gave a talk on Diatoms.

NOMINATIONS FOR TRUSTEES

The Annual Meeting of the Corporation of the Marine Biological Laboratory will be held in the auditorium of the Laboratory on Tuesday, August 11, at 11:30 A.M., for the election of Officers and Trustees and the transaction of other business. The Trustees will convene the same morning before the Corporation meeting and again in the afternoon.

The Nominating Committee of the Corporation of the Marine Biological Laboratory has posted the following slate:

For Trustees Emeritus: Caswell Grave, Ross G. Harrison, C. E. McClung.

Class of 1942 to replace Ross G. Harrison: Dugald E. S. Brown, New York University.

Class of 1944: H. B. Bigelow, Harvard University; R. Chambers, New York University; W. E. Garrey, Vanderbilt University; S. O. Mast, Johns Hopkins University; A. P. Mathews, University of Cincinnati; C. W. Metz, University of Pennsylvania; H. H. Plough, Amherst College; W. R. Taylor, University of Michigan.

Drs. Metz, Plough and Brown are proposed for Trusteeship for the first time; the other six men are presented for reelection.

Registration at the Marine Biological Laboratory late last week totaled 309, which compares with 296 at the corresponding time last year.

On Monday afternoon at 5 o'clock an interment service will be held at the Church of the Messiah for Dr. Henry McE. Knower, who died last January.

Dr. R. R. Gates, professor of botany at the University College, London, England, arrived in Woods Hole on Tuesday and will remain here until the conclusion of the meeting of the Genetics Society of America at the end of August.

Dr. Ernst Fischer, associate professor of physiology at the Medical College of Virginia, is engaged this summer in the moving of his department to a new building at the College. He will probably visit the Marine Biological Laboratory for a week in August.

Dr. Bostwick H. Ketchum, instructor in biology at Long Island University, is giving a course in laboratory technique and has charge of the combined histology-embryology course at the Marine Zoological Laboratory on the Isles of Shoals this summer. Dr. Ketchum has resigned his position at Long Island University to accept a research appointment at the Woods Hole Oceanographic Institution, which he will assume in August.

ITEMS OF INTEREST

The Woods Hole Oceanographic Institution's ketch *Atlantis* sailed Wednesday for a two-week cruise down the Eastern coastline as far as Virginia. Mr. Henry Stetson, member of the staff of the Oceanographic Institution, is in charge of the research program and will study the canyons that cut into the continental shelf. A new coring instrument will be used on this trip which will take fifteen-foot samples of the bottom.

Mr. R. B. Montgomery spoke on Thursday night at the weekly staff meeting of the Woods Hole Oceanographic Institution on "Some Boundary Layer Problems in Oceanography."

Mr. Fred G. Sherman, who has just completed the course in embryology at the Marine Biological Laboratory, was injured Wednesday when four of his teeth were accidently knocked out by a baseball bat.

M. B. L. TENNIS CLUB TOURNAMENT

Drawings for the men's singles in the Tennis Tournament have been posted on the Mess Court bulletin board. The first and preliminary rounds of the tournament must be played by August 8. Each player must furnish three new balls at the beginning of the match, the winner taking the new balls and the loser the used ones. The entries include: Stunkard, Evans, Jones, Rugh, Bodian, Warner, Summers, Henry and Rotman.

There have not been enough entries to make the other tournaments practicable. If additional names are obtained, however, the remaining tournaments could still be arranged.

ADDITIONAL INVESTIGATORS

Ballentine, R. res. fel. phys. Princeton. Br 231.
Benedict, D. Milton Acad. (Milton, Mass.). Br 309.
Bernheimer, A. W. grad. bact. Pennsylvania Med. lib.
Bloch, R. res. asst. bot. Yale. Br 231.
Cin, Ruth E. grad. bot. Michigan. Bot 1.
Cunningham, Ina grad. zool. Northwestern. Br 225. H 1.
DuBois, A. Milton Acad. (Milton, Mass.). Br 309.
Edgerley, R. H. grad. teach. asst. zool. Ohio State. OM Phys. Dr 2.
Everett, G. M. grad. phys. Maryland Med. OM Phys. Dr 3.
Fetter, Dorothy instr. biol. Brooklyn. Br 111.
Grand, C. G. res. assoc. biol. New York. Br 311.
Gwartney, R. H. DePauw. OM 31. Ho 2.
Heath, J. P. grad. teach. asst. Stanford. OM 41. K 1.
Kaiser, S. instr. bot. Brooklyn. lib.
Lloyd, D. P. C. asst. phys. Rockefeller Inst. Br 206.
Lucké, B. prof. path. Pennsylvania Med. L 25.
Ludwig, F. W. asst. prof. biol. Villanova. Rock 3.
Nash, C. B. instr. zool. Arizona. lib.
Rollason, H. D. grad. biol. Williams. OM 27. Dr 7.
Schaeffer, M. res. assoc. bact. N. Y. Dept. Health. Br 234.
Sherman, F. G. grad. lab. asst. Northwestern. Br 123. Ka 2.
Williamson, R. R. Chicago. Br 227. Dr 3.

Two fellowships have recently been authorized in the department of zoology at the University of Maryland. Dr. Norman E. Phillips, chairman of the department, will be glad to receive applications for the fellowships from graduate students who desire to major in zoology.

Dr. P. F. Scholander, Rockefeller Fellow and research associate at the University of Oslo, has begun work at the Woods Hole United States Bureau of Fisheries station on respiration and adjustment to diving in seals.

The annual meeting of the American Shellfisheries Association was held at Milford and New Haven, Connecticut, from Wednesday to Friday of this week. Dr. Paul S. Galtsoff, acting director of the United States Fish and Wild Life Service Station at Woods Hole, presided at the meetings. The following was the schedule of papers presented at the meetings:

"Some Observations on the Polychaete Worm, Polydora, on the Oyster Beds of Delaware Bay," Dr. Thurlow C. Nelson.
"Experiments in Oyster Growth and Culture in North Carolina," Dr. Herbert F. Prytherch.
"Seasonal Gonadal Changes of Adult Oysters in Long Island Sound," Dr. Victor L. Loosanoff.
"Oyster Drill in Long Island Sound," James B. Engle.
"A Review of Bacteriological Shellfish Scoring," Dr. Milton H. Bidwell.
"A Study of Microbiology of Shellfish from the Public Health Viewpoint," Dr. Leslie A. Sandholzer.
"Relation of Valve Closure to Heart Beat in the American Oyster," Leslie A. Stauber.
"Experimental Oyster Farming in South Carolina," R. O. Smith.
"Experiences with Lime in Limiting Destructiveness of Starfish," H. Butler Flower.
"Tray Culture of Oysters in the York River, Virginia," J. Richards Nelson.

DATES OF LEAVING OF INVESTIGATORS

Alexander, L. E.	July 25
Ballard, W. W.	July 24
Barnes, Martha	July 24
Brooks, S. C.	July 19
Brooks, Matilda M.	July 19
Duryee, W. R.	July 2
Frank, Sylvia R.	July 29
Kreite, B. C.	July 24
Luckman, C. E.	July 27
Michaelis, L.	July 8
Park, T.	July 29
Parker, Alice	July 29
Rogers, C. G.	July 25
Ronkin, R. R.	July 23
Runk, B. F. D.	July 27
Schotté, O.	July 12
Shannon, J. A.	July 16
Stilwell, E. Frances	July 29
Tucker, G. H.	July 8
Walther, R. F.	July 30
Whiteley, A. H.	July 23

EXTRA-CURRICULAR ACTIVITIES

About fifteen couples took part in folk dancing at the M. B. L. Club Wednesday night. This, the first of a series, was in charge of Dr. and Mrs. Robert H. MacKnight. The figures, called by J. P. Trinkaus, included the Virginia Reel, Christ Church Bells, and Divide the Ring. Accordion accompaniment was provided by Werner Maas.

The date of the annual concert of the Woods Hole Choral Club has been set for Monday, August 26. It will be presented in the Woods Hole Town Hall, which is located on Main Street next to the bridge. Rehearsals in preparation for the concert are proceeding satisfactorily and the club is looking forward to giving another successful program of sacred and secular music.

The program of the Monday night phonograph record concert at the M. B. L. Club: Consecration of the House, Overture, Beethoven; Concerto for Bassoon and Orchestra, Mozart; Classical Symphony in D major, Prokovieff; Violin Concerto No. 1, Prokovieff; Symphony No. 3 in E flat major ("Eroica"), Beethoven.

The Music Committee of the M. B. L. Club announces that two new loud speakers will be installed next week and that all the defects in the amplifying system have been found and corrected.

THE BIOLOGICAL FIELD STATIONS OF THE U.S.S.R. AND THE BALTIC STATES

Homer A. Jack
Cornell University

There are twenty-three biological field stations in Russia and the Baltic States. Eighteen of these institutions are in European Russia and there is one each in Estonia and Latvia. Despite the large number of Russian stations, comparatively little is known about their equipment or activities. This is due not so much to any secrecy on the part of the Russians, as to the lack of foreign scientists who have, in recent years, worked at these institutions as visiting investigators. While foreign investigators with acceptable political records have been allowed to do research at most of the Russian stations, both the prevalence of cumbersome formalities and the high rate of exchange have prevented all but the most determined of foreign scientists (and usually those who have been especially invited by the Russian government) from working at these institutions. What the future may bring in the way of encouraging foreign biologists to work at Russian field stations is not known, but mention at least should be made of the biological stations in this section of the world and the habitats in which they are located.

Three Russian stations are located on the Black Sea. The most famous of this group is the *Sevastopol Biological Station* in Crimea. This is the oldest biological station in Russia, having been founded in 1872 by the Imperial Academy of Sciences. In 1897 a relatively large, three-story building was erected to house this institution and this is still being used. After the Russian Revolution the station was taken over by the Academy of Sciences of the U.S.S.R. Professor S. A. Zernoff, who has been attached to the station since at least 1910, is still nominal director, although his offices are now in Leningrad at the headquarters of the Academy of Sciences. Another important station in this area is the *Novorossiisk Biological Station*. Located at Novorossiisk, this institution was founded in 1921 and dedicated to the late Professor W. M. Arnoldi. The remaining field station in this region is the *All-Ukrainian Scientific-Practical Station of the Black and Azov Seas* at Cherson. This institution was founded in 1918, one year after the November Revolution.

The Arctic Ocean is the site of two Russian stations. The *Algological Research Station* is at Archangel. The other station was founded near Archangel (on the Island of Solovetsky) but was moved to the Murman Coast in 1899. For many years the *Murman Biological Station* has been the best-known field station in Russia. About 1930 it was taken over by the Polar Scientific Research Institute of Marine Fisheries and Oceanography. The Academy of Sciences of the U.S.S.R. in 1937 announced plans for the construction of a new biological station in the Murman region at a cost of three and one half million rubles.

A number of Russian stations are located on fresh-water lakes. On Lake Onega near Finland is situated the *Borodin Hydrobiological Research Institute* at Petrozsavodsk. At Old-Peterhof in the suburbs of Leningrad is the *Hydrobiological Section of the Scientific Institute of Peterhof*. It is housed in the country estate of a former nobleman by the side of a small lake. On the shore of Lake Kossino in the suburbs of Moscow is the *Biological Station at Kossino*. The oldest fresh-water station in Russia was established on Lake Glubokoje in 1890. This institution, the *Hydrobiological Station on Lake Glubokoje* is now under the control of the station at Kossino. At

Vladikavkaz in the Caucasus Mountains is located the *North Caucasus Hydrobiological Station*. It was founded for theoretical investigations in alpine waters. Also in this general region on Lake Goktscha in Armenia is found the *Sevan Lake Station* at Elenowka.

There are a number of important rivers in Russia and on some of these biological stations are established. On the Volga River there are stations at Kostroma and Saratow. These are the *Biological Station of the Scientific Society for the Investigation of the Kostroma Region* and the *Volga Biological Station* at Saratow. The latter is one of the best-known limnological stations in Russia, having been under the direction of Dr. A. L. Behning since 1911. The *Hydrophysiological Station at Swenigorod on the Moskva* (River) was founded in 1910 and recently has been under the administration of the Ministry of Health. On the Kama River is the *Biological Station at Perm*. It is sponsored by the Biological-Scientific Research Institute of the University of Perm for theoretical investigations on the Kama basin. At Murom on the Oka River is the *Oka Biological Station*. Finally there is the *Biological Station of the Dnieper* (River). This is at Starosselje, near Kiev, and is sponsored by the All-Ukraine Academy of Sciences.

The remaining Russian field station in Europe is the *Institute of Research in High Altitudes* on Mount Elbrus. This station is located in the Caucasus Mountains at an altitude of 18,526 feet. Situated on the highest mountain in Europe, this institution is the highest field station in the world, being 4,276 feet higher than the Mount Evans Laboratory in Colorado.

The Russian biological stations in Asia are located in three diverse habitats: a river, a lake, and a sea. The *Siberian Ichthyological Laboratory* is located at Krasnoyarsk in Central Siberia. It is on the Yenisei River and is devoted to both practical and theoretical investigations. On Lake Baikal, at Maritui in Southern Siberia, is found the *Baikal Hydrobiological Station*. It is sponsored by the Academy of Sciences of the U.S.S.R. for the study of this lake which is one of the deepest in the world (with a reputed depth of 4,725 feet). On the Sea of Japan is the *Pacific Institute of Fisheries and Oceanography* at Vladivostok. This institution was founded in 1925 under the direction of Professor K. M. Derjugin and is located near Ussuri Bay, which is free from ice during the winter. It is sponsored by the All-Union Scientific Research Institution of Marine Fisheries and Oceanography for the purpose of investigating the hydrology, hydrobiology, and ichthyology of the waters near Vladivostok.

Little information is known about the two biological stations in the Baltic States. The *Biological Station of Tartu University* is located at Kusnomme near Tartu, Estonia. At Riga there is the *Hydrobiological Station of the University of Latvia*. This was founded in 1924 and now has accommodations for seven visiting investigators. It is under the direction of Professor Embrik Strand who is also director of the Institute of Systematic Zoology of the University of Latvia.

* * *

This author spent some weeks attempting to visit several of the Russian biological stations in the autumn of 1938. He was able to visit only three of them. In Moscow, for example, he tried to make arrangements through the proper governmental authorities to visit a nearby field station. Nothing came of these efforts, however, and the author decided to seek out the station for himself. He started early one November morning from his hotel near the Kremlin. Taking the new Moscow subway to the outskirts of the city, he came to a small railroad station. There he found a train and rode for perhaps an hour with a group of interesting peasants to a small wayside station. Contrary to expectations, he was not followed by the G.P.U. or any other agency. He wishes perhaps he were, for he might have saved several hours of aimless wandering in the muddy steppes by asking this agent the way to the biological station! Finally he came upon the institution in a small dwelling on the shore of a lake. He walked in and was welcomed by the staff. They showed him the equipment and arrangement of the station and made him at home by pointing out scientific bulletins from his own university. Tea was served and the talk drifted to biological techniques and problems. Soon this author had to take his leave in order to reach Moscow before nightfall. As he made his way back to the tiny railroad station he was reassured that scientists are quite the same throughout the world, even if political régimes are quite different.

One might generalize about the field stations of Russia by saying that, in 1938 at least, they had a relatively large personnel but insufficient equipment. This reflects perhaps both the apparently genuine eagerness on the part of the scientists in power to establish scientific institutions of all kinds (nine field stations were founded in Russia since the November Revolution) and the large number of persons who, being subsidized by the government while in school, graduate from the institutions of higher learning. Present, therefore, are both the desire to maintain field stations and an abundant supply of trained scientists. As microscopes must compete with military binoculars, however, the stations and scientists are relatively poorly-equipped.

THE COLLECTING NET

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FEATHER COLOR PATTERN PRODUCED BY GRAFTING MELANOPHORES DURING EMBRYONIC DEVELOPMENT

DR. B. H. WILLIER
Chairman of the Division of Biological Sciences, University of Rochester

This report deals with the effects on feather color pattern produced by grafting melanophores from one embryo to another of genetically different breeds of fowl or of different species of birds. It is proposed to analyze briefly the manner of control of feather color pattern, giving particular attention to barring and spotting (guinea) patterns.

By transplanting small pieces of tissue (skin ectoderm and underlying neural crest cells) containing potential melanoblasts from donor embryos (about 70 hours or equivalent age) into the right wing bud of hosts of the same age, melanophores of various breeds or species are introduced into the feather germs of white and pigmented fowl hosts. This results in the formation of an area of donor-colored down feathers on the wing and adjacent regions in the majority of cases. The down is replaced by juvenile contour feathers having the shape, rate of growth (*Continued on page* 138)

M. B. L. Calendar

TUESDAY, August 13, 8:00 P. M.

Seminar: Dr. A. C. Giese, "Effects of Ultra-violet Light on Respiration of the Luminous Bacteria."

Dr. Ivor Cornman: "Effects of Ether upon the Development of Drosophila."

Dr. Berta Scharrer: "Neurosecretory Cells in Cockroaches."

Dr. G. Haugaard: "The Mechanism of the Glass Electrode."

FRIDAY, August 16, 8:00 P. M.

Lecture: Dr. Alfred S. Romer: "Fossil Evidence Regarding Evolution of the Lower Vertebrates."

CATALYSTS OF BIOLOGICAL OXIDATION, THEIR COMPOSITION AND MODE OF ACTION

DR. ERIC G. BALL
Associate in Physiological Chemistry, Johns Hopkins School of Medicine

The reaction between oxygen and foodstuffs in the animal body is unusual if we stop to consider the fact that no such reaction occurs at body temperatures outside the living cell. The foodstuffs on our tables are relatively indifferent to the oxygen which surrounds them. Man has however long known that if he raised the temperature of his local environment sufficiently a violent reaction could occur in which such organic matter was said to be burned and energy in the form of heat was liberated. By the eighteenth century he had learned that in such conflagrations oxygen was consumed and carbon dioxide and water were produced. Soon thereafter Lavoisier showed that the animal body carried on a very similar type of process but in a remarkably well controlled fashion and at temperatures nearly equal to its surroundings. This then was the beginning of the search for the mechanisms by which the (*Continued on page* 127)

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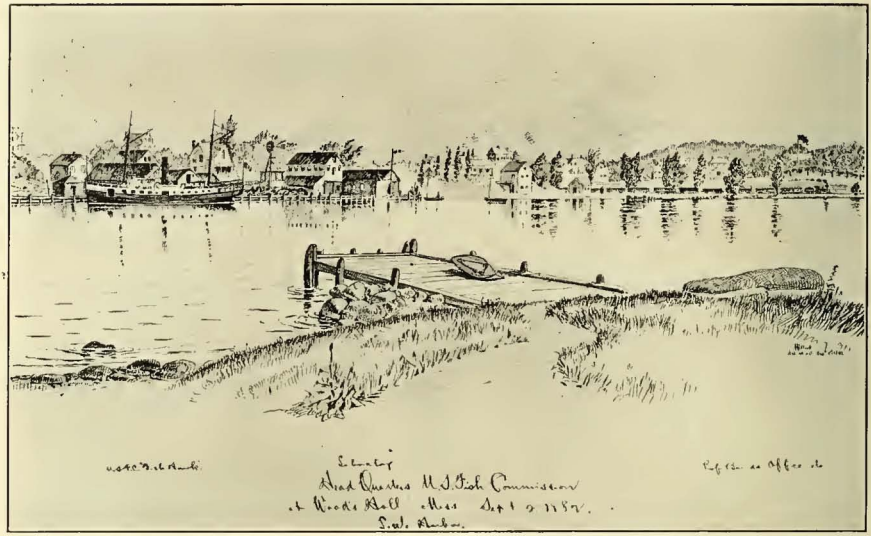

THE U. S. FISH COMMISSION STATION AT WOODS HOLE IN 1882

The headquarters of the U. S. Fish Commission were located from 1881 to 1883 in a building on the site of the present U. S. Lighthouse Service wharf at Little Harbor. The laboratories were located in the two-story building on the pier near the center of the picture, where the brick building of the Lighthouse Service now stands. A train may be seen to the right, running along the shore of Little Harbor. Juniper Point, now site of the Crane estate, extends to the left.

The Fisheries Laboratory was established at Woods Hole by Spencer F. Baird, who was Secretary of the Smithsonian Institution and was the first U. S. Commissioner of Fisheries, a position to which he was appointed in 1871. He set up laboratories at various points along the New England coast, but soon recognized the advantages of Woods Hole for biological research and was responsible for the permanent establishment of a station here.

Under the original terms of the act founding the Fish Commission, the heads of the various executive departments of the Federal Government furnished assistance needed by the Commission. The use of various buildings and ships of the Lighthouse Service for several years was thus granted to Professor Baird.

The temporary building was occupied until the completion of the present Woods Hole laboratory and residence of the Fish Commission. Land for the station, extending along the waterfront from the present property of the Marine Biological Laboratory to Penzance Point, was donated by a group of Woods Hole citizens, and the funds for the pier, residence and laboratory were provided by the Federal Government. Construction of the buildings was completed in 1883. Previous to that date, workers at the station dined at the residence of Professor Baird, which faces the harbor and is visible at the right of the picture.

The ship *Fish Hawk*, seen moored to the left of the picture, was one of the first vessels used by the Commission, being employed from 1880 to 1883. It was used in exploring the Gulf Stream and its fauna, particularly the distribution of tilefish. Chester Arthur, twenty-first president of the United States, rode on the ship on a dredging trip during his administration. The ship was superceded by the *Albatross*, which was used for nearly forty years for deep-sea work by the Fish Commission.

CATALYSTS OF BIOLOGICAL OXIDATION, THEIR COMPOSITION AND MODE OF ACTION

(Continued from page 125)

body catalyzed at low temperatures the smooth utilization of oxygen in the burning of foodstuffs. Lavoisier believed that a combustion of carbon particles occurred in the blood as it passed through the lungs and that the warmth generated there was carried by the blood throughout the body. We know today that the body is not merely a heat engine and while subsequent investigations of the rôle of the blood confirm Lavoisier's idea that it functions as a transport system between the lungs and the tissues, it is the oxygen we breathe in and the carbon dioxide to be exhaled that it transports.

In undertaking a survey of the catalysts concerned in biological oxidations let us begin first by attempting to follow the fate of oxygen from the time it first enters the body. The rôle of the blood pigment hemoglobin in the transport of oxygen from the lungs to the tissues, though not a truly catalytic one is worth, I think, brief review since this pigment has some properties in common with those catalysts with which we are concerned. Hemoglobin is a conjugated protein with a molecular weight of about 68,000 and possessing four iron porphyrin groups. How these groups are attached to the protein molecule is not known. You will subsequently see that all of the compounds with which we will deal tonight are similarly constituted, being composed of a protein part of large molecular size joined to a smaller organic molecule which I shall refer to in general as a prosthetic group. We are not entirely certain about the iron linkages in this compound. There is no doubt, however, that the iron is in the reduced state and that it remains in this state even after the hemoglobin has combined with oxygen. Now here is a most striking example of the sluggishness of oxygen to exert its oxidizing ability. Though oxygen is well able to oxidize ferrous iron to ferric, hemoglobin is able to combine loosely with oxygen and yet, so to speak, hold it at arm's length so that it does not strike in to oxidize the ferrous iron. If the oxygen should strike in and oxidize the iron to the ferric state then the compound is no longer capable of acting as a carrier of oxygen. Hemoglobin thus functions by picking up oxygen in the lungs where the partial pressure of this gas is high and releases it again to the tissues where the partial pressure is low.

The oxygen which hemoglobin thus brings to the tissues may be used directly or, as in the case of certain muscles, it may be put into "cold storage" against the time when a demand is made for it. So-called red muscles contain a pigment for this purpose called myoglobin which is similar to hemoglobin in its properties. Myoglobin is composed of a protein with a molecular weight reported to be about 18,000 and containing only one iron porphyrin group which, however, appears to be identical with those found in hemoglobin. It combines reversibly with oxygen in the same manner as hemoglobin, its iron remaining in the ferrous state throughout the procedure. Its affinity for oxygen is, however, much greater than that of hemoglobin. This fact is shown by a comparison of the oxygen dissociation curves of these two pigments. Since the prosthetic group of hemoglobin and myoglobin are the same you see here the first example of how variations in the protein part effect the behavior of the prosthetic group. Other examples will be encountered later.

Myoglobin is thus able to unload oxygen from hemoglobin and store it in the muscle cells. Certain aquatic mammals such as the seal possess muscles which are extremely rich in this pigment. These animals are capable of staying submerged for prolonged periods and it has been suggested that the oxygen capable of being stored in combination with this myoglobin is one important factor contributing to this ability.

Now regardless, however, of whether the oxygen comes directly from hemoglobin or through myoglobin its subsequent fate in the tissues is the same. Oxygen now encounters its first real catalyst and as we shall subsequently see its last one. Since the amounts of this catalyst present in the tissues are so minute in comparison to hemoglobin or myoglobin the isolation and study of its properties in a manner similar to that employed for these other compounds has thus far not been accomplished. Our knowledge of its very existence is therefore dependent upon evidence furnished by the alterations in consumption of oxygen that occurs when living cells are

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poisoned by cyanide or carbon monoxide. It was the known affinity of these poisons for iron compounds that first lead Warburg to postulate that their poisoning actions on tissue respiration was also due to their combination with an iron compound. That this iron compound was the catalyst which reacts with oxygen, and which we now call cytochrome oxidase, was proven by Warburg in an ingenious manner. Carbon monoxide and iron compounds form complexes which are reversibly dissociated by light. Warburg, therefore, placed living cells in a mixture of carbon monoxide and oxygen and found that the inhibitory effect of the carbon monoxide on their respiration was much less when they were well irradiated by white light. He now made use of the fundamental principle of photochemistry that only that part of the light radiations which are absorbed by a compound will exert any photochemical effect upon it. Irradiations of the preparation were now made with monochromatic light of varying wave lengths and it was found that the rate of oxygen consumption varied markedly as the wavelength of light was altered. By thus determining the relative efficiency of various wave lengths of light in restoring respiration he obtained the relative absorption spectrum of the carbon monoxide catalyst complex. Measurements of the quantum involved in this reaction and comparison with other known iron carbon monoxide complexes enabled him to convert the relative absorption spectrum into the absolute absorption spectrum. It resembles the absorption spectrum of the carbon monoxide complex of spirographis hemoglobin, an iron porphyrin compound not unlike hemoglobin. He thus reached the conclusion that this catalyst, cytochrome oxidase, also contains an iron porphyrin compound which is probably conjugated with protein.

We can now deduce certain points concerning the mode of action of cytochrome oxidase from behavior of other known iron porphyrin compounds. Carbon monoxide, for example, also combines with hemoglobin and in so doing prevents its combination with oxygen. It is thus reasonable to suppose that oxygen also combines with cytochrome oxidase and that carbon monoxide poisons it by preventing such a union. Oxygen and carbon monoxide, however, combine only with iron porphyrin compounds when the iron is in the ferrous state. Hence we can conclude that cytochrome oxidase contains iron in the reduced state. However, cytochrome oxidase can also be poisoned by cyanide and cyanide combines only with protein-iron-porphyrin compounds when the iron is in the ferric state. It thus appears that the iron in cytochrome oxidase may exist in either the ferrous or ferric state within the living cell. We, therefore, have this tentative picture of the mode of action of this enzyme. It combines with oxygen like hemoglobin or myoglobin, though in a much tighter union, but unlike these other compounds the oxygen here strikes in and oxidizes the ferrous iron to the ferric form. The oxygen thereby becomes reduced to water or to hydrogen peroxide. If hydrogen peroxide is formed it is decomposed to water and oxygen by catalase, another iron porphyrin compound whose discussion space will not permit.

Now whether this is the exact picture of events must naturally wait until the isolation of cytochrome oxidase permits us to study its properties directly. We are at any rate unable to trace the participation of oxygen in biological oxidations beyond this point. It thus appears that the oxygen we breathe in does not give rise directly to the carbon dioxide we exhale as was earlier believed, but yields water. Evidence for this is furnished by the recent experiments of Day and Sheel who allowed an animal to breathe air enriched with 300 p.p.m. of the heavy oxygen isotope. The expired carbon dioxide collected after a preliminary sweeping out period contained only 40 p.p.m. of the heavy oxygen isotope. How carbon dioxide is produced without the intervention of molecular oxygen we shall see later.

Though we have thus reached the end of the trail as far as oxygen is concerned, we have but barely begun on the series of oxidation and reduction reactions that are thus initiated. From now on you will see that our bodily oxidations entail the removal of hydrogen ions and electrons from the foodstuffs and their successive passage through a series of catalysts to ferric cytochrome oxidase which is thereby reduced. The ferrous cytochrome oxidase then reacts with oxygen and thus links the chain to this substance.

The substances that appear to stand next to cytochrome oxidase in this chain are, as its name implies, the cytochromes. Cytochrome is the name given by Keilin to certain cell pigments first observed by MacMunn in muscle tissue. If we examine with a spectroscope tissue which has been freed from blood, which interferes with the observation, we will see three strong dark absorption bands centered at $\lambda 605$, 565, and 550 $m\mu$ respectively. Keilin named the compounds responsible for these bands cytochrome a, b, and c, for as we shall see they belong to three different compounds. What Keilin clearly recognized and MacMunn apparently did not was that these bands were only seen if the tissue was deprived of oxygen. In the presence of oxygen these bands fade out. Keilin, therefore, concluded that these bands were given by the reduced form of these pigments and that by oxidation they were converted to sub-

stances with weak absorption bands. The process of oxidation and reduction was readily reversible by altering the oxygen supply of the tissue. Keilin now found that these bands could be made to appear even in the presence of oxygen if cyanide or carbon monoxide were also present. These poisons did not appear to act directly on the cytochromes since no change could be noted in their absorption bands. The oxidation of these three cytochromes by oxygen must therefore be brought about through the intervention of cytochrome oxidase which we have seen is susceptible to these poisons.

Of the three cytochromes only c can be extracted from the tissues. It has been obtained in what appears to be a pure state though not crystalline. The results of its analysis indicate that it is a conjugated protein with a molecular weight of about 13,000 and that it contains the same iron porphyrin group as hemoglobin. The isolated material gives the same absorption spectra for the reduced form as that shown in the intact tissue. In this reduced state it neither combines with nor reacts with oxygen. It can be oxidized, however, by suitable agents and it then possesses ferric iron and shows only a weak absorption spectrum. Theorell has proposed that its prosthetic group is joined to the protein part by thioether linkages, though his evidence is by his own admission not clean cut.

Though the compounds responsible for the bands labeled a and b have not yet been separated from each other it can be shown that different compounds are responsible for these bands. They both appear also to be iron porphyrin compounds.

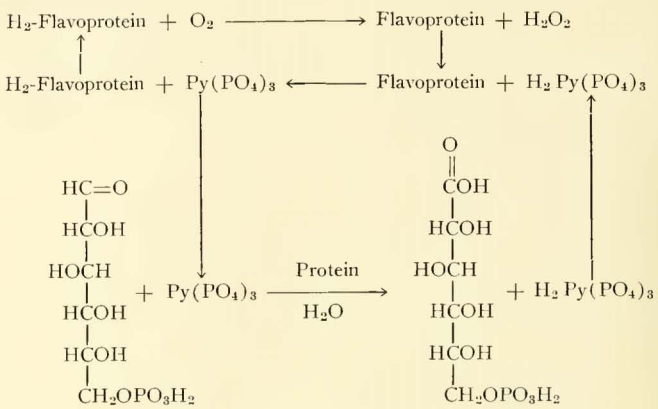
We have now dealt with no less than six iron porphyrin compounds. Though these compounds appear to possess prosthetic groups which are identical or nearly so the behavior of the iron atom in each with regard to oxygen is markedly different. We have seen that hemoglobin and myoglobin, possessing ferrous iron, combine reversibly with oxygen without oxidation of the iron occurring. Cytochrome oxidase containing ferrous iron also appears to combine with oxygen but here the oxygen strikes in and oxidizes the iron to ferric. The three cytochromes appear neither to combine with nor react with oxygen. It is thus obvious that the protein combined with the iron porphyrin group influences its behavior markedly.

Some years ago I was able to obtain a rough estimate of the relative oxidation-reduction potentials of the three cytochromes. From that data we can predict that if the cytochromes act in a chain and not separately the order in which they react must be a, c, b. This places soluble cytochrome c between the two apparently insoluble cytochromes a and b. We can therefore picture a chain of reactions in which the oxidation of cytochrome oxidase by oxygen produces water and ferric cytochrome oxidase. This ferric form then reacts with ferrous cytochrome a, the cytochrome oxidase being reduced again and ferric cytochrome a is formed. This in turn reacts with cytochrome c in a like manner. The ferric cytochrome c which is formed in turn reacts with cytochrome b. Thus an electron exchange occurs stepwise throughout the chain.

There appear to be but few living forms in which the cytochromes do not occur and arbacia eggs seem to be one of them. The more active the organ or the organism as a whole the higher the concentration of these pigments encountered. Last summer Miss Meyerhof and I felt that if there was any living form that might be expected to lack cytochrome it would certainly be those marine forms whose blood contains the copper protein compound hemocyanin, which functions in a manner similar to hemoglobin in these animals. We accordingly examined the tissues of the lobster, horse-shoe crab, whelk, and the squid and found them all to possess the three cytochromes. Some even possessed myoglobin in their muscles. The squid, which is undoubtedly the most fidgety of these animals, was richly supplied with cytochrome.

You are now perhaps prepared to ask what does cytochrome b oxidize and I cannot answer. If I could answer, you would probably want to know why cannot cytochrome oxidase react directly without acting through the chain of cytochrome compounds and again I could give you no concrete answer though we will return to this question later. Finally you might say, well, how do the foodstuffs enter into this picture. The investigator in this field has asked himself these very questions and it is because of his inability to follow the pathway further from the oxygen side that his attention in recent years has been directed towards experiments to learn the immediate fate of the various foodstuffs as they undergo oxidation in the body.

The most outstanding of these efforts has been the elucidation of the rôle played by certain of the vitamins in these processes. Vitamins, as someone has said, are peculiar substances because whereas we usually become sick from eating most things, vitamins make us sick if we don't eat them. Though we have long known that vitamins were essential to our well being we are now beginning to learn why vitamins are so essential. The splendid work of Dr. Wald in elucidating the rôle of vitamin A in vision is well known to you. Some of the functions of the vitamins of the B group will become evident to you as we proceed.



$Py(PO_4)_3$ = Triphosphopyridine Nucleotide

Time will not permit me to give you all the events leading up to these discoveries or to mention all the workers who have contributed their bit to the understanding of the chain of events I wish now to summarize for you. The reactions that we are about to consider constitute a series of oxidation and reductions brought about by the exchange of hydrogen atoms or of electrons with or without hydrogen ions. The catalysts concerned in these reactions are reversible oxidation-reduction systems which can accept hydrogen from the foodstuffs and pass it on to other catalysts in a chain which includes the cytochromes and are thus ultimately linked with oxygen.

We may group these catalysts into three classes depending upon which of the three vitamins, nicotinic acid, riboflavin, or thiamine, their prosthetic groups contain. Let us consider first the chemical composition of those prosthetic groups containing nicotinic acid and known as the pyridine nucleotides. Two such compounds are known. The first one to be isolated was obtained from red blood cells in Warburg's laboratory in 1935. It contains one nicotinic acid amide, one adenine, two pentose, and three phosphoric acid groups. I shall refer to it as triphosphopyridine nucleotide. The other isolated a year or so later in both Warburg's and Von Euler's laboratory contains the same units less one phosphoric acid group and hence it will be referred to as diphosphopyridine nucleotide. The exact structural formula for these two compounds is not known. From the evidence available it appears that we are dealing with two mononucleotide units which are linked together in some manner through the phosphoric acid groups which perhaps also serve to link them to the protein constituent.

What we may term the functional group of these two prosthetic groups is none other than the pellagra preventative vitamin itself, the nicotinic acid amide portion. It was the contribution of Warburg's laboratory to show that because of this group the pyridine nucleotides constituted reversible oxidation-reduction systems. Reduction occurs at the carbon-nitrogen linkage in the pyridine ring, a hydrogen ion and two electrons being involved in the process, the quarternary nitrogen disappearing. The reduced form possesses a characteristic band at λ 340 mμ which is not present in the oxidized species. This difference in the absorption spectra of the oxidized and reduced forms of the pyridine nucleotide has been of inestimable value in following their participation in the biological reactions we will now consider.

A characteristic example of the rôle of the pyridine nucleotides in biological oxidations is the system which led Warburg, Christian, and Griese to the discovery of the triphosphopyridine nucleotide. Here the substrate to be oxidized is glucose monophosphate. If we symbolize triphosphopyridine nucleotide as $Py(PO_4)_3$ then the first step of the reaction may be represented as it is here. The aldehyde group of the sugar is oxidized to an acid group, with concomitant reduction of the pyridine nucleotide, the elements of water entering into the reaction. The reaction is dependent on the presence of a specific protein which functions by uniting with both substrate and pyridine nucleotide. Now the reduced pyridine nucleotide thus formed is not oxidized by air. Warburg

found that it required for its oxidation a substance he called a yellow enzyme, one of a new class of compounds which now that their composition are known are called flavoproteins. The one symbolized here is capable of oxidizing the reduced triphosphopyridine nucleotide and thus regenerating it for another cycle. The reduced flavoprotein thus formed can be oxidized by oxygen. Thus it also is regenerated and can react in a cyclic fashion. However the rate of its reaction with oxygen is so slow at the partial pressures of this gas existing in living tissues that it is doubtful that this is the manner in which it is reoxidized in living cells. It is probably reoxidized in the cells with the aid of the cytochrome system as we shall discuss later. The phosphohexonic acid produced may be further oxidized with the help of the triphosphopyridine nucleotide and flavoprotein cycle if further specific proteins are added.

The flavoprotein concerned in this reaction functions as a reversible oxidation-reduction system by reason of its prosthetic group. It differs from diphosphopyridine nucleotide only in that the nicotinic acid amide group is replaced by an isoalloxazine ring and in that the linkage of this ring to the ribose molecule is not the glucosidic one encountered in the pyridine nucleotides. This difference in linkage is reflected in the fact that the vitamin part of this prosthetic group is the intact riboflavin group. The isoalloxazine ring alone possesses no vitamin B_2 activity. Thus in this case the body is apparently not only unable to synthesize the special nitrogen ring but is also unable to couple it with the ribose molecule in the manner required to form this compound.

The exact structure of this dinucleotide is also not known though it appears that the two mononucleotide units are linked through the phosphoric acid groups. These groups as well as the -N-H group in the isoalloxazine ring appear to be concerned in the linkage of the prosthetic group to its protein partner. The functional group of this dinucleotide is the isoalloxazine ring. This group is capable of undergoing reversible oxidation and reduction. In the oxidized form it is yellow, in the reduced form colorless. It is this group, then, of the flavoprotein which accepts from the reduced pyridine nucleotide the hydrogen which it in turn accepted from the sugar. The direct reaction of the flavoprotein with the sugar does not occur, nor will the prosthetic group of the flavoprotein alone react with the reduced pyridine nucleotide.

(*Concluded Next Week*)

PHOTOCHEMICAL SPECTRUM OF THE PASTEUR ENZYME

Dr. Kurt G. Stern, Dr. Joseph L. Melnick and Mr. Delafield DuBois
Laboratories of Physiological Chemistry and of Physiology, Yale University School of Medicine

When fermenting cells are brought in contact with oxygen, as a rule less carbohydrate is broken down and less fission products are formed than under anaerobic conditions. This phenomenon was discovered by Louis Pasteur in 1861; it is now known as the *Pasteur reaction*. The effect has been interpreted in terms of an oxidative resynthesis of carbohydrate from the end products of fermentation (Meyerhof), of a suppression of fermentation by respiration (Warburg), and of an inhibition of fermentation by oxygen (Lipmann, Laser). The selective inhibition of the Pasteur reaction by ethyl isocyanide (Warburg), by lowering the oxygen tension, and by suitable concentrations of carbon monoxide (Laser) indicates that a catalyst distinct from the respiratory enzyme is involved and that this agent contains heavy metal. The name *Pasteur enzyme* is proposed for this thermolabile catalyst. Inasmuch as any mechanical or chemical injury suffered by the cell tends to abolish the Pasteur effect, the procedures usually employed for the extraction, purification and identification of enzymes do not appear applicable to the present problem. For the special case where a biocatalyst contains iron which, in the course of the catalysis, undergoes a cyclic change between the ferrous and the ferric form, Otto Warburg has developed an ingenious method which permits one to determine the spectrum of the catalyst in the living cell and in amounts which are too small to be detected by direct spectroscopy. The method takes advantage of the affinity of ferrous iron to carbon monoxide and of the reversible splitting of iron carbonyl complexes by light. Since only that fraction of incident light which is absorbed can be expected to exert a chemical effect, it follows that the photochemical efficiency of *mono*chromatic radiation will be proportional to the intensity of absorption of light of any given wavelength by the system. Warburg was able to show that a plot of the photochemical efficiencies against wavelength yields a curve which is identical with the shape of the absorption spectrum of iron carbonyl complexes.

The reversal of the carbon monoxide inhibition of the Pasteur effect in mammalian tissues by white light, as observed by Laser, has enabled the present authors to apply Warburg's photochemical method to the study of the spectrum of the Pasteur enzyme. Rat retina was chosen as the experimental tissue because of its convenient thickness, of its high glycolysis, and especially be-

cause its active respiration remains unaffected by carbon monoxide in concentrations sufficient to inhibit the Pasteur reaction. The arrangement of the experiments is briefly the following. A sufficient amount of retina tisue is suspended in a medium containing bicarbonate and glucose and is then equilibrated with a gas mixture containing CO, O_2, and CO_2. Due to the inhibition of the Pasteur effect by the CO the already considerable aerobic glycolysis of the retina is further increased to almost the level of the anaerobic glycolysis. One molecule of lactic acid formed by the tissue liberates one molecule of CO_2 from the bicarbonate of the medium, thus causing a pressure to develop which is measured with the aid of a differential manometer. Upon illumination of the system with monochromatic light of high intensity, the enzymatically inactive complex between the ferrous iron of the Pasteur enzyme and CO is reversibly dissociated to an extent determined by the intensity and by the wavelength of the radiation employed. A certain fraction of the iron of the enzyme becomes thus available for combination with oxygen. The oxidized form of the enzyme is capable of inhibiting the glycolysis, probably by reacting with the reduced form of a coenzyme of fermentation. Illumination of the tissue will, therefore, produce a certain decrease in the rate of lactic acid formation and of the subsequent liberation of CO_2 by the reaction system.

The photochemical efficiency ratios for 24 different wavelengths of visible light between 405 and 655 mμ as referred to the blue mercury line at 436 mμ as the standard radiation have thus far been measured. The results obtained indicate that the peak of the main absorption band of the Pasteur enzyme in rat retina is situated in the neighborhood of 450 mμ. Two secondary maxima are located at 515 and 578 mμ. When compared with the spectrum of the respiratory ferment in yeast or acetobacter the main band of the Pasteur enzyme shows a red shift of approximately 150 Å and the band in the yellow shows a blue shift of about 140 Å. While the Pasteur enzyme in retina differs from the respiratory ferment in the same tissue and from that in yeast or acetobacter by its affinity for oxygen and carbon monoxide and from the latter two by the position of the absorption bands of the CO complex, the general pattern of the Pasteur enzyme spectrum reveals it to be a porphyrin-iron proteid. The enzyme appears to belong to the class of pheohemin derivatives just as the respiratory ferments in yeast and acetobacter, the worm blood pigment chlorocruorin, and very probably also certain cytochrome-a components. The nature of the respiratory ferment in retina is as yet not known.

(This work was aided by a grant from the Jane Coffin Childs Memorial Fund for Medical Research.

This article is based upon a seminar report presented at the Marine Biological Laboratory on August 6.)

STUDIES ON ERYTHROCRUORINS (INVERTEBRATE HEMOGLOBINS)

Dr. Kurt Salomon

Research Fellow in Physiological Chemistry, Yale University, Medical School

The most widely distributed respiratory pigments in the animal kingdom are the iron containing hemoglobins and the copper containing hemocyanins. The hemocyanins occur only in invertebrates, and all have high molecular weights (350,000 to 5,000,000). The hemoglobins on the other hand, are universally distributed throughout the animal kingdom. Vertebrate hemoglobins, as a rule, have a molecular weight of 68,000 whereas invertebrate hemoglobins, which Svedberg calls erythrocruorins, vary in their molecular weights from about 34,000 to several millions.

Two erythrocruorins occuring in worms have been studied from a chemical and physical-chemical point of view, in order to enable a comparison of their properties with those of vertebrate hemoglobin. Two very different types of erythrocruorin were studied, viz., the macromolecular pigment of the common earth worm (*Lumbricus terrestris*) and the low molecular respiratory protein of the so-called bloodworm (*Glycera dibranchiata* Ehlers. In accordance with the experience of Svedberg the former is freely dissolved in the plasma whereas the latter is locked up in blood corpuscles which are suspended in the body fluid.

Earthworm erythrocruorin was isolated by repeated salting out or by repeated ultracentrifugation (67,000 × gravity) of purified worm extracts. The ultracentrifugally prepared material showed only one sedimenting boundary in the analytical centrifuge. Beams' air driven concentrating ultracentrifuge proved to be a suitable tool for the precipitation and purification of this high-molecular pigment.

Upon oxidation of earthworm erythrocruorin with potassium ferricyanide a band appears in the red, the center of which is at 645 mμ, that is shifted fifty Ångstrom units towards the long wave region as compared with the ferrihemoglobin band. Addition of fluoride at pH 5 shifts it to the yellow part of the spectrum, without, however,

producing an intensifying effect. It is worth mentioning that the oxybands of *Lumbricus* erythrocruorin persist partially, even when an excess of potassium ferricyanide is used. In general one may say qualitatively that *Lumbricus* erythrocruorin is oxidized by the same agents as hemoglobin; for instance gallocyanine produces ferrihemoglobin as well as ferrierythrocruorin in phosphate buffer at pH 7.5. *Lumbricus* erythrocruorin is not oxidized when its solution is aerated at room temperature for several hours.

The metband of bloodworm hemoglobin is located at 640 mμ, that is, identical with that of ferrihemoglobin. It is however not influenced by the presence of sodium flouride at pH 5. The intensity remains unchanged. The bands of the oxy- and of the carbon monoxide compounds of human hemoglobin and the erythrocruorins studied occupy the same position.

Bloodworm hemin crystallizes in an identical form with mammalian hemins. The relatively large amount of blood pigment present in *Glycera dibranchiata* Ehlers has made it possible to isolate sufficient quantities of pure crystalline hemin to permit a determination of the configuration of the porphyrin, in order to decide whether the blood heme grouping present in worms is identical with that of the vertebrates. The mesoporphyrin-dimethyl-ester was prepared and its absorption spectrum in ether was found to be identical with that of a natural mesoporphyrin IX-dimethyl-ester. The readings were as follows:

I. 495 II. 530 III. 570 IV. 630 mμ

The melting point of the ester prepared from bloodworm hemin was 212° C.; the melting point of the ester when mixed with an authentic sample of synthetic ester prepared in Professor Hans Fischer's laboratory showed no depression.

The dissociation rate of *Lumbricus*—and *Glycera*—oxyerythrocruorin was compared with that of human oxyhemoglobin by Mr. Delafield DuBois in his reaction meter. Human and *Glycera* hemoglobin proved to have an identical dissociation rate t_{50} (= half time of the reaction) being 0.026 seconds. *Lumbricus* oxyerythrocruorin on the other hand had a half time three times greater, namely of 0.070 seconds. By comparing these values with the half time measured for hemocyanins of different molecular sizes, one finds in accordance with Millikan, that the order of magnitude of the reaction is the same, even when the molecular size and the chemical structure of the pigments greatly differ. Whether this is a general rule cannot be definitely stated before additional measurements on the dissociation rate of other respiratory pigments are available.

(This article is based upon a seminar report presented at the Marine Biological Laboratory on August 6.)

INVERTEBRATE CLASS NOTES

Recovering from our Tuesday morning immersion, we hurriedly returned to the coelenterates. Besides being interesting from a scientific point of view, this phylum presented many an opportunity for a good (?) pun. Hydroids brought up the query, "What do you want a gonophore?" and star coral was blamed for the voice raised in lab to announce, "Hey! We have Astrangia in our midst."

Bunny Shanks' alarm clock, in spite of its reputation to ring at any unexpected moment, came through at the appointed time, one night, as a signal that all lights be turned out. - - - Oh yes. The reason for this unusual procedure was the desire to see the beauties of luminescent Mnemiapsis.

Wearied by three strenuous days of acquiring a familiarity with coelenterates, we turned in our laboratory reports with one parting pun, "It's not Ctenophore but five of eight." By the way—come to the beach some day to learn the new medusa stroke developed by several members of our class.

Friday introduced us to the flat worms and Dr. Rankin. With a quick-fire rapid lecture that gave us a bad case of writer's cramp, we learned of the characteristics, taxonomy and morphology of the Platyhelminthes. Then, with the cry, "Bdelloura makes me Bdellourious," we started tracking down the internal anatomy of turbellarians and the life cycle stages of trematodes.

We finally had our first introduction to *Winifred* and *Nereis* Saturday when we travelled to Lackey's Bay. Those on *Winnie* enjoyed the songs led by Dr. Martin and Dr. Matthews. Invertebrates were plentiful and we soon had many types in the arks ready to be classified in the evening. After supper found us gathered in our small collecting groups in lab, trying to identify strange worms and crustaceans and at the same time learn the names of all the various forms. One group failed to find an animal in a small vial of sea water and was about to dispose of it when one member shouted, "Don't throw that away! That's a protozoan I collected."

Sunday morning saw a strange transformation in lab. All desks were covered with comic sections, and those of us not reading these were gathered in small social groups discussing various problems. For most of us this was a day of relaxation, because we knew we were to travel to Kettle Cove Monday morning for our first all-day field trip.

—*Grace Coe.*

The Collecting Net

A weekly publication devoted to the scientific work at marine biological laboratories.

Edited by Ware Cattell and Robert Chambers with the assistance of Boris I. Gorokhoff and Peggy Browning; Contributing Editor, Homer A. Jack.

Entered as second-class matter, July 11, 1935, at the U. S. Post office at Woods Hole, Massachusetts, under the Act of March 3, 1879, and re-entered, July 23, 1938.

Introducing

Dr. Reginald Ruggles Gates, Professor of Botany, King's College, University of London.

Educated at Mt. Allison (Sackville, N. B.), McGill and Chicago, Dr. Gates received his Ph.D. from the latter institution in 1908. After a year as assistant in botany at the University of Chicago, he conducted research at the Missouri Botanical Gardens until 1911. He then went to England, where he held a position as lecturer in biology at St. Thomas Hospital, and in cytology at Bedford College, London, from 1912 to 1914. He returned to America in 1915, when he held a position for one year as acting associate professor in zoology at the University of California. In 1917 and 1918 he was instructor in aerial gunnery for the Royal Air Force. At the conclusion of the War, he was appointed reader in botany at King's College, London, where he became professor of botany in 1921.

Dr. Gates has travelled extensively; expeditions have taken him to such varied places as the Amazon River Valley and the Arctic regions of Canada. He has visited South Africa and India as well as many European countries.

Dr. Gates' work has been carried out particularly in cytology and genetics. He has concentrated upon such subjects as cell structure, chromosomes and mutations (especially in *Oenothera*), and blood grouping of primitive peoples, racial crossings and other aspects of human heredity. He has published five books, most of them dealing with genetics, and has contributed one hundred sixty-five articles to scientific publications. He is author of a book, "Biological Botany," to be published this fall.

During his present visit to North America, Dr. Gates plans to continue work on a new method of staining plant cells, in which chromosomes stain red and the nucleus green. The tracing of nuclear phylogeny from species to species and from genus to genus has been facilitated by the use of this method.

His work has brought him a number of honors, including fellowship in the Royal Society and an honorary degree from Mt. Allison. He has been president of the Royal Microscopical Society, and vice-president of the Royal Anthropological Institute and of the Eugenics Society. In 1938 he delivered the De Lamar Lectures at the Johns Hopkins University.

Dr. Gates arrived in Woods Hole on July 30 after a trip from England, being on leave of absence from the University of London for the duration of the war. This is not his first visit to Woods Hole; he worked here under scholarships from 1904 to 1908. He will leave for Canada during the latter part of this month. Dr. Gates expects to be available for lectures during the coming academic year.

SEMINAR ON PHYSIOLOGICAL CHEMISTRY

DR. H. C. BRADLEY, CHAIRMAN

Dr. Albert Oxford, University of Wisconsin and formerly of the University of London, England, described a new compound, isolated from the metabolic products of *Penicillium grisco-fulvum* grown on glucose and $NaNO_3$ as the only source of C and N. The crystalline compound, weakly acidic in character, yields on hydrolysis a terpene-like hydrocarbon, a substituted phenol related to tyrosine, NH_3, CO_2 and acetaldehyde. The author proposes a structural formula for this new nitrogenous compound. He indicated that mold cells contain a proteolytic system somewhat similar to the autolytic mechanism so widely distributed in animal tissues—a proteinase of the papain type, together with amino-, carboxy-, and dipeptidase.

Dr. Kurt Salomon, of the Yale Medical School, identified the red blood pigment of the earthworm and the bloodworm, as hemochromogens related closely to vertebrate hemoglobins. Both sources yield hemin crystals identical with vertebrate hemin, indicating the same porphyrin pattern. The difference between these hemochromogens and the hemoglobin of man and the vertebrates resides in the protein part of the molecule.

Dr. Kurt Stern, Yale Medical School, presented the data obtained by his group of workers, to substantiate the hypothesis that the "Pasteur effect" is mediated by an enzyme, for which the name Pasteur enzyme is proposed. The Pasteur enzyme is found to belong to the group of respiratory catalysts which contain iron in a heme complex, capable of cyclic changes, $Fe'' \rightleftharpoons Fe'''$. When CO is present its affinity for the Fe" results in a combination with that fraction of the enzyme and thus its effective removal from the reacting system. Light of a specific wave length dissociates this ferrous-carbonyl compound and thus restores

(Continued on page 139)

ITEMS OF INTEREST

DR. C. E. MCCLUNG, who recently retired as director of the biological laboratories at the University of Pennsylvania, has been appointed visiting professor of biology at the University of Illinois.

DR. WARREN H. LEWIS, who is retiring as research associate in the department of embryology of the Carnegie Institution of Washington and professor of physiological anatomy at the Johns Hopkins University, has been appointed a member of the Wistar Institute of Anatomy and Biology.

DR. JOHN HUTCHENS, who is working this summer under a National Research Council fellowship at Harvard Medical School, is completing a week's visit to Woods Hole with Mrs. Hutchens. Dr. Hutchens will return to Johns Hopkins University this fall.

DR. ARTHUR DZIEMIAN, graduate student at Princeton University, who worked at Woods Hole in 1937 and 1938, visited Woods Hole this week. He has been awarded a National Research Council fellowship for the coming academic year, and will work with Dr. M. H. Jacobs at the University of Pennsylvania.

MR. ARTHUR WOODWARD, JR., has been appointed teaching fellow in biology at New York University.

MR. J. PHILIP TRINKAUS will study at Columbia University this fall under the Cramer Fellowship in Biology of Dartmouth College.

Rockefeller Foundation Fellows

The following investigators are working at the Marine Biological Laboratory under Rockefeller Foundation Fellowships: E. J. W. Barrington University College, Nottingham, England, who has been working with Professor B. P. Babkin at McGill University; A. E. Oxford, University of London, who has been working with Drs. E. B. Fred and W. H. Peterson at the University of Wisconsin; H. C. G. Haugaard, Carlsberg Laboratory, Copenhagen, who has been working with Dr. Max Bergmann of the Rockefeller Institute; H. M. Kalckar, Copenhagen, who has been working with Dr. Linus Pauling at the California Institute of Technology and with Dr. Carl F. Cori at Washington University School of Medicine; P. F. Scholander, University of Oslo, who has been working with Dr. Lawrence Irving at Swarthmore College. There are four other men from Europe working in the biological sciences in the United States under Rockefeller Fellowships who are not at Woods Hole.

The trustees of the Woods Hole Oceanographic Institution will hold their annual meeting on Thursday, August 15.

The Woods Hole Oceanographic Institution's ketch *Atlantis* cut short her trip to the Virginia coast this week when the trawl winch was broken. The *Atlantis* sailed again Thursday with Dr. Stetson on board to complete the interrupted work; it will return next week.

At the staff meeting of the Woods Hole Oceanographic Institution last Thursday, Dr. Riley spoke on "The Rôle of the Phytoplankton in the Productivity of Georges Bank."

The showing of slides and motion pictures of marine animals presented by Mr. George C. Lower was repeated on Wednesday afternoon in the auditorium of the Marine Biological Laboratory.

DR. L. J. MILNE, associate professor of biology at Randolph-Macon Woman's College, presented a motion picture demonstration Thursday evening in the M. B. L. Auditorium on "Animated Diagrams of Biological Processes." Dr. Milne is visiting Woods Hole together with his wife, who is instructor in biology at Randolph-Macon and received her doctor's degree from Radcliffe in June, 1939. She took the M. B. L. course in protozoology in 1934.

The annual exhibition of the pupils' work of the Children's School of Science and Junior Laboratory was held yesterday in the Woods Hole School House. A meeting of parents, members and friends of the Children's Science School Association was held the same afternoon.

MISS ADAIR BRASTED was married recently to Dr. Charles W. Gould. Mrs. Gould was a student in the embryology course at the Marine Biological Laboratory last year and received her Ph.D. from the University of Rochester this June. Dr. and Mrs. Gould are now living in Akron, Ohio.

Mountain Lake Biological Station

A record registration of about 70 persons marked the first term of the Mountain Lake Biological Station at Mountain Lake, Virginia. The first term ended on July 27, and the second will conclude at the end of August. Seminar reports at the Mountain Lake Biological Station for the month of July included the following: Dr. L. L. Woodruff spoke on the history of biology. Dr. John M. Fogg, Jr. spoke on the distribution of plants. Dr. Robert K. Burns discussed the experimental treatment of opossum embryos.

ITEMS OF INTEREST

Dr. Melville T. Cook, who has just retired from his position as plant pathologist and vice-director of the Insular Experimental Station at Rio Piedras, in Puerto Rico, is completing, with his wife, a month's visit at Woods Hole.

Dr. Guido W. Loewi, of the School of Hygiene at the University of Toronto, arrived in Woods Hole on Monday to visit his father, Dr. Otto Loewi.

Dr. N. W. Rakestraw, of the Woods Hole Oceanographic Institution, will attend the meeting of the New England Association of Chemistry Teachers to be held at the University of Maine during the week of August 12.

Dr. Charles W. Hock recently arrived at Woods Hole to work at the Oceanographic Institution. He has been working in bacteriology at the Bureau of Standards.

Dr. Marie A. Hinrichs, who has worked at Woods Hole for a number of years, is completing a summer quarter as professor and head of the department of physiology and director of the Student Health Service at the Southern Illinois Normal University at Carbondale, Illinois.

Dr. C. Parry Kraatz, instructor in physiology and pharmacology at the Chicago Medical School, arrived last Saturday with Mrs. Kraatz in Woods Hole for a stay of several weeks.

Dr. W. W. Ballard of Dartmouth College has been elected secretary-treasurer of the New Hampshire Academy of Sciences.

Dr. M. W. Bosworth, who has been connected with the Bridgeton Academy, has been appointed head of the science department at Vermont Academy.

Mr. J. J. Malone, apprentice fish culturist of the Bureau of Fisheries, was injured Tuesday when a shark that he was taking into the collecting boat slashed his arm. He was taken to the hospital at Marthas Vineyard where he will remain for a few days.

DATES OF LEAVING OF INVESTIGATORS

Andersch, Marie	July 31
Buck, J. B.	August 3
Copeland, D. E.	August 1
Fetter, Dorothy	July 31
Goldin, A.	August 5
Hendley, C. D.	August 5
Höber, R.	July 30
Kabat, E. A.	July 26
Katzin, L. I.	August 3
Lower, G. C.	August 10
Root, C. W.	August 2
Thompson, R. H.	August 7
Wolfson, C.	August 5

Openings are available in a mid-western Medical School for an instructor in physiology, one in bacteriology, two in pathology, and possibly one in anatomy. Candidates may submit a brief statement of qualifications to "M. W. M.", % The Collecting Net, for preliminary consideration. The Collecting Net will be glad to publish announcements of any other positions which are available for qualified members of the Woods Hole community.

According to a recent compilation, there are 640 zoologists and naturalists receiving $2,000 or more annually in the civilian service of the United States Government. Forty of these are women. These figures do not include entomologists, botanists, or bacteriologists.

Miss Eunice Stunkard, daughter of Dr. Horace W. Stunkard, head of the department of biology at New York University, has won the annual American Youth Forum Award of $1,000 for the best article by a high school student on the subject, "Today's Challenge to American Youth." Nearly 500,000 high school students submitted papers. Dr. Stunkard arrived in Woods Hole this week.

M. B. L. CLUB

Mrs. Marshall Smith has been appointed hostess of the M. B. L. Club, succeeding Mrs. Dorothy Bosworth, who is leaving this week.

The following persons have been appointed to the house committee of the Club: Galina Gorokhoff, Joe Malone and Ted Genther.

The membership of the M.B.L. Club has reached three hundred thirty-seven.

A ping pong tournament is being organized at the Club. Any persons wishing to enter it are requested to give their names to Teru Hayashi.

Names of the winners of the ping pong tournaments of the last three years have been engraved on the ornamental paddle overlooking the ping pong table in the Club-house.

Group singing will take place on Thursday evening at the Club. It was postponed from last Thursday in order to avoid conflicting with the Falmouth Nursing Association's Fête.

The program of the Monday night phonograph record concert at the M. B. L. Club: Overture to "Alceste," Gluck; Cantata, "Ich werde nicht sterben," Heinrich Schütz; Cantata, "L'Impatience," Rameau; Canzonetta, "Sento un certo non so che" from the opera "L'Incoronazione di Poppea," Monteverdi; Sonata for flute and harpsichord in G. major, Johann Christian Bach; Third Tenebrae Service for Wednesday of Holy Week (1714), Couperin; Requiem, Fauré.

THE BIOLOGICAL FIELD STATIONS OF THE BALKAN STATES

Homer A. Jack
Cornell University

The Balkan Peninsula, which has contributed its share of troubles to the statesman and more than its share of charm to the traveler, contains a number of field stations which, in normal times, would entice the biologist. These institutions extend from Split on the Adriatic to Constanza on the Black Sea. A triangle is formed with the Italian station on the island of Rhodes which, though not actually a part of the Balkans, is most easily reached from Athens. The other important biological stations in this area are those at Stâna de Vale and Sinaia in Roumania and at Varna in Bulgaria. In Yugoslavia at Struga am Ochridasee is located a small fresh-water station (*Die Hydrobiologische Abteilung der Antimalariastation zu Struga*) which is devoted to faunistic and limnological research. In the past, field stations were in operation in the suburbs of Athens (*Marine Biological Station of Phaleron*) and on the Bosporus in Turkey (*La Station Biologique de la Faculté des Sciences de l'Université de Istanbul*), but in recent years both have been abandoned. There is no record of a biological station ever having been established in Albania.

The Oceanographic Institute of Split (*Oceanografski Institut*) is on the Adriatic Coast of Yugoslavia. It was founded in 1930 by the Yugoslavia Academy of Sciences at Zagreb and the Royal Serbian Academy at Belgrade for research and instruction in oceanography and biology. Today it has a budget of about 500,000 dinars (about $11,350) which is administered by Professor A. Ercegovic who is director of the station. At present the institution has three buildings. The main one contains a public aquarium, library, and twenty-five laboratories, each of which is equipped with 220-volt electricity and running fresh- and sea-water. Another building contains living quarters for students and investigators, while a third accommodates the station's employees. The laboratories are open to investigators throughout the year. There is a research fee of 400 dinars a month (about $9.08) and board and lodging may be obtained for 1,520 dinars a month (about $34.50). Two courses in marine biology are also offered by the institution. One is given by members of the station staff while the other is in charge of outside professors.

At the famous Roumanian vacation resort of Sinaia is found the Sinaia Zoological Station (*Stațiunea Zoologică din Sinaia*). In a forested zone at the base of Mt. Bucegi (which has an elevation of 8,200 feet), this institution has been conducted by Professor A. Popovici-Baznoșanu for the past eighteen years. Today there is a modest building which houses the laboratory and lodging quarters of any foreign or Roumanian investigators who may wish to study the fauna or flora of the region. For this purpose the station is open each year from the first of June to the end of October. Ordinarily there are no laboratory or living charges, except for board which may be obtained within 25 minutes walking distance of the laboratory for about 6,000 lei a month (about $42.60).

A similar Roumanian institution is the Botanical Station of Stâna de Vale (*Stațiunea Botanică Stâna de Vale*). This, too, is located in a mountainous region, being in the Bihors at an altitude of about 3,600 feet in a spruce forest. During August a course in phytosociology is given by Professor Al. Borza, who is both director of the station and professor of botany at the University of Cluj. In addition to instruction, this institution is equipped for investigations in the fields of ecology, floristics, and phytosociology. The station is open during July and August to qualified research workers. There are no laboratory fees and free lodging is provided in the laboratory building for eight persons.

The largest Roumanian station is located on the Black Sea. A few miles south of Constanza, at Agigea, stand the three buildings of the Marine Zoological Station "King Ferdinand I" of Agigea (*Stația Zoologică Maritimă "Regele Ferdinand I" dela Agigea*). These three structures comprise a two-story laboratory building, a students' laboratory, and a three-story, twenty-room dormitory. Construction on these buildings was begun in 1926 under the guidance of Professor I. Borcea. Today the station is sponsored jointly by the Roumanian Ministry of National Education and the Laboratory of Zoology of the University of Jassy, with Professor C. Motaș, professor of zoology in that university, director of the station.

The work of the Roumanian seaside station revolves around "the investigation of the fauna of the Black Sea and neighboring lakes and the completion of the zoological education of university students." Dr. Seriu Căraușu conducts year round zoological research at the station and outside investigators are invited to work in the laboratories between June first and the end of October. There is an interesting sliding laboratory fee, which is 1,000 lei a month (about $7.10) for

professors, one half that amount for assistants, and only 250 lei a month for students, to whom a practical course is given during July and August. Board and lodging may be obtained at the station for 1,480 lei a month (about $10.51). The published scientific work of the institution is collected into a volume of reprints (*Lucrări ale Staţiei Zoologice Maritime "Regele Ferdinand I" dela Agigea*) which is available to interested investigators and institutions.

One of the most striking examples of the indirect effects of war on scientific institutions is shown in the history of the *Biological Station and Aquarium at Varna*, Bulgaria. This institution was hopefully founded in 1906 and by 1911 a large, three-story building was ready for occupancy. Soon came the Balkan and World Wars, however, with their resultant economic chaos, and it was not until 1932 that this station was able to be opened. During the last few years, under the direction of Dr. G. W. Paspaleff, the institution has apparently been attempting to make up for its 26 years of inactivity. Its educational program includes both higher and public instruction, the latter by means of an aquarium and museum. Two formal courses are offered by the station, one in early July for university students and the other in late July and early August for teachers of natural history in the schools of Bulgaria. Research investigators are admitted to the station at any time of the year. Free lodging may be obtained and there are no laboratory fees, the investigators only being requested to present to the station fifty copies of any published research which was conducted at the institution. Much of the scientific work of the station appears in *Arbeiten aus der Biologischen Meeresstation am Schwarzen Meer in Varna, Bulgarien*, a part of the yearbook of the University of Sofia.

A day's journey by boat southeast of Athens brings one to the delightful Italian island of Rhodes. Here in the harbor towered the Colossus. Here resided a group of the medieval crusaders. Today modern crusaders may find a veritable colossus to science in these barren Dodecanese Islands a very short distance from the site of the famous statue. This is the Royal Institute of Biological Research in Rhodes (*R. Istituto di Ricerche Biologiche, Rodi*). It was founded in 1936 by several agencies of the Italian Government for "research in the oceanographical, biological, and chemical sciences as well as agricultural studies with special regard to marine biology in relation to fisheries." A modernistic, two-story laboratory has been erected. This is fully equipped for research in bio-chemistry, physiology, and histology and contains a unique underground public aquarium. It is in charge of Dr. Carlo M. Maldura. Investigators must secure special permission to work at this laboratory from the Royal Government of the Italian Islands of the Aegean, because in the past few years the island has been an important military post for the eastern Mediterranean. Acceptable investigators may work at the station throughout the year, securing excellent living accommodations at nearby hotels for 1,200 lire a month (about $63.12).

* * *

In those relatively care-free days when Americans could and did go to Europe, some scientists showed hesitation about venturing outside the British Isles, France, or Germany to conduct research and consult colleagues because of the "language difficulty." Not a few American scientists, conscious of their linguistic provincialism, wondered whether they would be able to talk with their contemporaries in the Balkans, for example, except by the use of mathematics or an interpreter. To obtain some information on this situation, the author kept careful account of his linguistic experiences while talking to the directors (or persons in charge) of 66 biological stations he visited in sixteen European countries during 1938. It was found that two thirds of the directors interviewed spoke understandable English. Of those who did not speak English, eighty per cent spoke French and the others, German. There were good assurances, therefore, that if an American scientist did go to Europe he could have made himself understood at least scientifically.

FEATHER COLOR PATTERNS PRODUCED BY GRAFTING MELANOPHORES DURING EMBRYONIC DEVELOPMENT

(Continued from page 125)

and distribution in tracts characteristic of corresponding regions of host control chicks, but invariably the color or color pattern of the donor breed or species.

From several lines of evidence it has been proved that melanophores migrate out from the implant into the host epidermis and the feather germs developing from it and produce the area of donor-colored feathers. Donor melanophores from pigmented birds deposit melanin granules of specific size, shape and color in the epidermal cells of the shaft, barbs and barbules of the host feathers. Melanophores from white breeds (4 examined) enter and occupy all the available positions in the host feather germs, thus excluding those of the host which come in later. Owing,

however, to some peculiarity in genetic constitution few or no melanin granules are deposited with the result that the host feather is white. Owing to some lethal factor the melanophore dies before depositing pigment.

The color or color pattern of the feathers is specifically in accord with the genotypic composition of the donor breed. If the donor breed has solid colored feathers (e.g., black or buff minorca, white silkie, etc.) its melanophores produce the same solid coloration in the host feather. If the donor breed has a two or multi-colored pattern its melanophores reproduce very faithfully the same kind of color pattern in the host feathers.

Barred rock melanophores produce a barred pattern in host contour feathers of non-barred breeds (N. H. Red, White Leghorn & Black Minorca). Two types of barring pattern occur, one being darker than the other. In the darker pattern the black bars are wider and darker than in the lighter one. These differences are identical with sex-linked differences in plumage found in donor control chicks of the same age, where the females are darker than the males. It is clear therefore that melanophores from the ♀ donor (1 gene for barring) produce a darker-colored host feather than those from a ♂ donor (2 genes for barring). The sex of the host has no effect on the result.

Similarly F_1 hybrid embryos (R. I. Red ♂ × Barred Plymouth Rock ♀) give sex-linked differences in plumage. Melanophores from ♂ and ♀ embryos (sex ascertained after donor is hatched) produce respectively barred and non-barred contour feathers in a white leghorn host irrespective of its sex.

From these results the conclusion is reached that the action of the melanophore in controling color pattern is in accord with its genotypic composition and is to a high degree independent of the foreign host environment.

The extent to which the melanophore behaves as an independent system in the production of color patterns in the host feather remains to be considered. That it is not independent of the host feather germ is brought out very nicely in patterns produced in White Leghorns by barred rock and guinea melanophores. When barred rock melanophores are transplanted the black bars are *wider* in rapidly growing feathers such as the wing primaries and *narrower* in slow growing feathers such as the coverts and breast feathers. An important point to note is that the width of the black bar shows much variation on the same host, even though the melanophores all came from the same region of the donor (head).

In a similar way the guinea melanophores produce in white Leghorn feathers patterns which vary with the time of emergence of and position of the feather. For example, secondary flight feathers which emerge first are gray with tan-brown tips and outer vane margins are mottled with brown-gray. Later emerging secondary flight feathers show irregular cream-white barring on a gray background; in the last to emerge the whitish bars begin to break up into irregular spots. These patterns are identical with those of corresponding feathers in guinea fowl controls. It is thus seen that the guinea fowl melanophore in a particular feather germ produces a specific color pattern. The exact pattern produced depends upon the inherent nature of the individual feather germ. Each feather germ apparently has certain physiological properties (rate of growth, threshold of reaction, etc.) peculiar to it, which controls the action of the melanophore in pattern formation.

(This article is based upon a seminar report presented at the Marine Biological Laboratory on July 30 and based upon a paper by Willier and Rawles, Physiol. Zool., *13*:177; see also Anat. Rec., 76 Sup. P. 46).

SEMINAR ON PHYSIOLOGICAL CHEMISTRY

(Continued from page 134)

the inactivated enzyme to its active form. This may be determined by the removal of the inhibitory "Pasteur effect" on glycolysis when light of the effective wave length is directed on the reaction chamber. From the same data, the absorption spectrum of the Pasteur enzyme may also be plotted. This absorption spectrum clearly indicates the heme structure and its relation to other respiratory enzymes and heme compounds (such as the erythrocruorin described by the previous author). The author suggested that in some tumor tissues there may be a disturbance of the Pasteur enzyme.

The last two papers, together with the recent lecture by Dr. Eric Ball, serve again to accentuate the wide and varied use which organisms are able to make of some single potent structure—in this case the porphyrin-iron complex. By changes in the protein component which is combined with the heme complex, together with small changes in the porphyrin nucleus perhaps, we see a large group of specifically active compounds emerging which carry on or catalyze an equally large number of important functions in cell metabolism. One recalls the similarly potent family of compounds of the phenanthrene pattern which are functionally active in the rôle of vitamins, cortical and sex hormones.

THE COLLECTING NET

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THE EFFECT OF ULTRAVIOLET RADIATIONS ON THE RESPIRATION OF A LUMINOUS BACTERIUM

DR. A. C. GIESE

Rockefeller Fellow, Princeton University

Claims that ultraviolet light greatly accelerates respiration were made by a number of investigators at the beginning of the century. Several attempts to check these claims were made by Tanner and his coworkers, who found that division of yeast was readily inhibited and that fermentation and respiration were little affected or declined; they attributed the apparent stimulation reported by the earlier workers as probably due to imperfect measurements. Although many other studies have appeared the subject has remained controversial. It therefore seemed interesting to investigate the effects of these radiations on some unicellular organism and to control conditions so as to be able to arrive at a definite conclusion.

For this work one of the luminous bacteria, *Achromobacter fischeri*, was chosen because two indices of the effects of the radiations on the metabolism could be obtained—the (*Continued on page* 157)

M. B. L. Calendar

TUESDAY, August 20, 8:00 P. M.

Seminar: Dr. W. Gordon Whaley: "Developmental Changes in Apical Meristems."

Dr. Harry G. Albaum and Dr. Barry Commoner: "The Relation between Auxin and the Four-Carbon Acid System in the Growth of Oat Seedlings."

Mr. R. K. Skow: "Respiratory Changes Following Stimulation in Nitella."

Dr. L. R. Blinks: "Relation of Potassium to Bio-electric Effects of Light and Temperature in Valonia."

FRIDAY, August 23, 8:00 P. M.

Lecture: Dr. D. E. S. Brown: "The Regulation of Metabolism in Contracting Muscle."

THE MOLECULAR ORGANIZATION OF PROTOPLASMIC CONSTITUENTS

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As we come closer and closer to bridging the gap between the molecular and the microscopic, between the Ångstrom unit and the micron, it becomes more and more necessary to apply the newer knowledge of ultrastructure in the theoretical and experimental approach to almost every field of biology. I assume it is unnecessary to defend such a statement before this audience. However, a few examples may be useful as illustrative of the trend.

In *physiology* a knowledge of tissue ultrastructure is essential, for before one can determine how a complex mechanism functions one must have some insight into the construction of the system. With the great recent strides in the organic and physical chemistry of high molecular weight substances the physiologist must now think in terms of molecular and micellar units rather than those of gross and microscopic anatomy. Indeed, the needs of the physiologist in

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Back row: F. P. Knowlton, E. R. Clark, H. B. Goodrich, Wm. R. Taylor, P. B. Armstrong, T. H. Morgan, R. Chambers. **Middle row:** C. C. Speidel, M. H. Jacobs, B. M. Duggar, Caswell Grave, W. C. Curtis, E. N. Harvey, Laurence Irving, W. R. Amberson, A. P. Mathews, L. V. Heilbrunn, L. Riggs, Jr., L. L. Woodruff, G. H. Parker, R. S. Lillie, A. H. Sturtevant, J. H. Northrop. **Front row:** Otto Glaser, S. O. Mast, Charles Packard, G. N. Calkins, W. B. Scott, F. R. Lillie, H. C. Bumpus, E. G. Conklin, D. H. Tennent, W. E. Garrey.

this direction have forced him to take the initiative in exploring the molecular anatomy of cells, a field perhaps more properly that of the morphologist, though in fact as close to chemistry as to cytology.

In *morphology* it has long been clear that protoplasmic structures are very sensitive to alterations in their chemical environment and, if the just criticism of his chemical and physiological colleagues is to be avoided, the morphologist must discover the conditions which determine the metastability of the structures he studies. If he cannot work with living cells he must evaluate the kind and degree of artifact production introduced by his fixatives. Actually, modern crystallography and X-ray diffraction studies have provided a new basis for cytology in demonstrating a close correlation, in many instances, between the microscopic and even macroscopic structure of tissue components and their submicroscopic, molecular organization. Thus a fiber has its peculiar shape and properties because the molecules or micelles are themselves fibrous; a membrane looks and behaves as it does because it is composed of molecular layers or membranes. There is, therefore, much in morphology which may lead to clues regarding molecular organization. Indeed, many of the facts discovered by the classical morphologists by entirely empirical means are now useful in interpreting the properties of the molecules themselves. Thus the shrinking or swelling actions of certain fixatives, which were chiefly nuisances to be avoided by the cytologist, are now useful in interpreting the types of linkages between protein groups. If one had the patience to read through the wordy and voluminous papers of the masters of descriptive morphology in the light of the modern knowledge of the physical chemistry of the proteins and lipides one might bring forth many gems worth polishing and adding to the fabric of present day concepts.

In *experimental embryology* sufficient biological evidence is now at hand concerning morphogenetic fields, induction, primary and induced polarity, and regulation, to make it profitable to seek a physical explanation of these phenomena. It seems probable that this search will center about an investigation of the differential orientations of complex and specific protein and lipide systems which characterize the reacting system, and of the processes by which the chemical metabolism interacts with the specific structural substratum to bring about the orderly unfolding of the organism.

In *genetics* the bearing of ultrastructure analysis is particularly direct. In seeking a physical basis for the gene one must deal with properties of linear arrays of protein units, sub-units, and super-units and with combinations of these with other groups which may have a prosthetic character. Also, to understand the mechanism of chromosome division, pairing, deletions, inversions, extensibility, and contractility, one must apply to these unique protein strands the large body of information which is accumulating regarding similar properties in simpler fibrous protein systems. Finally, if the geneticist is to attack the problem of the fundamental nature of the interaction of genes on the same and on different chromosomes and with the entire reacting system, he must be prepared to do some pioneering in the already complicated field of enzyme chemistry. It may well be that a long strand of interconnected apoenzymes, or protein carriers, may react differently with the various prosthetic groups and with each other than might be supposed from the properties of single enzyme systems as now understood.

In some quarters this rapidly growing tendency to seek explanations of biological phenomena in terms of the properties of the constituent molecules is viewed with some concern. It is felt that too much emphasis on this analytical approach may divert attention from the search for the higher order emergent phenomena which are characteristic of no systems simpler than living cells. I must confess to some misgivings of my own on this score. But I cannot agree with the organismic positivists who, in their zeal to establish biology as a science in its own right, would seek to discover the higher order phenomena without benefit of the theoretical and technical equipment offered by the exact sciences. I cannot believe that the two methods of approach are so mutually incompatible that they cannot be pursued in the same intellectual atmosphere. Indeed, if we may use the search for the solution of the structure and emergent properties of the protein molecule as an example, it would seem that the greatest advances are made through the closest cooperation of chemists, who provide analytical data, and biologists who study the emergent properties, such as enzyme and virus action. Similarly we may hope for great advances through the close cooperation of geneticists, embryologists,

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and physiologists, who study the higher order phenomena, with those who are attempting to analyze the structure and physical chemical properties of protoplasmic systems.

Methods of Ultrastructure Anaylsis

A detailed account of the various methods available for studying protoplasmic fine structure would be inappropriate since we are more interested in results and conclusions than in methods. However, a few remarks, especially about some of the newer methods may be helpful.

A point worth stressing concerning all of these methods is that useful and significant results may be expected only when the optical equipment is adequate, properly adjusted and calibrated. Success, especially in investigating the optical properties of very small microscopic objects, frequently depends on a critical adjustment of certain factors. For example, many of the recent discoveries about the birefringence of chromosomes and other cell organelles might have been made a generation ago if sufficiently intense illumination had been used and the proper biological material chosen.

Ultrastructure may be studied directly with the ultraviolet microscope and the electron microscope. Aside from the increased resolution afforded by the shorter wave length, the ultraviolet microscope offers enormous possibilities because certain important substances, like nucleic acid, absorb specifically in this spectral range. The now classical work of Caspersson on chromosome structure is a good example of what can be accomplished when the possibilities of the method are adequately exploited. Another useful tool in this category is the fluorescence microscope. Certain cellular structures fluoresce when radiated with ultraviolet light and similar properties may be conferred on most structures by treatment with fluorescent substances. The method has considerable chemical diagnostic value and its possibilities deserve further development.

The electron microscope would appear to be ideal for use with materials which may be dried without too much artifact production. Resolution twenty to thirty times that of the best light microscope have already been achieved, i.e., objects as small as 100 Å have been resolved. Interesting structure has been observed in certain biological objects thus highly magnified, although in some instances the results have been somewhat disappointing. Little is known about the stability of organic molecules when subjected to such intense electron bombardment and this factor may limit the application of the method somewhat. However, the method is very new and with its further technical development may be expected important advances in our knowledge of fine structure. The modification of G. H. Scott, at Washington University, has already given information about the preferential distribution of calcium and magnesium in cells.

Among the indirect methods the oldest is that of polarization optics. Birefringence data reveal the specific orientations of submicroscopic particles and determine whether the asymmetric particles are themselves crystalline or isotropic. Other useful information includes the partial volume of the oriented particles, their refractive index, and other clues as to their general chemical composition. Under optimal conditions the method is extremely sensitive. Thus polarization crosses may be observed very distinctly in the envelopes of red cell "ghosts" although independent evidence shows that the material producing these phenomena is only a few molecular layers in thickness. With polarized light, structures may be detected in living cells which could not be observed in ordinary light because of refractive index conditions. The recent observations of Monné on the birefringence of the Golgi apparatus in living cells is an example in point. The method has the distinct advantage that its use has no harmful effects on the living cell.

As anisotropic objects may have two descriptive refractive indices (birefringence), so they may have two characteristic absorption coefficients (dichroism). Thus with white light a dichroitic fibril may appear green when oriented parallel with the plane of vibration of the plane-polarized light, and some shade of yellow when oriented perpendicular thereto. With monochromatic light one may obtain total extinction or full intensity depending on the orientation. Dichroism may be conferred on cellular objects by impregnation with highly dichroitic dyes and metals. With such optical amplification, evidence of molecular orientation has been observed even in very poorly organized cellular structures. The method is a valuable aid to the cytologist because of the contrasts of color or intensity which it provides in very small objects. The only optical accessory needed for the ordinary microscope is a polaroid plate to determine the plane of vibration of the light.

Before leaving the field of birefringence I should stress the possibilities which await the development and application of the ultraviolet polarizing microscope. Here, aside from increased sensitivity, one has the possibility of natural dichroism of many structures due to preferential orientation of ultraviolet-absorbing substances. A prominent crystallographer recently remarked that the ultraviolet polarizing microscope may be expected to reveal more about the microcosmos of

the cell than the new 200 inch telescope will reveal about cosmic matters.

X-ray diffraction data provide information about the dimensions, configurations, and orientations of molecules. It is applicable to tissues or cell populations which provide sufficient diffracting planes for coherent and detectible scattering. It is difficultly applicable to microscopic objects although patterns have been obtained from 10μ samples of keratin. X-ray diffraction and polarized light data are mutually helpful in interpreting the structure of biological systems.

The most recent tool for fine structure analysis is the analytical leptoscope developed by Dr. D. F. Waugh and myself. Objects, such as red blood corpuscle envelopes are deposited on a glass slide of high refractive index. When viewed with a microscope fitted with a vertical illuminator, the thickness of the object may be determined from the intensity of light reflected from its surface, provided the refractive index of the object is known. Instead of measuring the intensity of reflected light with a photometer it is more convenient to compare this intensity with that reflected from a built-up step film of barium stearate. The standard step film, also deposited on high refractive index glass, is viewed through a similar microscope set-up and matching is accomplished with the aid of a comparison ocular. The method is accurate to ± 10 Å if many objects are tested, and it has recently been used to determine the thickness and general chemical composition of the red cell envelope. The method is particularly useful in detecting the presence of molecular discontinuities in membranous structures, and this was, indeed, the purpose for which it was originally designed.

The Molecular Organization of Some Cellular Structures

The shape of cellular constituents is determined by the geometry and chemical combining properties of their molecular building stones, the proteins and lipides. The linear polymerization of the proteins has been inferred since the work of Fischer and it was natural to make the polypeptide chain the structural unit of protein fibers. It has long been known that lipides and fatty materials occur in layers or two-dimensional grids, and recent polarization optical and diffraction data show that proteins may also be arranged in planar leaflets. A third type of symmetry, namely radial, has been observed in protoplasmic granules but this is exemplified chiefly in the reserve food stuffs, the carbohydrates. Our attention will, therefore, be centered chiefly on the linear and lamellar protoplasmic *Bausteine*.

Fiber Structure

The results of the polarization and X-ray optical analysis are in agreement with the view that animal fibers, whether in large compact bundles (muscle, tendon), or microscopic and intracellular (chromosomes, spindle and astral fibers) are constructed of anastomosing meshwork of submicroscopic fibrous particles or micelles oriented with long axes parallel to the fiber axis. Until recently the micelles were pictured, after the original concept of Naegeli, as little isolated particles suspended in an intermicellar matrix. However, data on extensility and viscosity require that the particles be interlinked by covalent strands such as compose the particles themselves, although the greater fraction of the strands are longitudinally oriented.

This type of construction has been found typical of muscle, collagen, cilia, flagella, axopodia, myonemes of protozoa, sperm tails, chromosomes, spindle and astral fibers. Even the highly solvated neurofibrils show positive form birefringence indicative of this structure although no actual fibrils can be seen microscopically. The polarization optical results, therefore, resolve a problem long debated by morphologists and physiologists, as to whether some form of fibrillar system actually exists in cases like the cell spindle and nerve axis cylinder. Fixed preparations show beautiful fibrils but no such structures can be seen in the strictly normal living cells. Examination of the living cell in polarized light shows that oriented submicroscopic strands are indeed present in a tenuous, highly solvated lattice. When fixed, these aggregate into slender or coarse fibrils, depending on the nature of the fixative. So the morphologist was in error in laying too much stress on the particular shape and structure of the fixed fibrils and the skeptical physiologist was in even greater error in supposing no structure present at all.

All protein fibers except some of the simplest like silk show elasticity, extensibility, contractility, and chemical and thermal shortening. These are properties to be expected of polypeptide chains having reactive side chain groupings capable of self-induction in the sense of K. H. Meyer. The degree to which a given fiber will display these properties depends on the chemical nature of the protein, and in particular upon whether the side chains are free and capable of taking on a large complement of water molecules. This explains why keratin is a stable, supporting fiber and myosin is very labile and capable of rapid and reversible contraction.

It should be emphasized that reversible solvation and desolvation are at the bottom of most fundamental structuration processes in proto-

plasm. This is well illustrated in the case of chromosomes, which undergo perhaps the widest variation in solvation of any animal fibers. In the resting cell the chromosome strands are so heavily solvated and so poorly oriented that their presence cannot usually be detected even by the sensitive polarized light method. Orientation occurs in prophase but not until metaphase is the desolvation sufficient to give the chromosomes marked rodlet form birefringence. This desolvation persists in anaphase but in later stages the strands again become heavily solvated. In sperm cells, where the chromatin is, as it were, packed in tight bundles for shipment, the desolvation is so marked that the positive form birefringence of the protein fibers is completely overshadowed by the negative crystalline birefringence of the nucleic acid. Indeed, the birefringence of sperm heads has a magnitude among the highest of any natural fibers. When the sperm enters the egg and forms a sperm nucleus the chromatin strands again unfold because of the penetration of much water of solvation.

In salivary gland giant chromosomes the chromatic bands, which contain a large complement of nucleic acid, show striking negative birefringence characteristic of this substance. The phenomenon is so striking in alcohol-desolvated preparations that it would seem feasible to attempt quantitative measurements at the various levels of the chromosome map, in the hope of correlating such information on molecular organization with genetic data.

It is now known that the nucleic acid occurs as elongated particles oriented with long axes parallel to the axis of the chromosome. From X-ray data Astbury suggests that the phosphoric acid residues are spaced about the same distance apart along the axis of the micelles as are the amino acid residues in extended protein fibers. Hence the nucleic acid fits on automatically along the fiber and serves to integrate its structure, if not, indeed, to be important in the synthesis of the strands. However, the evidence for this is debatable, and since the protein component of chromosomes may be considerably more complex than mere strands of polypeptide chains, the suggestion must be considered only as an interesting speculation.

The simple polypeptide chain theory as developed by Astbury and others to explain the structure of textile and other fibers is probably inadequate in the case of many cell and tissue fibers. These are composed of columnar micelles which may have a more complicated and specific "domestic architecture", to borrow an expression from Dr. Wrinch, than is implied in the extended polypeptide chain theory. Supporting this view is the fact that long-spacing equatorial diffractions have been observed in the X-ray patterns of certain fibers, such as muscle, by Astbury, Meyer, and in our own laboratory, indicating that the unit structure of the micelles may be as much as 60-100 Å in thickness. Wrinch has recently suggested that some fibers may be essentially a linear array of particles having essentially molecular status rather than bundles of polypeptide chains indefinitely extended. This view is attractive particularly for the specific fiber type which she was discussing, namely, chromosomes. In this connection it may be pointed out that it is by no means certain that the genic proteins are necessarily the relatively small basic protamines. The assumption that they are such rests on chemical investigations on the highly specialized sperm cells, and may not be valid in the case of the chromatin of the interkinetic nucleus or typical tissue cell.

Frequently lipide is associated with protein in the construction of fibrils. According to W. J. Schmidt, the retinal rods are made of alternate layers of lipide and protein. A different relative orientation occurs in the case of filamentous mitochondria. According to the polarized light studies of Caswell Grave II, the rodlets which pack the distal convoluted tubule cells of the amphibian kidney contain protein strands oriented parallel to the axis of the rodlets and lipide molecules oriented with long axes perpendicular thereto. It is significant that the cells which are so packed with these protein rodlets are those which very actively transport water from the lumen of the tubule into the blood. Through the optical properties a clue is being sought to the nature of the process in the high degree of solvation of which these rodlets are capable.

The nature of the "lipide" material in mitochondria is still uncertain. From the work of Bensley on "isolated mitochondria" and from X-ray diffraction patterns which we have obtained from material isolated by Dr. G. H. Scott according to Bensley's method, the fatty material appears not to be phospholipide or cerebroside, but a somewhat shorter chain, probably unsaturated compound.

The only observations on the birefringence of the centriole of which I am aware are those of Dr. G. W. Taylor made very recently in our laboratory. He found the fibrillar centriole of the termite protozoan, *Trichonympha,* to show birefringence which is negative with respect to its long axis. This is apparently not due to lipide since it is increased in magnitude by alcohol extraction. He is investigating the possibility that it may be due to nucleic acid.

(*Continued Next Week*)

PRODUCTION OF A COMPLEX NITROGENOUS COMPOUND, RELATED TO TYROSINE, BY A SPECIES OF PENICILLIUM

Dr. A. E. Oxford
Rockefeller Foundation Fellow, University of Wisconsin

Although the lower fungi show certain biochemical resemblances to the algae, especially with respect to their carbohydrate metabolism and in the production of the sugar alcohols mannitol and erythritol, no peptides corresponding to those isolated by Haas & Hill (*Biochem. J., 25,* 1472 (1931); *27,* 1801 (1933); *32,* 2129 (1938)) from marine algae have so far been isolated from mold tissue. Since the latter contains dipeptidase and a variety of polypeptidases (see Johnson and Peterson, *J. Bact., 29,* 90 (1935)) the presence of appropriate substrates might reasonably be inferred. In the course of investigations on the carbohydrate metabolism of *Penicillium griseofulvum* (see Raistrick *et al. Biochem. J., 25,* 39 (1931); *27,* 628 (1933); *29,* 1102 (1935); *33,* 240 (1939)) a crystalline and weakly acidic compound, of empirical formula $C_{22}H_{28}O_5N_2$, and m.p. 172°, has been encountered, the structure of which appears to be derived from that of an acylated tyrosine. The medium on which the mold was grown contained glucose and sodium nitrate as sole sources of carbon and nitrogen respectively, and the yield of the above product was relatively considerable, accounting for 5-10% of the nitrogen supplied as nitrate. A partial structural formula can be deduced from the following facts: acid hydrolysis yields a terpene-like hydrocarbon $C_{10}H_{16}$, together with NH_3, CO_2 (2 mols.), acetaldehyde, and the known base p-hydroxy-ω-aminoacetophenone. Alkaline hydrolysis of the metabolic product yields NH_3 (1 mol.), and a crystalline acid $C_{17}H_{22}O_3$, which is split by acid hydrolysis to yield the hydrocarbon $C_{10}H_{16}$ and p-hydroxybenzoic acid. The metabolic product appears therefore to contain a β-ketotyramine residue etherified with an alcohol $C_{10}H_{17}OH$, and linked probably through a peptide linkage to a residue yielding acetaldehyde on hydrolysis. The molecule probably contains an acid amide group also and the following structural formula is tentatively suggested:

$$C_{10}H_{17}\cdot O\cdot C_6H_4\cdot CO\cdot CH(CONH_2)\cdot NH\cdot CO\cdot C_2H_3O$$

It is noteworthy that the mold in question yields a great variety of non-nitrogenous phenolic metabolic products in addition to the above suggesting a possible connection between its carbohydrate and its nitrogen metabolism.

(This article is based upon a seminar report presented at the Marine Biological Laboratory on August 6.)

NEUROSECRETORY CELLS IN COCKROACHES

Dr. Berta Scharrer
The Rockefeller Institute for Medical Research, New York

Neurosecretory cells, i.e. cells which in addition to their nervous character show histological features of gland cells, are known in vertebrates as well as in invertebrates. Several species of cockroaches, as representatives of the insects, are suitable objects to demonstrate to what extent a nerve cell can assume the character of a gland cell. Different types of neuroglandular elements within one species suggest different phases of a secretory cycle. These stages are in principle similar to those observed in vertebrates. There is a stage when only fine fuchsinophile granules are scattered over the cytoplasm. The cytoplasmic inclusions appear to increase in size and number and may fill the cell to such an extent as to impart to it the character of a gland cell rather than that of a nerve cell. Such granules are also seen to extend from the cell along the axis cylinder. Finally there are cells giving the impression of an endstage in the cycle.

The morphological evidence of secretion in the central nervous system of insects is of particular interest in view of the physiological results obtained in recent years which provide that the central nervous ganglia exert an endocrine control over the processes of molting and pupation. In Lepidoptera the larval brain furnishes a substance which causes pupation (Kopeć, Kühn and coworkers), and in Hemiptera (Rhodnius) the nymphal brain is the source of a molting hormone. In transplantation experiments Wigglesworth recently succeeded in localizing the positive effect on molting in the dorsal half of the central mass of the brain, i.e. the very region where in Rhodnius neurosecretory cells are found. There is good evidence to suggest, therefore, that gland-like nerve cells are actually the source of hormones which control insect development. This is the first case in which the morphological evidence for the neurosecretory activity can be corroborated by physiological data.

(This article is based upon a seminar report presented at the Marine Biological Laboratory on August 13.)

THE BIOLOGICAL FIELD STATIONS OF FORMER CZECHOSLOVAKIA AND SURROUNDING COUNTRIES

Homer A. Jack
Cornell University

The largest biological station in the territory formerly occupied by Czechoslovakia is at Doksy (or Hirschberg) in Bohemia. It was founded in 1905 as the Biological Station of Hirschberg by Dr. Viktor Langhans of the German University at Prague. In 1920 the station was taken over by the Czechoslovakian Research Institute for Animal Production as the Institute for Fishery Research and Hydrobiology. Since the Munich Pact it has been the *Lake Hirschberg Station of the Reich Institute for Fisheries.* For some years the station has been housed in a large, three-story building in the center of the small village of Doksy, while its small field annex is on the shores of the nearby lake. No instruction has been given at the station, but visiting investigators are invited to make use of its laboratory facilities. There are lodging accommodations for five research workers in the laboratory building and board may be obtained at a nearby hotel. The research program of the station is directed by Dr. Trude Schreiter, the only woman in Europe who is director of a biological station.

Previous to its disintegration, Czechoslovakia had six other biological stations. The *Biological Station of the University of Brno* was located at Lednice. Strbské Pleso was the headquarters of the *Geobotanical Station of the Czechoslovakian Botanical Society,* while at Velké Meziříči was the *Franz Harrach Station for Fishery and Hydrobiological Research.* There was a station for fishery and hydrobiological research directed by Professor Schäfterna at Blatna and the University of Komenského sponsored a small field station at Samorin, in Bratislava. The remaining Czechoslovakian station was located on the island of Rab off the Dalmatian Coast of Yugoslavia. This was established in 1930 by a group of biologists in order that Czechoslovakian students and investigators could have an opportunity to work with marine forms.

There are three biological stations in the territory formerly occupied by Poland. The *Marine Station at Hel* is located near Danzig. This small laboratory was founded in 1932 by the Nencki Institute of Experimental Biology of Warsaw. Another station founded by the same institution five years later is the *Biological Station at Pinsk.* This is located on a vast marshy plain among a series of slow-running rivers and is concerned with a study of the limnological problems of those rivers and marshes. There is a two-story laboratory building which is equipped for instruction in hydrobiology and contains seven research places. Visiting investigators are not required to pay laboratory fees and may obtain living accommodations at a nearby city for about 100 zlotys a month (about $18.81).

The largest biological station in Poland is the *Hydrobiological Station of Lake Wigry.* It is located on the shores of Lake Wigry near Suwalki. Founded in 1920 by Dr. Alfred Lityński, the present director, the station was able to erect a new building in 1928 through a donation from the National Culture Fund. This structure contains modern equipment for the study of fresh water problems. There is also a pavilion used as a residence for visiting investigators and another wooden building serves as living quarters for the personnel. University students come to the station for a two-week course in theoretical limnology. Independent investigators are welcomed to work at the institution any time of the year. There are no laboratory fees and living may be obtained at the station for about 112 zlotys a month (about $21.06). Much of the research work done at the station by staff or visiting investigators is published in *Archiwum Hydrobiologii I Rybactwa* (Archives of Hydrobiology and Ichthyology).

The only biological station in Hungary is the *Hungarian Biological Research Institute* at Tihany. This is on the shore of Lake Balaton, the largest lake in Central Europe. The station was founded in 1925 at Révfülöp by the Hungarian National Museum. In 1927 the buildings at Tihany were officially opened in the presence of the Regent of Hungary and members of the Tenth International Zoological Congress. Today the institute contains a four-story laboratory building, a boarding house for investigators, a dormitory for students, and two small apartment houses for staff members. In the main building there are special laboratories for research in zoology, botany, bacteriology, microscopy, physiology, and chemistry. All laboratories are equipped with 440- and 220-volt A. C. electricity, 110-volt D. C. electricity, gas, compressed air, vacuum pipes, and running lake water. Other equipment of the station includes a large shop, a vibration-proof laboratory, an operating room, and a motorboat accommodating twenty persons.

The work of the institute at Tihany is concerned

both with the limnological problems of the region and with general biological problems independent of local questions. Professor Geza Entz heads the staff of nine investigators who work at the station, which now has an annual budget of 35,000 pengo (about $6,857). Independent investigators are invited to do research at Tihany. The laboratory fees are 65 pengo a month (about $12.73) and board and lodging may be obtained at the institute for 139 pengo a month (about $27.24). The station is also host, twice a year, to groups of middle-school biology teachers who come to Tihany for a three-week extension course in biology.

The Lunz Biological Station (*Biologische Station Lunz*) is the most important field station in former Austria. It is located on the outskirts of the village of Lunz which is about seventy miles southwest of Vienna. The area is mountainous and contains a number of lakes. The station itself is located on Lunz Lake which is a typical sub-alpine body of water at an altitude of about 2,000 feet. About two hour's walk from the laboratory is Obersee. Here, at an altitude of about 3,664 feet, the station has a small field annex with laboratory and living accommodations for six persons. In such surroundings it is quite natural that the purpose of the Lunz Biological Station is instruction and research in freshwater and alpine ecology.

The main, two-story laboratory building at Lunz contains offices, greenhouses, a darkroom, a library, and laboratories, the latter supplied with 220-volt electricity, gas, and distilled water. The library contains about 2,000 bound volumes, 8,000 reprints, and 25 current scientific periodicals. Near the main laboratory building on the shore of Lunz Lake is a boathouse and a laboratory-classroom for about twenty students. This is used for a summer course in hydrobiology. Visiting investigators also make use of the facilities of the Lunz station. In the past their projects have centered about limnology, bioclimatics, and experimental biology. Investigators are expected to pay a laboratory fee of 28 Rm. a month (about $11.23) and are given every assistance by Dr. F. Ruttner, the director of the station since 1919. There are no living facilities in the laboratory building, but lodging may be obtained in a portion of a nearby castle leased by the station, while meals can be secured at a tavern. The only other biological station in former Austria is the Botanical Station at Hallstatt (*Botanische Station in Hallstatt*). This is the small private laboratory of Dr. Friedrich Morton, although visiting scientists may make use of his equipment.

* * *

The biological stations of these countries have been effected by war and occupation almost as much as have the inhabitants themselves. Before 1914, both Austria and Hungary had biological stations on the Adriatic Sea. The Royal Zoological Station (*K. K. Zoologische Station*), founded in 1875, was situated in a large building in Trieste. The Royal Hungarian Marine Biological Station (*Magyar Királyi biologiai Állomás*) was on the waterfront of Fiume. With the World War treaties, these institutions ceased to exist, as both Trieste and Fiume were given to Italy. The building of the Trieste station was used by the Royal Italian Oceanographic Committee for a geophysical institute. The Hungarian station's instruments were destroyed during the battle of the port of Fiume and the station's vessel, *SMS Najade*, was given to Yugoslavia, although some of the station's collections were removed to Budapest where they are still being studied.

The swift events of the last few years have also been felt by the biological stations of Central Europe. Dr. Ruttner of the Lunz Biological Station tells how his station presaged the Anschluss with Germany by fourteen years. In 1924 that Austrian institution which was under the direction of the Academy of Sciences of Vienna asked the Kaiser Wilhelm Institute of Berlin to be a co-sponsor. Ever since, Germany has contributed to the expenses of the station at Lunz. One Czechoslovakian biological station which was located in Sudetenland, however, had no desire for German support even when the Treaty of Munich thought it should. The director of this particular station wrote the author, early in 1939, that "after the forcible occupying of South Moravia by Germany—in consequence of the treason of Munich in September 1938—the biological station was moved" to another location in the then-independent Czecho-Slovakia. In all fairness, it must be stated that another biological station director in Czechoslovakia welcomed German occupation. The letter of this person, written in June, 1939, in part said, "In consequence of the fact that the German districts of the past Czechoslovakia have been fortunately connected with their native country in autumn 1938, there are many corrections. . . ." Thus the reactions of scientists differ as much as the plants and animals they study.

The Collecting Net

A weekly publication devoted to the scientific work at marine biological laboratories.

Edited by Ware Cattell and Robert Chambers with the assistance of Boris I. Gorokhoff and Peggy Browning; Contributing Editor, Homer A. Jack.

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Introducing

Dr. H. M. Kalckar, Assistant Professor of Physiology, Institute of Medical Physiology, University of Copenhagen; Rockefeller Foundation Fellow, Washington University School of Medicine, St. Louis.

Dr. Kalckar received his medical doctorate from the University of Copenhagen in January, 1939. His thesis dealt with phosphorylations in animal tissues, particularly in the kidney cortex, work which was carried out in the department of Prof. E. Lundsgaard.

Almost immediately after he had received his doctorate, Dr. Kalckar sailed for the United States to work under a Rockefeller Foundation fellowship at the California Institute of Technology at Pasadena. There he studied the methods and theory of thermodynamics, particularly thermal data of various organic compounds. This work was done particularly under Drs. H. M. Huffman and Henry Borsook.

During the summer of 1939 he worked at the Hopkins Marine Station on the coast of California. His work there, which was directed by Dr. C. B. van Niel, was in the field of microbiology, particularly propionic acid fermentation.

In the fall of 1939, Dr. Kalckar moved to St. Louis to work in the laboratory of Dr. Carl F. Cori at the Washington University School of Medicine. He resumed his studies there on phosphorylation in kidney and heart muscle, studying its relations to respiration.

Dr. Kalckar is working at Woods Hole this summer on phosphate-transferring enzymes in marine animals, particularly in aglomerular kidneys. This fall he will return to Washington University to resume his work on phosphorylation under a renewal of his Rockefeller Foundation fellowship.

In his trip to America, Dr. Kalckar is accompanied by his wife Vibeke, who is an accomplished musician.

The statistical seminar for research workers conducted by Dr. C. I. Bliss will meet on Monday and Thursday from 7 to 8 in the smoking room of the Fisheries Residence for the remaining weeks of August.

OBSERVATIONS ON THE TUESDAY SEMINAR

DR. LAURENCE IRVING, CHAIRMAN

Dr. Giese examined the depression of respiration which ultraviolet irradiation produced upon luminous bacteria. Irradiation is a convenient agent to use because it is measurable as to amount and quality. It appeared that irradiation diminished respiration by affecting the cellular substances concerned with respiration. It was particularly interesting to notice Dr. Giese's observation that irradiation which did not alter respiration greatly diminished the capacity of the cells for reproduction, and that luminesence was influenced in a still other degree. It was made obvious that respiration, reproduction and luminesence are dependent upon metabolic steps or sequences which are quite distinct, and it is agreeable to see another move being made toward the designation of the distinct cellular chemical reactions which activate the several vital processes.

Mr. Corman described the alterations which ether produced in the nuclear material of cells of larvae of fruit flies. During the rearrangement of nuclear material in cell division in the etherized animals the orderly sequence of mitosis was disturbed. Unfortunately for the use of this effect as a means of investigation, the nuclear alterations were irregular and could scarcely promise the establishment of a new system of nuclear arrangement. The persistence of nuclear damage was, however, strikingly illustrated.

The neurosecretory cells which were shown in the nice preparations of Dr. Scharrer indicate the existence of an anomalous type among nerve cells. These cells have been represented in the brains of a few other insects and fishes besides the brain of the cockroach in which they were distinguished by Dr. Scharrer. Her suggestion that the cells secrete hormones activating metamorphosis of insects is interesting and reasonable. With the nice morphological distinction which has now been made, the relation of these cells to metamorphosis can be better examined. At present the activation of metamorphosis is a difficult subject to start upon because of the number of external factors. Pointing out one internal site of change may greatly facilitate the examination of the sequence.

The glass electrode is now commonly used for the measurement of hydrogen ion concentration because of the reliability with which its accuracy can be controlled. Dr. Haugaard's study of the physical system which is involved illustrated the practical measurements which help to define the nature of the system when electricity is transferred through the glass. During electrolysis of a glass membrane, sodium ions moved through the glass followed by hydrogen ions in exchange. The hydrogen ions, according to rather clear-cut meas-

(Continued on page 156)

ITEMS OF INTEREST

Dr. Charles Packard was appointed director of the Marine Biological Laboratory last Tuesday at the annual meeting of its Board of Trustees. He had been associate director since 1938, and previously had served as Clerk of the Corporation for seven years. He was elected a member of the Corporation in 1909.

At the Corporation meeting of the Marine Biological Laboratory, Drs. C. W. Metz, Harold H. Plough and Dugald E. S. Brown were elected members of the Board of Trustees.

Dr. George W. Corner, professor of anatomy at the University of Rochester, has been appointed director of the department of embryology at the Carnegie Institution of Baltimore, replacing Dr. George L. Streeter who has retired.

Mr. Nelson T. Spratt, Jr., who has been research fellow in embryology at the University of Rochester, has been appointed research assistant in embryology at the Johns Hopkins University.

Dr. Daniel Pease, who worked at Woods Hole last summer, will be at Stanford University during the coming academic year under a National Research Council Fellowship.

Dr. E. G. Conklin underwent a major operation at the University of Pennsylvania hospital last week and is now resting comfortably. This is the first time in many years that he has not attended the annual meetings of the trustees of the Marine Biological Laboratory and of the Woods Hole Oceanographic Institution.

The *Atlantis* will sail on Monday for a ten-day cruise which will take it beyond the Gulf Stream. The trip will be under the scientific direction of Dr. A. F. Spilhaus.

M. B. L. CLUB NOTES

The ping pong tournament at the M. B. L. Club is under way; charts have been posted in the ping pong room. The first round is to be played off before Monday. The winner of the tournament will have his name engraved on the ornamental paddle at the Club.

New M. B. L. Club stationery, designed by Mrs. Carl Smith is on sale at the Club. The design includes a view of the Club-house.

The chairs at the Club-house are being refinished by Mr. Reginald MacHaffie.

Group singing was held Thursday evening at the Club under the direction of Teru Hayashi.

The program of the Monday night phonograph record concert at the M. B. L. Club: Tapiola (tone poem for orchestra), Sibelius; Symphony No. 5 in E flat major, Sibelius; Symphony No. 5, Beethoven.

Among the trustees attending the annual meeting of the Marine Biological Laboratory who have not been in residence here this summer were Drs. H. C. Bumpus, W. B. Scott, Ross G. Harrison, Ivey Lewis, Franz Schrader, W. C. Curtis, Otto Glaser, H. B. Bigelow and D. H. Tennent.

Dr. H. H. Plough, who has been working at the U. S. Fisheries Biological Station at Beaufort, N. C., is arriving in Woods Hole today.

Dr. W. S. Ladd, dean of the Cornell University Medical College, arrived in Woods Hole on Monday in a seaplane which landed at the Breakwater Beach. He came to visit Dr. Dayton J. Edwards, assistant dean of the Cornell University Medical College, who is spending the summer at Woods Hole.

Dr. D. E. Lancefield, associate professor of biology at Queens College, and Mrs. Lancefield returned last Saturday from a month's trip to Jackson, Wyoming, with their daughter, Jane. They were joined by Dr. and Mrs. A. H. Sturtevant, who had come from California.

Dr. Arthur K. Parpart, assistant professor of physiology at Princeton University, has arrived in Woods Hole. This summer he taught a section of the history of science course at Princeton University.

President Edmund E. Day of Cornell University has been visiting Dr. Bradley Patten and Dr. Manton Copeland in Woods Hole during the past week.

Other visitors this week included Drs. H. K. Hartline and Dr. D. W. Bronk, who have recently been appointed to the department of physiology at the Cornell University Medical College.

Mr. R. Marvel, of the U. S. Bureau of Fisheries, returned Wednesday after a week's trip in the Fisheries' boat *Skimmer*, in which he was engaged in tagging haddock off Chatham for purposes of studying migration.

Dr. R. Ruggles Gates, professor of botany at the University of London and on leave for the duration of the war, left for the home of his parents in Middleton, Nova Scotia, this week.

DATES OF LEAVING OF INVESTIGATORS

Benedict, D. .....Aug. 5	Kaylor, C. T.....Aug. 14
Bloch, R. .....Aug. 2	Kidder, G. W. .....Aug. 2
Doyle, W. L. .....Aug. 1	McVay, Jean .....Aug. 5
Evans, Gertrude Aug. 10	Meglitch, P. A.....Aug. 14
Ferguson, F. .....Aug. 10	Morrill, C. V. .....Aug. 14
Gates, R. R. .....Aug. 14	Rimmler, L., Jr. Aug. 4
Gilbert, W. J. .....Aug. 3	Snedecor, J. .....Aug. 3
Haywood, C. .....Aug. 7	Turner, C. L. .....Aug. 1
Heath, J. .....Aug. 12	Workman, G. .....Aug. 12
Hemstead, G. .....Aug. 4	Zimmerman, A. ....Aug. 1

ADDITIONAL INVESTIGATORS

Adams, M. H. asst. chem. Rockefeller Inst. Lib.
Addison, W. H. F. prof. normal histol. & emb. Pennsylvania. Br 336.
Armstrong, Mary Milton Academy (Milton, Mass.). Br 309.
Bloch, R. res. asst. bot. Yale. Br 321. (Left)
Block, M. H. fel. anat. Chicago. OM 1.
Brücke, Ernst von res. assoc. phys. Harvard Med. Lib.
Cobb, S. Harvard Med. OM 7.
Cooper, K. W. instr. biol. Princeton. Br 127.
Cooper, Ruth E. S. res. asst. biol. Princeton. Br 127.
Cori, C. F. prof. pharmacol. Washington Med. (St. Louis). Lib.
Cori, Gerty T. res. assoc. pharmacol. Washington Med. (St. Louis). Lib.
Cunningham, Ina grad. zool. Northwestern. Br 225. Ki 3.
Dean, P. M. Princeton. Br 127.
Everett, G. M. grad. phys. Maryland Med. Phys.
Fraser, Doris A. res. asst. anat. Pennsylvania Med. Br 336. H 1.
Gates, R. R. prof. bot. London (England). Br 313. (Left)
Gayer, H. K. grad. asst. zool. Washington (St. Louis). Br 217j.
Graef, I. assoc. prof. path. New York Med. Bot 26.
Grinnell, S. W. res. assoc. phys. Swarthmore. OM 2.
Ito, T. res. fel. path. New York Med. Bot 26.
Kaiser, S. instr. bot. Brooklyn. Lib.
Kalckar, H. M. asst. prof. phys. Copenhagen (Denmark). Br 217 i.
Kraatz, C. P. instr. phys. & pharmacol. Chicago Med. Lib.
Kunitz, M. assoc. mem. Rockefeller (Princeton). Br 209.
Perlmann, Gertrude E. res. asst. phys. chem. Harvard Med. Lib.
Ryan, Elizabeth J. grad. asst. zool. Columbia. Br 314.
Ryan, F. J. asst. zool. Columbia. Br 314.
Salomon, K. res. fel. phys. chem. Yale Med. L 33.
Samorodin, A. H. grad. biol. Minnesota.
Wrinch, Dorothy lect. chem. Johns Hopkins. Br 313.

OBSERVATIONS ON THE TUESDAY SEMINAR

(Continued from page 154)

urements, have a lower conductance than the sodium ions. Soaking fresh glass in water slowly produced this exchange until the steady conditions suitable for practical measurements were attained.

It appears that the hydrogen ions involved in the exchange in the glass are hydrated. If alcohol as well is the solvent, alcohol is also absorbed with the hydrogen and adds a complication, but one which by conformity with the Nernst formula satisfies the mind that the system is theoretically definable.

These observations upon the behavior of the glass surface when freshly placed in contact with solutions gives a picture of the operation of the glass electrode which should help those who use it with hitherto blind confidence. The discussion also indicates the interest of the practical and theoretical consideration of the subject.

It only remains to add that the commentator upon this interesting series of papers appreciates that in expressing his opinions he is not influencing the validity or significance of the work.

INVERTEBRATE CLASS NOTES

In fine spirit we began our week's work Monday with an exciting trip to Kettle Cove on *Mary II* and *Winifred*. A group on *"Winnie"* laboriously composed "I've been working in the littoral zone all the livelong day" which received a few compliments and many groans, causing one to believe that it will not readily become popular.

Eating lunch on the beach while basking in the sun was a pleasant experience, and, after being filled with sandwiches (no peanut butter ones at that), we hurried back to hunt for more invertebrates. Team one unearthed the prize specimen of the day, a fifty-cent piece, and with the cry of "Pieces of eight" from Dr. Martin the shovel men ambitiously tried to duplicate the feat.

Next day, Dr. Rankin started us on the last lap of Platyhelminthes with a rapid, interesting lecture and we spent the day studying scoleces of Rhyncobothrium and Otabothrium. Phylum Nemathelminthes appeared on the scene here as we studied Metoncholaimus, the little worm that actually resembled the chart drawn of it.

Passing from one worm to another, as Dr. Lucas commented at the start of his lecture, we began the study of phylum Annelida. Nereis and Arenicola consumed all of our time on Wednesday, and a remark was made that we were now completely introduced to a new member of that great family Coco-Cola, Pepsi-Cola and "Areni-Cola." Arenicola was abundant for the first time in several years. We were impressed by this good fortune and made the most of our opportunity.

Work arrived in a mighty rush Saturday morning for we found ourselves with two lectures, one written on the blackboard and one delivered personally by Dr. Bissonnette, introducing phylum Bryozoa—or as it is now being classified, phyla Endoprocta and Ectoprocta. These small animals attracted most of us and we went to work with a will, but before the day ended students were heard singing, "Some day I'm going to murder

the Bugula." Anyway most of us did some more work for a time on Sunday while one group made a pilgrimage to Provincetown and were reprimanded in no uncertain terms by the town crier for attempting to photograph him.

Heard around lab: the exciting adventures of Warren Walker in the Andes. Get him to tell of his 15-day trip with only an 8-day food supply (monkey stew kept him alive) and many other exciting tales of his trip last summer—a rumor that there will soon be an attempt at union organization of the Invertebrate lab for a forty-hour week—Frank White's assurance that he shall see that the M. B. L. Club gets some new records (not bad, Frank)—yours truly accused of being a feminine Winchell seeking news by looking through the keyholes of Schizoporella.

—Grace Coe

THE EFFECT OF ULTRAVIOLET RADIATIONS ON THE RESPIRATION OF A LUMINOUS BACTERIUM

(Continued from page 145)

change in the oxygen consumption and on the luminescence. Suspensions of these bacteria prepared under standard conditions were irradiated in quartz Warburg vessels and the measurements of respiration were made before, during and after irradiation. The bacteria were irradiated with a Sterilamp which emits about 80% of its radiations at λ 2537 Å.

The irradiated bacteria show, during and immediately following irradiation, an increase in the rate of respiration as compared to controls, but it was observed that glucose gives off some gas during irradiation even in the absence of bacteria and when this correction is made, the rate of respiration of irradiated bacteria is only slightly greater than that of controls. The luminescence is also only slightly increased by irradiation. After a lapse of time the irradiated bacteria show a decline in respiration which is proportional to dosage and indicates that either the concentration of the nutrient or of the enzyms has been reduced Glucose was used as nutrient and the rate of respiration of controls was practically constant and independent of glucose concentration over a fair range, being apparently determined by the enzym concentration. Since the decline in respiration of irradiated bacteria was not prevented by adding more glucose, it must be due to effects on the enzyms. It is possible that something which affects the enzyms is formed in the medium, but the respiration of bacteria added to irradiated medium is comparable to controls. Moreover, bacteria may be irradiated in salt solutions, and when glucose is added, respiration proceeds at a reduced rate comparable to that observed for bacteria irradiated in the presence of glucose. Therefore the effect of the radiations is not upon the medium but directly upon the bacteria.

Attempts were made to determine how the decline in respiration was produced by the radiations. It might be due to cytolysis of some of the bacteria; however, the same number was found to be present before and after relatively large dosages of radiations. It might be due to injury of some of the bacteria. Tests, however, demonstrated that colony formation may be prevented in most of the bacteria without altering the rate of oxygen consumption and dosages which reduce respiration injure the bacteria to such an extent that less than one in a thousand form colonies. The decline in the respiration and the apparent decrease in the effective enzym concentration is proportional to the dosage and after irradiation is stopped, this decrease does not continue, for bacteria irradiated in salt solutions to which glucose is added at intervals for as long as nine hours after irradiation show comparable respiratory rates following each addition of glucose.

Irradiated bacteria are similar to controls in that they respond to peptone to a comparable degree and are affected by urethane and cyanide in a similar manner, but they differ from the controls strikingly in their constructive activities, for their respiration declines much more rapidly indicating their inability to replace components necessary for maintaining a given rate of respiration.

When extracts obtained from bacteria injured by ultraviolet radiations were added to suspensions of bacteria containing no nutrient, a marked increase in respiration occurred; when glucose was present, a much smaller increase was observed; when both glucose and peptone were present, and the respiration was probably near a maximum value, the extract had no effect. The extract thus appears to act as a nutrient, not as an accelerator. Similar results were obtained with extracts from irradiated Arbacia sperm and dividing eggs.

We may conclude that in these bacteria irradiation stimulates respiration very slightly if at all, that the reproductive mechanism is more readily affected than the respiratory mechanism, that synthetic activities are impaired before respiration decreases, that some oxidation chains such as those resulting in luminescence are more readily affected than others, and that respiration is decreased when sufficient dosages are given the bacteria, the decrease being proportional to dosage.

(This article is based upon a seminar report presented at the Marine Biological Laboratory on August 13.)

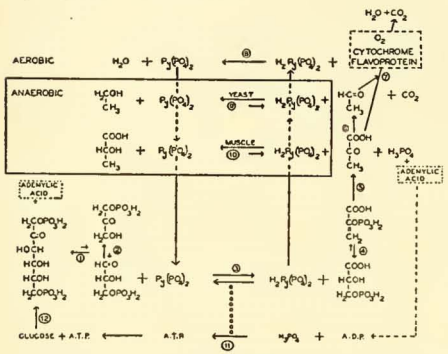
CATALYSTS OF BIOLOGICAL OXIDATION, THEIR COMPOSITION AND MODE OF ACTION

Dr. Eric G. Ball

Associate in Physiological Chemistry, Johns Hopkins School of Medicine

(Continued from Last Issue)

In the carbohydrate oxidation just portrayed the diphosphopyridine nucleotide can not be substituted for the triphosphopyridine nucleotide. The diphosphopyridine nucleotide is active however in another set of reactions in which carbohydrate is oxidized. The substrate in this case is hexose diphosphate. Meyerhof and his coworkers have



shown that this phosphorylated hexose undergoes an enzymatic fission as shown here in reaction 1 whereby two phosphorylated triose molecules are produced. They can be converted one into the other in the presence of a suitable enzyme as indicated by reaction 2. All three compounds are apparently in equilibrium in muscle brei, the equilibrium state being indicated roughly in the diagram by the length of the arrows. One of the triose molecules, presumably the aldehyde form, now reacts with diphosphopyridine nucleotide in the presence of a specific protein according to reaction 3. As in the previous case the pyridine nucleotide is reduced, while an acid is produced. Also as before the reduced pyridine nucleotide may be reoxidized by oxygen acting through a flavoprotein cytochrome chain as represented in reaction 8 and so reenter the cycle. The flavoprotein is not identical with that which reacts with reduced triphosphopyridine nucleotide.

Now the phosphoglyceric acid formed by reaction 3 may undergo a series of enzymatic rearrangements which produces phosphopyruvic acid. This in turn may decompose in the presence of adenylic acid into pyruvic acid as shown in reaction 5. The pyruvic acid may then be further oxidized, with the aid of diphosphothiamine and the flavoprotein-cytochrome-oxygen system as indicated by arrow seven. We will return to this reaction as well as to the fate of the PO_4 radical shortly. Thus the carbohydrate in the presence of O_2 may be oxidized completely to CO_2 and water; and the pyridine nucleotide undergoes a cycle of oxidation and reduction, and participates over and over again in the primary reaction 3.

Observe, however, what may happen if the supply of oxygen is cut off. The reoxidation of the reduced pyridine compound by reaction 8 is now no longer possible. The primary reaction 3 therefore will come to a standstill due to the depletion of the oxidized pyridine nucleotide which is of course present in small quantities in comparison to the substrate. However, the pyruvic acid formed will also now no longer be removed and therefore another reaction may occur. This is the oxidation of the reduced pyridine nucleotide by pyruvic acid yielding lactic acid and regenerating the pyridine nucleotide for the primary reaction, which is shown in reaction 10 and proceeds in the presence of a special muscle protein. Breakdown of carbohydrate, anaerobically, to lactic acid will then proceed until equilibrium conditions or acid formation call a halt to the process.

In yeast a similar reaction may occur. Here, however, the pyruvic acid is first decarboxylated by means of a specific protein and phosphorylated vitamin B_1 to form aldehyde and CO_2 according to reaction 6. Here then we see for the first time one source of the carbon dioxide produced by combustion of foodstuffs. In the absence of oxygen the aldehyde reoxidizes the pyridine nucleotide with the aid of another protein as shown in reaction 9 and alcohol is produced. The carbohydrate breakdown in yeast then proceeds in a manner analogous to that in muscle except that alcohol and CO_2 are produced instead of lactic acid. By the production of CO_2 by the carboxylase reaction, yeast tends to shut off its oxygen supply and thus establishes an anaerobic existence. If the oxygen is not completely shut off then the aldehyde instead of being reduced to alcohol may become oxidized to acid. A reaction which I hope has not been the sad experience of those of you who make your own wine.

This scheme furnishes us with a possible explanation of the so-called Pasteur effect. The Pasteur effect is usually defined as the action of oxygen on living cells which reduces the rate of carbohydrate destruction and suppresses or diminishes the accumulation of the products of anaerobic metabolism. The chief products of anaerobic metabolism are recognized as lactic acid and alcohol. How oxygen suppresses the accumulation of these products, is obvious from the relationships here portrayed. The action of oxygen in reducing the rate of carbohydrate destruction

must, I think, be sought in the fact that the aerobic process by its complete combustion makes available the total energy of the carbohydrate molecule. The anaerobic process on the other hand by its incomplete combustion liberates only a small part of the available energy of the carbohydrate. Hence to furnish the same amount of energy the rate of carbohydrate disappearance must be greater under anaerobic conditions than when oxygen is present.

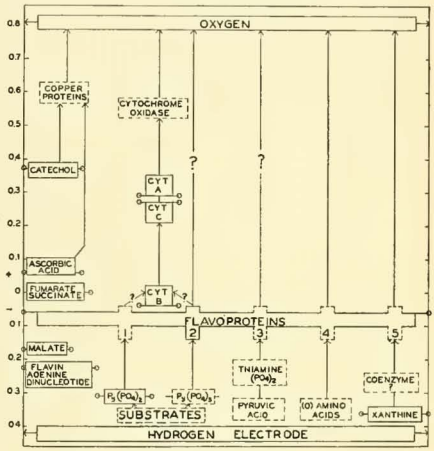
The dephosphorylation of phosphopyruvic acid that occurs in reaction 5 is apparently dependent on adenylic acid as a phosphate acceptor. You will recall that adenylic acid is a constituent of the pyridine nucleotides and the flavin prosthetic group. In this way adenosine diphosphate (A.D.P.) is formed. Now this compound can be apparently further phosphorylated by inorganic phosphate if concomitantly there occurs the oxidation-reduction reaction 3. It appears as if the energy of the oxidation-reduction reaction was utilized in the phosphorylation process. In fact the oxidation-reduction apparently proceeds rapidly only if it is coupled with such a phosphorylation process. The adenosine triphosphate (A.T.P.) so formed may then phosphorylate glucose and thus replenish the substrate hexosediphosphate.

As was mentioned the decarboxylation of pyruvic acid in reaction 6 or its oxidation by reaction 7 requires the presence of diphosphothiamine and a specific protein. The exact mode of action of this vitamin B_1 containing prosthetic group in these reactions is not yet known. It has however been suggested by Lipmann, and Stern and Melnick, that diphosphothiamine may participate in the oxidation of pyruvic acid by acting as an oxidation-reduction system. The reduction occurs at the quarternary nitrogen as in the case of the pyridine nucleotides.

We have now seen how both carbohydrate and protein materials may be oxidized in living cells. The pathways outlined here, however, do not necessarily hold in all their details for every living cell, for it is well known that different organs of the same animal vary markedly in their utilization of various foodstuffs. It should also be noted that we have not dealt with that other group of foodstuffs, the fats. This is because we are still in ignorance with regard to the catalysts concerned in their oxidation.

However, let us now in conclusion endeavor to correlate the pathway of biological oxidations that we followed from the oxygen side at the beginning of this evening with that from the substrate side which we have just recently discussed. In our laboratories we have been particularly interested in the energy relationships of these catalysts and their substrates as obtained by measurement of their oxidation-reduction potentials. Such information enables us to predict not only what reactions between the various components are thermodynamically possible and thus to eliminate from consideration those which can not occur but also tells us exactly what amount of free energy will be liberated when a given reaction does occur. Obviously the first step in such a study must be the recognition of these components and if possible their isolation. You have already seen what progress has been made in this direction.

I have, therefore, in drawing up this final chart incorporated in it what little we know as yet of



the oxidation-reduction potentials of these catalysts and their substrates. Those substances enclosed in solid blocks are components of systems whose oxidation-reduction potentials have been determined and whose normal potentials at pH 7.0 lie at the levels indicated. The placement of all other systems here shown has been made in an arbitrary manner and this fact indicated by enclosing them in dotted lines. The limits within which energy exchange occurs in most living cells is defined by the potentials of the hydrogen electrode on one side and that of the oxygen electrode on the other at a pH in the neighborhood of 7.0. Not far above the hydrogen electrode lies the potential of the diphosphopyridine nucleotide system; symbolized here as before by $Py(PO_4)_2$. The $Py(PO_4)_3$ system probably also lies within this region. These systems are capable of being reduced by various substrates and we may therefore expect that when their potentials are known they will lie somewhere in the vicinity here indicated. It should be remembered however that the potential of the pyridine nucleotide system may be shifted from that given here when it combines

with the protein partner necessary for its action. The reduced pyridine nucleotides are now in turn oxidized by a flavoprotein, a different one apparently being required for each pyridine nucleotide. The potential of one of these flavoproteins, here designated as number 2, is known and lies well above the pyridine nucleotide systems. Note that the prosthetic group alone, flavin adenine dinucleotide, forms a system with a much lower potential.

The trail over which the electrons and hydrogen atoms pass from the foodstuffs to oxygen now becomes uncertain. How is the reduced flavoprotein oxidized? From the potential relationships here portrayed we might expect that cytochrome b is the next link in the chain. If so then the way is clear for we have seen how the cytochromes are linked to oxygen. However though we have obtained a knowledge of the oxidation-reduction potential of cytochrome b we have not yet been able to prepare it in pure state. To be sure we can obtain tissue preparations which we know contain cytochrome oxidase and the three cytochromes, which when added to a purified flavoprotein-pyridine nucleotide-substrate mixture will bring about an oxygen uptake. However such tissue preparations also appear to contain at least one other enzyme system which can not be separated from the cytochromes. This is an enzyme which was first discovered by Thunberg and has been called succinic dehydrogenase. It brings about the oxidation of succinate to fumarate. The fact that succinic dehydrogenase and the cytochrome system are always found together, along with the observation that small additions of either fumarate or succinate to living cells stimulates their respiration markedly, has caused Szent-Györgyi to postulate that this system is concerned in the respiratory chain that we are now considering. He believes it links the flavoprotein system to the cytochromes. The potential of the fumarate-succinate system is not incompatible with such a rôle though it is not situated so as to possess its maximum efficiency in performing it if cytochrome b is the cytochrome concerned in the linkage. We definitely know that the cytochrome c and the flavoproteins systems do not react directly even though the potential of the two systems is favorable for such a reaction. Whether cytochrome b is the only link needed between these two systems or whether the succinate-fumarate system or some yet unknown system is also required we are at present unable to say. Certainly such substances as the vitamin ascorbic acid, catechol, or malate for which respiratory rôles have been postulated can hardly be considered in this present connection when we observe the position of the potentials of their systems.

It should be noted that certain substrates like the unnatural amino acids, hypoxanthine and xanthine are oxidized with the aid of specific flavoproteins which are unusual in that their reduced forms appear to react directly with oxygen in a rapid manner. This variation in behavior toward oxygen of different flavoproteins containing however the same prosthetic groups recalls the similar variation in behavior of the iron porphyrin compounds toward oxygen. The existence of such systems helps explain the fact that cyanide or carbon monoxide which poison the iron porphyrin compounds inhibit at best only about 90% of the total respiration of the cell. Such systems are therefore undoubtedly of minor importance in furnishing the main energy requirements of the cell.

We have been mainly interested tonight with the catalysts in biological oxidation and their mode of action. The cell is however mainly concerned with obtaining energy for its many duties from these processes. From the relationship of the oxidation-reduction potentials of the catalysts here portrayed it is obvious that the total energy obtained by the oxidation of foodstuffs is released in small units or parcels, step by step. Just as in a canal we descend from one level to the next by locks in easy stages so here the energy is released in a similar fashion. The reduced form of each substance in this chain does not react rapidly with oxygen nor with any other member in the chain unless it lies next to it in this chain. Here also no lock can be skipped in passing from one energy level to the next. Thus the living cell controls smoothly the burning of its foodstuffs and also thereby budgets its energy expenditures. Just what use is made of the energy released in each step and how is a problem for the future. Apparently however nearly two-thirds of the energy released in this chain occurs at the hands of the iron porphyrin compounds.

To summarize then we may say that biological oxidations occur through a series of catalysts which are oxidation-reduction systems. Some of these catalysts are iron porphyrin compounds while others contain in their structure certain of those substances we call vitamins. These catalysts form a chain which transmit step by step the electron and hydrogen ions which are removed from the foodstuffs and pass them on to oxygen which is thus reduced to water. The energy of the overall process is thereby released in small units, step by step. How this energy is utilized by the living cell to perform its many duties is the exciting task that lies before us, and I hope that by this lecture I have been able to arouse in some of you a desire to join in the fun of ferreting out some of the many secrets that still remain in this fascinating field of research.

(This article is based upon a lecture delivered at the Marine Biological Laboratory on August 2.)

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THE OFFICIAL MEETINGS OF THE MARINE BIOLOGICAL LABORATORY

DR. CHARLES PACKARD
Director

One of the important duties of the Trustees at their Annual Meeting is the election of new members to the Corporation. The way in which they are chosen is this. A committee of Trustees examines the applications to determine whether the candidates have certain definite qualifications. One of these is that each shall have worked at least two summers at the Laboratory, during which time he has had an opportunity to become familiar with the character and aims of the institution. Another requirement is that he shall have published several substantial papers in addition to his doctor's thesis, thus giving evidence that he is able to carry on independent research. In general, he should have the same qualifications that are required for election into one of the major national scientific societies. The names of those candidates who fulfill these requirements are then presented to the Trustees and voted on. (*Continued on page* 183)

M. B. L. Calendar

TUESDAY, August 27, 9:00 A. M.
General Scientific Meeting
Continued at 2:00 P. M.

WEDNESDAY, Aug. 28, 9 A. M.
General Scientific Meeting

THURSDAY, August 29, 9:15 A. M.
Genetics Society: Reading of papers, M. B. L. Auditorium.

FRIDAY, August 30, 8:00 A. M.
Genetics Society: Demonstrations and Exhibits, Old Lecture Hall.

FRIDAY, August 30, 8:00 P. M.
Lecture: Dr. Curt Stern: "Dependent Growth and Form of the Testes in Various Species of Drosophila."

THE SUMMER MEETING OF THE GENETICS SOCIETY OF AMERICA

DR. R. H. MACKNIGHT
Local Secretary

The annual summer meeting of the Genetics Society of America, omitted last year in view of the International Congress of Genetics at Edinburgh, will be held this year at Woods Hole on August 29 and 30. Geneticists from the United States and Canada are expected to attend, to discuss their problems, and to demonstrate their materials and methods of study. An opportunity for informal contacts will be afforded by a boat trip, swimming party, and clam bake at Tarpaulin Cove, which is scheduled for Thursday afternoon and evening, August 29th.

The meetings will begin on Thursday morning at 9:15 with the presentation of short papers in the Marine Biological Laboratory auditorium. Advance abstracts of these papers are published in this issue of THE COLLECTING NET, as well as advance abstracts of the demonstration papers which will be presented Friday morning and Friday after-

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THE MARINE BIOLOGICAL LABORATORIES OF WOODS HOLE

noon in the Old Lecture Hall. The Friday evening lecture, to be delivered by Professor Curt Stern of the University of Rochester, is certain to interest geneticists as well as other biologists.

All persons, whether members of the Society or not, are welcome to come to the clambake. Tickets will be on sale in the main lobby of the Brick Building. They should be purchased Wednesday night, or before the Short Paper session Thursday morning. Immediately after lunch Thursday the boat *Winifred* will depart from the Eel Pond for a cruise around the islands, ending at Tarpaulin Cove. For those who are not able to go on the *Winifred* there will be a smaller boat leaving at 3:15 P. M. to go direct to Tarpaulin Cove. The single price, $1.70, covers both the boat trip and the clambake. The small boat will return at 9:00 P. M., the *Winifred* later in the evening.

The program of the Meetings follows:

PROGRAM OF THE SUMMER MEETING OF THE GENETICS SOCIETY OF AMERICA AT THE MARINE BIOLOGICAL LABORATORY, AUGUST 29 AND 30, 1940

Officers of the Genetics Society of America

President, L. J. COLE, University of Wisconsin, Madison, Wisc.

Vice-President, TH. DOBZHANSKY, Columbia University, New York, N. Y.

Secretary-Treasurer, E. W. LINDSTROM, Iowa State College, Ames, Iowa.

Chairman of Local Committee, P. W. WHITING, University of Pennsylvania, Philadelphia, Pa.

Local Secretary, R. H. MACKNIGHT.

Thursday Morning Session, August 29, 9:15 A. M., Auditorium

Reading of Papers (15 min. limit)

(1) THIGPEN, LORNA W., Storrs Agricultural Experiment Station, Storrs, Conn.: Skin grafts in mice.

(2) CASPARI, ERNST, Lafayette College, Easton, Pa.: The inheritance of kinky tail and choreotic behavior in a strain of the house-mouse.

(3) BURKS, BARBARA S., Carnegie Institution of Washington, Cold Spring Harbor, N. Y.: Oval red blood cells in human subjects tested for linkage with normal traits.

(4) BREHME, KATHERINE S., Carnegie Institution of Washington, Cold Spring Harbor, N. Y.: Growth of the optic disc of *Drosophila melanogaster* as studied by transplantation.

(5) STEINBERG, ARTHUR G., Columbia University, New York, N. Y.: The growth curve of modified bar eye discs in *Drosophila melanogaster*.

(6) WARMKE, H. E., and BLAKESLEE, A. F., Carnegie Institution of Washington, Cold Spring Harbor, N. Y.: Further difference in the determination of sex in Melandrium and Drosophila.

(7) MACKNIGHT, R. H.: The chemical constitution of chromosomes.

(8) SAX, KARL, Harvard University, Cambridge, Mass.: Differential sensitivity of cells to X-rays.

(9) GILES, NORMAN, Harvard University, Cambridge, Mass.: The effect of fast neutrons on the chromosomes of Tradescantia.

(10) WHITING, ANNA R., University of Pennsylvania, Philadelphia, Pa.: Further data on sensitivity to X-rays of Metaphase I eggs in Habrobracon.

(11) WHITING, ANNA R., University of Pennsylvania, Philadelphia, Pa.: Temperature effects on sensitivity to X-rays of different meiotic stages in Habrobracon eggs.

(12) HUSKINS, C. L., SANDER, G. F., and LOVE, R. M., McGill University, Montreal, Canada: Chromosome mutations in Avena.

(13) HUSKINS, C. L., and SMITH, S. G., McGill University, Montreal, Canada: Compactoid and speltoid mutations in *Triticum vulgare*.

(14) HARNLY, M. H., Washington Square College, New York University: The reversal of dominance in vestigial/vestigial-pennant examined by deficiency studies.

Thursday Afternoon and Evening, August 29

Excursion on the Boat *Winifred* starting at 2:15 P. M. Trip around the islands ending at Tarpaulin Cove for swim and clam bake.

Boat trip direct to Tarpaulin Cove starting from the Eel Pond at 3:15 P. M. (Purchase tickets Wednesday evening or as early as possible Thursday morning at the main entrance, Brick Building. The same price, $1.70, covers boat trip and clam bake.)

An early return from Tarpaulin Cove arriving at Woods Hole at 9:00 P. M. may be arranged for one of the boats if desired.

Friday Sessions, Morning and Afternoon, August 30, Old Lecture Hall

The entire day beginning at 8:00 A. M. will be available for demonstrations and informal discussion. Spencer Lens Company has very kindly agreed to cooperate and will send a representative from Boston with microscopic equipment.

Demonstrations and Exhibits

(1) COPELAND, FREDERICK C., Harvard University, Cambridge, Mass.: Growth rates in inbred and hybrid corn embryos.

(2) DEMEREC, M., and KAUFMANN, B. P., Carnegie Institution of Washington, Cold Spring Harbor, N. Y.: Time required for *Drosophila melanogaster* males to exhaust the supply of mature sperm.

(3) GOODRICH, H. B., and TRINKHAUS, J. P., Wesleyan University, Middletown, Conn. and the Marine Biological Laboratory, Woods Hole, Mass.: A gene affecting melanophore response in *Lebistes reticulatus*.

(4) HINTON, TAYLOR, Carnegie Institution of Washington, Cold Spring Harbor, N. Y.: An inert region in

THE COLLECTING NET was entered as second-class matter July 11, 1935, at the Post Office at Woods Hole, Mass., under the Act of March 3, 1879, and was re-entered on July 23, 1938. It is devoted to the scientific work at marine biological laboratories. It is published weekly for ten weeks between July 1 and September 15 from Woods Hole, and is printed at The Darwin Press, New Bedford, Mass. Its editorial offices are situated in Woods Hole, Mass. Single copies, 30c; subscription, $2.00.

the second chromosome of *Drosophila melanogaster* located by means of a secondary constriction.

(5) HOLLAENDER, ALEXANDER, and EMMONS, C. W., Division of Industrial Hygiene and Infectious Diseases of the National Institute of Health, Bethesda, Md.: The action of ultraviolet radiation on Dermatophytes. Apparent modification of mutation rate by treatment after irradiation.

(6) HOWARD, ALMA, McGill University, Montreal, Canada: Occurrence of a mutation at the hairless locus in mice.

(7) MACKNIGHT, R. H.: The alternate disjunction of chromosomes from rings.

(8) NEEL, J. V., Dartmouth College, Hanover, N. H.: Studies on some combinations of mutations affecting the chaetae of *Drosophila melanogaster*.

(9) NICHOLS, CHARLES, Harvard University, Cambridge, Mass.: Spontaneous chromosome aberrations in root tips of Allium.

(10) POULSON, D. F., Yale University, New Haven, Conn.: Developmental effects of deficiencies in the *white-facet* region of the X-chromosomes of *D. melanogaster*.

(11) SAWIN, PAUL B., and JOHNSON, REUBEN B., Brown University, Providence, R. I.: A new paralytic mutation in the rabbit.

(12) SCHWEITZER, MORTON D., Cornell University Medical College, New York, N. Y.: Genetic studies in rheumatic fever.

(13) SKIRM, GEORGE W., The Arnold Arboretum, Harvard University, Jamaica Plain, Mass.: A technic for the germination of "non-viable" hybrid embryos.

(14) SMITH, HAROLD H., U. S. Dept. of Agriculture, Washington, D. C.: Heteroploid types of Nicotiana resulting from colchicine treatment.

(15) WHITING, P. W., University of Pennsylvania, Philadelphia, Pa.: Proof of quadruple alleles in sex differentiation of Habrobracon.

Friday Evening, August 30, 8:00 P. M., Auditorium Marine Biological Laboratory Evening Lecture

CURT STERN, University of Rochester, N. Y.: On dependent growth and form of the testes in various species of Drosophila.

ABSTRACTS OF PAPERS PRESENTED AT THE 1940 SUMMER MEETING OF THE GENETICS SOCIETY OF AMERICA AT THE MARINE BIOLOGICAL LABORATORY, WOODS HOLE, MASS., AUGUST 29-30

BREHME, KATHERINE S., Carnegie Institution of Washington, Cold Spring Harbor, N. Y.: *Growth of the optic disk of Drosophila melanogaster as studied by transplantation.*—In order to determine whether the growth rate of the optic disk is affected by a host with a different growth rate, transplants have been made at 25° between female larvae of Florida wild type (puparium formation at 100 hours from hatching) and *Minute-w* isogenic with Florida (puparium formation 144 hours). The transplants were dissected from the host after eclosion and the facets counted. Experiments with wild type and *Mw* have previously shown (Brehme 1939) that the length of time elapsing between transplantation and pupation of the host is an important factor in determining the number of facets formed by the transplant. Accordingly, donors and hosts were operated at 36 hours before puparium formation. *Mw* disks in *Mw* hosts formed a mean of 601.6 facets; *Mw* in + formed 646.4 facets; + in *Mw* formed 562.4 facets. The differences between the means of *Mw* in *Mw* and *Mw* in +, and of *Mw* in *Mw* and + in *Mw* are shown by the *t* test (Fisher, 1936) to be insignificant, with P between .3 and .4, and between .2 and .3 respectively. It is concluded that the growth rate of *Mw* disks is not changed by transplantation to a wild type host at this stage of development, and that + and *Mw* disks grow equally in the *Mw* host. Acetocarmine smears of optic disks just before pupation show numerous mitoses, bearing out earlier evidence from transplantation that growth by cell division is still occurring at this time.

BURKS, BARBARA S., Carnegie Institution of Washington, Cold Spring Harbor, N. Y.: *Oval red blood cells in human subjects tested for linkage with normal traits.*—During the course of a field study undertaken in 1939 by Wyandt in order to collect human pedigrees showing oval blood cells, it was possible to gather data upon several additional traits that could be used as test factors in a search for linkage, viz.: hair color, eye color, ability to taste phenyl-thio-carbamide, presence or absence of mid-digital hair, the A-B agglutinogens, and of course sex.

With the exception of eye color, for which there were too few heterozygous families to permit a test, the traits were tested against oval and round blood cells by the method of "like" and "unlike" sibling pairs. The data have also been examined as to evidence for "non-linkage," since failure to establish linkage in small population samples does not *ipso facto* disprove its existence. Close partial sex linkage and likewise close linkage with mid-digital hair seem to be ruled out by the present material. The data are equivocal for oval cells with taste blindness and with hair color (probably negative for the latter). On the basis of results that would only arise by chance with P of about .06, the possibility of linkage between oval cells and the A-B agglutinogens deserves further investigation.

CASPARI, ERNST, Lafayette College, Easton, Pa.: *The inheritance of kinky tail and choreotic behavior in a strain of the house-mouse.*—A strain of house mice, characterized by kinky tail, choreotic behavior and deafness, is described. Kinky is inherited as a dominant, F_1 animals giving 47.4±2.6% and 47.9±3.2% kinky offspring in the reciprocal back-crosses to a normal line. The appearance of only 61.4±4.2% kinky prog-

eny in F_2 is assumed to indicate lethal action of the gene in homozygous condition. This hypothesis is supported by the fact, that out of 91 progeny tested animals derived from Kink × Kink crosses only 7 which were inadequately tested failed to segregate. Furthermore, the progeny of Kink × Kink crosses from three inbred lines yielded the same percentage of Kink progeny as the F_2(59.7±1.9%, 64.3±3.4%, 64.3±6.4% Kink). Finally, the litter size in F_2 was about 19.9% reduced as compared with the backcrosses.—Of 41 apparently normal animals derived from Kink parents five bred as Kink.—In the same strains, 164 out of 617 Kink animals showed choreotic symptoms, while 12 out of 593 normal-tailed mice were choreotic. This suggests either close linkage between a gene for choreotic behavior and Kink, or dependence of this condition on the Kink gene. The fact that three of the 12 normal-tailed choreotic animals proved to be genotypically Kink, and four more were also likely to carry the gene Kink, supports the latter hypothesis. Besides this, the appearance of choreotic behavior seems to depend on other genetic factors, since the percentage of choreotic progeny from choreotic Kink parents is significantly higher than in matings of non-choreotic Kinks.

COPELAND, FREDERICK C., Harvard University, Cambridge, Mass.: *Growth rates in inbred and hybrid corn embryos.*—It has been known for a long time that hybrid corn plants usually show considerable excess vigor over their inbred parents. But, in many cases, the actual growth rate of the hybrids has been found to be identical with that of one of the inbred parents. Ashby has suggested that it is the difference in "initial capital" of the hybrid which accounts for the final heterosis.

A study of growth in corn embryos starting at the time of fertilization has shown that the hybrids already exhibit vigor at from four to ten days of growth. This difference in growth rate at such an early stage is sufficient to account for the larger "capital" of the mature hybrid embryo and suggests that this in itself is an expression of heterosis where the action of genes is in the very early stages of development.

DEMEREC, M., and KAUFMANN, B. P., Carnegie Institution of Washington, Cold Spring Harbor, N. Y.: *Time required for Drosophila melanogaster males to exhaust the supply of mature sperm.*—Testes of the adult fly are almost entirely filled with mature sperm, although some cells in earlier stages are present. It is known that changes induced in the mature sperm by irradiation are transmitted to the zygote in fertilization, whereas changes induced in spermatocytes may be eliminated during the divisions preceding the formation of the sperm. Thus the frequency of induced changes is different in sperm subjected to irradiation in the mature stage and sperm which had been irradiated in the spermatocyte stage. Since in a large proportion of irradiation experiments adult males are treated, it is important to know how long after irradiation males may be repeatedly mated without exhausting the sperm which was mature at the time of treatment.—In the experiments here reported males treated with 3000 r-units were repeatedly mated on the day of the treatment and on the 6th, 7th, 12th, and 19th days thereafter. A drop in the percentage of dominant lethals was not observed until the 19th day, indicating that the sperm which was immature at the time of treatment does not become available until sometime after 12 days. The data show that the fully matured sperm available for immediate transfer may become exhausted in a few consecutive matings.

GILES, NORMAN, Harvard University, Cambridge, Mass.: *The effect of fast neutrons on the chromosomes of Tradescantia.*—The effects of fast neutrons on the chromosomes of Tradescantia during the development of the microspore have been investigated and compared with the effects of X-rays. Qualitatively the results are the same as those found after X-ray treatment. Quantitatively, however, neutrons appear to differ considerably from X-rays in their effects on chromosomes. For equal total doses in terms of ionization as measured with a bakelite Victoreen ionization chamber, neutrons are from 16 to 17 times as effective as X-rays in producing chromatid dicentrics—aberrations which have been shown to result from a single X-ray hit. Also, exchange break aberrations, producing chromatid and chromosome rings and dicentrics, are found to show an approximately linear relationship to dosage instead of the exponential relation found with X-rays. An attempt is made to explain these differences between neutrons and X-rays in terms of the great difference in the types of ionization paths which these two radiations produce in tissue.

GOODRICH, H. B., and TRINKAUS, J. P., Wesleyan University, Middletown, Conn., and The Marine Biological Laboratory, Woods Hole, Mass.: *A gene affecting melanophore response in Lebistes reticulatus.*—A mendelian variant of *Lebistes reticulatus* has been found which is characterised by a distinctly lighter color than that of the wild type. This lighter color is caused solely by being smaller and in a continually contracted condition. The character is an autosomal recessive. The gene for wild type coloration is com-

pletely dominant over the blonde gene. Preliminary observations indicate that the character can be distinguished as early as the pectoral fin-bud stage. There is no reduction in the number of the melanophores in the blonde. There are, however, striking differencies in the physiological responses of these cells as compared with the wild type melanophores (whose reactions are similar to those of *Fundulus heteroclitus*). These blonde melanophores are completely unresponsive to light and dark background changes, denervation, injection of intermedin, injection of ergotamine, and to immersion in KCl and NaCl solutions to which the normal wild type cells readily respond. It is concluded that the blonde phenotype is chiefly due to the production of a very exceptional non-responsive type of melanophore. Derangement by the gene of the normal innervation of the cell is also a possibility which has not yet been excluded.

Harnly, Morris Henry, Washington Square College, New York University: *The reversal of dominance in vestigial/vestigial-pennant examined by deficiency studies.*—The author has demonstrated previously that: 1) the wings of homozygous vestigial flies vary directly with the temperature in length and area, the phenotype changing from vestigial through strap and antlered to notch; 2) the phenotype of homozygous vestigial-pennant remains normal but the wing size varies inversely with the temperature; and 3) the length and area of the wings of vestigial/vestigial-pennant flies vary inversely with the temperature from 16° to 22° C. and directly from 26° to 32°, the phenotype changing from antler to strap to antler to notch. At lower temperatures the curve of the heterozygote follows that of vestigial-pennant and in the higher range it follows the vestigial response. This would indicate a reversal of dominance in the heterozygote below 22° and above 26°. The haplo-vestigial locus response has been examined by using the deficiency vestigial-Depilate. The size of the wings of vestigial/vestigial-Depilate vary directly with the temperature from 16° to 32°, the major change occurring at the higher temperatures. The wings of vestigial-pennant/vestigial-Depilate vary in size inversely with the temperature, the major change being in the lower range. The data are in agreement with the above interpretation of a reversal of dominance in the heterozygote vestigial/vestigial-pennant.

Hinton, Taylor, Carnegie Institution of Washington, Cold Spring Harbor, N. Y.: *An inert region in the second chromosome of Drosophila melanogaster located by means of a secondary constriction.*—A secondary constriction in the left arm of the second chromosome has previously been described in mitotic nuclei of *D. melanogaster*. However, this constriction is not apparent in the salivary chromosomes. A comparison has been made, therefore, between the salivary and mitotic second chromosomes in order to determine the location of the constriction in the salivaries. The comparison has been made by studying deficiencies, insertions, and translocations between the second and X-chromosomes; and by measuring from camera lucida drawings the sections identified by means of the aberrations. It has been found that the region between the constriction and the centromere of 2L (about one-fifth to one-sixth of the length of the mitotic chromosome) is represented only by the most proximal part of division 40 of the salivary chromosome.

Hollaender, Alexander and Emmons, C. W., Divisions of Industrial Hygiene and Infectious Diseases of the National Institute of Health, Bethesda, Md.: *The action of ultraviolet radiation on Dermatophytes. Apparent modification of mutation rate by treatment after irradiation.*.— We have reported previously the lethal and genetic effects of monochromatic ultraviolet radiation on the spores of *Trichophyton mentagrophytes*. (*J. Cell. & Comp. Physiol. 13*:391-402, 1939; *Amer. J. Bot., 26*:467-475, 1939) It was found that the mutation rate increases in the surviving spores with increasing energy up to a certain level. The rate of mutation decreased following additional irradiation.

Treatment of the spores after irradiation by incubating in solutions of such composition that little effect was produced on nonirradiated spores, apparently increased further the rate of mutation of the irradiated spores. There is no indication that the types of mutations found after incubation differ from the mutations found at once after irradiation. The effects become most apparent after about 95% of the spores are inhibited from forming colonies.

Several explanations for this phenomenon could be advanced.

1. Treatment of the spores after irradiation may help to extend or complete a process of change initiated in the nucleus.

2. Spores which received considerable amounts of radiation often have a tendency if incubated in liquid suspensions to recover from the radiation effect. It is possible that the mutated spores recover more readily than the spores which received extra nuclear injuries.

These effects have been found after irradiation with ultraviolet between 2180 and 2950 Å only.

Howard, Alma, McGill University, Montreal, Canada: *Occurrence of a mutation at the hairless locus in mice.*—A mutant gene, which appeared in an inbred line of house mice, causes, in the homozygous condition, a progressive thinning and final loss of the hair at 2-4 weeks of age, hypertrophy and curvature of the claws, and a marked thickening and wrinkling of the skin at 3 months and later. The gene is an allele of hairless (*hr*) and is recessive both to *hr* and to the normal allele. It has been given the name "rhino" (hr^{rh}) and is probably a recurrence of the mutation shown by the "rhinoceros mice" described by Gaskoin, Allen and Campbell. Both sexes are fertile, but females have a reduced amount of mammary tissue and are incapable of supplying adequate milk to their young.

Huskins, C. L., Sander, G. F., and Love, R. M., McGill University, Montreal, Canada: *Chromosome mutations in Avena.*—Steriloid, fatuoid and sub-fatuoid mutations in *Avena sativa* var. Banner and *A. byzantina* var. Kanota change the phenotype of the cultivated oat towards that of the wild type. This series of mutations is due to the removal of wild-type inhibitors by partial or complete loss of the long arm of the C-chromosome. This chromosome also carries factors affecting synapsis and the growth and viability of the plant.

Huskins, C. L., and Smith, S. G., McGill University, Montreal, Canada: *Compactoid and speltoid mutations in Triticum vulgare.*—Twenty-seven chromosomal types involving changes in the C-chromosome have been found in 16 strains of speltoid or compactoid mutants. The normal phenotype is determined by a balance between ear-lengthening and speltoid glume factors whose location is unknown, and compacting and round glume factors borne on the long arm of the C-chromosome. Upset of the balance by deficiency or duplication of the C-chromosome (or certain parts of it) modifies the phenotype in the speltoid or compactoid direction respectively.

MacKnight, R. H.: *The alternate disjunction of chromosomes from rings.*—Several kinds of evidence point to the possession by chromosomes of a twisted structure. If the meiotic chromosomes tended to untwist in late prophase, chiasmata would be forced to move apart, to terminalize. Further, if homologous spindle attachment bodies, during diakinesis, are held at a more or less fixed distance from each other, an internal torsion in a ring will bend it (as can be seen by manipulation of elastic models) into a zigzag form, so that adjacent chromosomes are oriented away from each other. If the ring goes into the spindle thus oriented, alternate disjunction will result, and all gametes will receive a complete haploid set of chromosomes. In support of this view of the mechanism involved one may cite the well-known fact that alternate disjunction occurs in those organisms (Oenothera, Datura, Rhoeo, Campanula) which show terminalization of chiasmata, and not in those which do not.

MacKnight, R. H.: *The chemical constitution of chromosomes.*—The idea that chromosomes are composed of protamines or histones combined with nucleic acid rests on chemical analyses of fish sperm. In view of the fact that chromosomes are of almost universal distribution, whereas histones and protamines are absent from many animal species and tissues, and entirely absent from plants, it seemed desirable to repeat the studies on fish sperm. When fat free sperm of *Rhombus tricanthus* were treated first with a solvent for protamines and histones, then with a solvent for nucleic acids, there still remained a residue whose dry weight was 42% of that of the starting material. From a review of the literature it appears that no more than 20% of protamine or histone has ever been extracted from sperm heads or other nuclear material; it appears doubtful whether as much as 50% of nucleic acid has ever been similarly obtained. It is concluded that no chromosomes are proved to contain protamine or histone, that most chromosomes are free of them.

Neel, J. V., Dartmouth College, Hanover, N. H.: *Studies on some combinations of mutations affecting the chaetae of Drosophila melanogaster.*—Hairy wing (*Hw*), polychaetoid (*pyd*), and hairy (*h*) are three *Drosophila melanogaster* mutants characterized by an increase in the number of micro and/or macrochaetae. Wild-type, *pyd, se h, y Hw, se h pyd, y Hw; pyd, y Hw; se h,* and *y Hw; se h pyd* males were investigated with respect to the length of the femur, number of dorsocentral bristles, number of scutellar hairs, number of scutellar bristles, number of hairs on the second longitudinal wing vein, and number of teeth in the sex-comb. By appropriate breeding techniques the strains had been rendered genetically comparable with respect to almost all genes except those detectable mutations which served to distinguish the strains.—As judged by the length of the femur, all the mutant strains were considerably smaller than wild-type. Usually the effects upon the chaetae of combinations of two or three of the mutations were greater than the sum of the deviations from wild-type produced by these mutations when acting separately. The condition of the teeth in the sex-comb was an excep-

tion to this general rule. The strain combining all three bristle mutations was particularly characterized by the occurrence of these "super-additive" effects.—Correlations between the various chaetal characteristics of any one genotype were for the most part not significant, indicating an absence of developmental interdependence between the traits.

Nichols, Charles, Harvard University, Cambridge, Mass.: *Spontaneous chromosome aberrations in root tips of Allium.*—Root tips of germinating seed of several varieties of *Allium cepa* L. were examined and a rather high frequency of spontaneous chromosome aberations was observed. In some cases as many as 15 percent of the cells contained aberrations. Different varieties differed markedly in the number of these alterations. Age and condition of the seed was found to be correlated with number of aberrations. Older seeds showed higher percentages of abnormalities and poorer germination.

Poulson, D. F., Yale University, New Haven, Conn.: *Developmental effects of deficiencies in the white-facet region of the X-chromosome of D. melanogaster.*—Deficiencies of different extents in the *white-facet* region of the X-chromosome have been obtained by Demerec and the extent of many of these determined cytologically by Slizynska. Deficiencies which remove the *facet* locus (band 3 C 7) are phenotypic *Notches* in the heterozygous condition. The embryological effects of these *Notch* deficiencies, all of which are lethal in the male, are early (6-8 hrs.) and very specific. The anterior and ventral ectoderm produces an hypertrophied nervous system; no ventral hypoderm is formed. The development and differentiation of the mesoderm are very incomplete. Mid-gut rudiments fail to unite. The fore-gut is rudimentary, and associated structures fail to appear. These upsets are the same in all of a series of seven *Notches* ranging in extent from 264-38 (bands 2 D 4 to 3 E 2) to those in which no cytological deficiency is visible. One of these (264-34) involves a 1:3 translocation in which the point of breakage in the X is at the *facet* band (3 C 7). The effect must therefore be laid to a minute deficiency.

Deficiencies for the *white* locus (band 3 C 1) are lethal in the male, but the nature of the abnormalities produced is different from that of the *Notches*. Hypoderm and nervous system are nearly normal, but even though the mid-gut rudiments unite, the gut remains incompletely differentiated. Differentiation of mesoderm is abnormal. The general level of development in the one most fully studied, 258-45 (band 3 C 1 only absent), is not beyond the 12 hour or half-way point in embryonic development.

When the *white* locus as well as the *facet* locus is absent as in the larger *Notch* deficiencies the effects are the same as in the small *facet* deficiencies, indicating that the *facet* locus comes into action in development much before the *white* locus. Other small deficiencies are being studied.

Sawin, Paul B., and Johnson, Reuben B., Brown University, Providence, R. I.: *A new paralytic mutation in the rabbit.*—A fourth paralytic character in the rabbit differs from those described by Nachtsheim in several respects. In time of onset (two to three months of age) it most closely resembles "shaking palsy" but little if any shaking movements have ever been observed. Like spastic spinal paralysis it affects primarily but not exclusively the hind legs. Like both of these the proportion of affected and non-affected individuals segregating for eight generations in inbred family V may be interpreted as the result of a monogenic autosomal recessive. It is semi-lethal since none of the affected animals have reached sexual maturity. In inheritance and in time and manner of onset it resembles spastic paraplegia of man. Although the clinical picture of the disorder suggests that the defect causing it is in the central nervous system, histological examination thus far has shown no certain evidence of degeneration. The character may prove of interest to the neurological as well as the genetic field.

Sax, Karl, Harvard University, Cambridge, Mass.: *Differential sensitivity of cells to X-rays.*—Of the various stages in the nuclear cycle the early resting stage is least sensitive and the mid-prophase is most sensitive as measured by the frequency of chromosome aberrations in Tradescantia microspores. Of the various types of cells in Tradescantia increasing sensitivity is found in the following order,—generative nucleus of the pollen grain, root tip cells, microspores, and microsporocytes. Tradescantia microspores are more sensitive than those of Allium. Differential sensitivity is related to chromosome structure and relative freedom of chromosome movement.

Schweitzer, Morton D., Cornell University Medical College, New York, N. Y.: *Genetic studies in rheumatic fever.*—The family pedigrees of 395 rheumatic children from the Children's Cardiac Clinic of New York Hospital were subject to analysis. Of these, 122 families were under continuous observation for a sufficiently extended period so that more than 95% of the siblings have reached or passed the age of peak

incidence of rheumatic fever under observation. Appropriate methods for the investigation of heredity in a relatively common, possibly communicable disease are presented. The results are consistent with the interpretation of a single recessive gene with nearly a hundred percent penetrance under the environmental and exposure conditions of the clinical sample.

SKIRM, GEORGE W., The Arnold Arboretum, Harvard University, Jamaica Plain, Mass.: *A technic for the germination of "Non-Viable" hybrid embryos.*—Embryos of Lilium and Prunus, resulting from species hybridization under controlled conditions, frequently abort prior to maturation of the fruits. Embryos of certain of these crosses, when removed from the maternal influence and cultured under aseptic conditions, are capable of being germinated to produce viable seedlings. The subsequent behavior of the embryos appears to be associated with the formula of the media upon which they are germinated. Photographs to illustrate the technique, and preliminary data on results are presented.

SMITH, HAROLD H., U. S. Department of Agriculture, Washington, D. C.: *Heteroploid types of Nicotiana resulting from colchicine treatment.*—Treatment of germinating seeds with 0.4 percent colchicine for 24 hours has produced autotetraploids of the following species of Nicotiana: *langsdorffii* (n = 9), *sanderae* (n = 9), *alata* (n = 9), *longiflora* (n = 10), *plumbaginifolia* (n = 10), *debneyi* (n = 24), *repanda* (n = 24) and *tabacum* (n = 24). One haploid was obtained among the 53 plants of 2n *langsdorffii* that were permanently affected by the treatment. There was a progressive increase in the size of leaf and flower from 1n to 2n to 4n. A branch of one cutting from the haploid produced flowers that were intermediate in size between the 1n and 2n. Some of the root tips of this cutting had 16 chromosomes (2n-1-1) which was presumed to be the number in the anomalous branch. A triploid *langsdorffii*, from 4n × 2n, was crossed with diploid *langsdorffii* and *sanderae;* so that types with extra chromosomes from *langsdorffii*, on the background of this species and of the F_1 with *sanderae*, were obtained. Plants with single extra chromosomes (of which at least four and possibly seven have been found) showed differences in leaf shape and in the color, pattern and size of the corolla—thus demonstrating that different genes affecting these characteristics were present in the various chromosomes involved.

STEINBERG, ARTHUR G., Columbia University, New York, N. Y.: *The growth curve of modified bar eye discs in Drosophila melanogaster.*—The growth curve of the eye discs of *B;m(B) px sp* (*B*=Bar, *m*(*B*)=a second chromosome inhibitor of Bar, *px*=plexus, *sp*=speck; the latter two do not affect facet number), larvae from 36 hours after hatching (Temp.=27±1°C) until just before puparium formation (84 hrs.) is identical with that of the eye discs of Bar larvae. The eye discs of both stocks are the same in size at 36 hours and remain so throughout the remainder of the larval period.

It has previously been reported (Steinberg, D.I.S. 11 and the Seventh International Genetics Congress) that the growth rate of the Bar eye discs is identical with that of the wild type but that the former are smaller than the latter at all times; the same is of course true for modified Bar.

At 25°C. Bar and modified Bar eyes have 75 and 200 facets respectively. At 29° C. the corresponding values are 37 and 160. No counts were made at 27° C. but it is certain that the difference in facet number between Bar and modified Bar at this temperature is at least 125 facets. That such a difference in facet number is great enough to lead to a detectable difference in disc size was shown by comparison of *BB* and B^i eye discs with *B* eye discs.

The failure of the modified Bar eye discs to show any size difference from the Bar eye discs may be explained as follows: In the development of the eye there is a period during which a portion of the disc is labilely determined to form either facets (ommatidia) or head chitin; several extrinsic and intrinsic factors are known to affect the final determination of this tissue in Bar; it is assumed that *m*(*B*) is an intrinsic (genic) factor which affects the final determination of this tissue so that more of it forms facets than in the case of unmodified Bar.

THIGPEN, LORNA W., Storrs Agricultural Experiment Station, Storrs, Conn.: *Skin grafts in mice.*—Grafts were exchanged within 24 hours after birth between litter mates from inbred stocks. A tight bandage of adhensive is applied around the belly in two slightly overlapping sections which automatically slip as the animal grows, eliminating injury from removal by hand. About 75% of the grafts have remained long enough to produce hair, and in one case, hair follicles are still active after 20 months.

Skin from mice homozygous for dominant hairlessness (*NN*) usually does not produce normal hair, but when grafted on hosts of other genotypes produces, in addition to the typical *NN* unerupted coiled hairs, a varying number of erupted hairs approaching normal structure. On

caracul hosts, these hairs tend to curl and on normal hosts they tend to be straight. Albino *NN* grafts on pigmented non-*NN* hosts, may produce a few pigmented hairs, suggesting the invasion of pigment-producing cells from the host. Of these pigmented hairs, some are unerupted, coiled hairs characteristic of *NN*, while others are of the erupted type which appeared as a result of grafting.

Warmke, H. E., and Blakeslee, A. F., Carnegie Institution of Washington, Cold Spring Harbor, N. Y.: *Further differences in the determination of sex in Melandrium and Drosophila.*—Sex is determined in Melandrium and in Drosophila by the XY mechanism: 2A + XX individuals are female, and 2A + XY individuals are male. The Y is larger than the X in both cases. The basic interaction of chromosomes, however, is different in the two forms. In Drosophila the Y-chromosome plays no role in primary sex determination. In Melandrium it is male determining as shown by the fact that 4A + XXXY individuals are male, while 4A + XXX individuals are female. Also, 4A + XXXX individuals are female, while 4A + XXXXY individuals are hermaphroditic. The X-chromosome is female determining in both Melandrium and Drosophila. In Melandrium 4A + XY (X/Y ratio = 1.0) is male; 4A + XXY (X/Y ratio = 2.0) is made with a rare hermaphroditic blossom; 4A + XXXY (X/Y ratio = 3.0) is male with an occasional hermaphroditic blossom; 4A + XXXXY (X/Y ratio = 4.0) is hermaphroditic and self fertile. As the X/Y ratio increases, the number of autosomes remaining constant, femaleness increases. In Drosophila the autosomes supply the male tendency; in Melandrium they play little if any role in sex determination. In the following series all plants remain female, though the ratio of sets of autosomes to X chromosomes is reduced from 1.5 to 0.5: 2A + XXX (X/A ratio = 1.5); 4A + XXXXX (X/A ratio = 1.25); 4A + XXXX (X/A ratio = 1.0); 4A + XXX (X/A ratio = 0.75); 3A + XX (X/A ratio = 0.66); 4A + XX (X/A ratio = 0.5). This latter type would be male in Drosophila.

Whiting, Anna R., University of Pennsylvania, Philadelphia, Pa.: *Further data on sensitivity to x-rays of metaphase I eggs in Habrobracon.*—Unlaid eggs of unmated females treated in late metaphase I range from 37.5% mortality for 50 r to 100% for 1820 r. These percentages are linearly proportional to dosage and significantly higher than those for prophase eggs which do not differ significantly from controls for this range of treatments. Some prophase eggs survive 25,000 r. In metaphase I eggs tetrads have begun to divide and chromatids appear to be under tension at time of treatment. Single ionizations in tense regions might cause permanent breaks resulting in terminal deletion or eventual loss of a whole chromosome (McClintock). This would not interfere with completion of meiosis and would be obvious in earliest cleavages. Since embryo is haploid, it would fail to mature from any egg with pronucleus so affected. Mortality from this cause would follow one-hit curve (Singh, Alexander, Muller). Ionizations of unseparated ends of chromatids might cause minute changes primarily because of restricted lengths. These, likewise fatal if permanent, follow a one-hit curve (Demerec, Marshak, Muller). All metaphase I eggs exposed to 2500 r die. At least 96% of these complete meiosis and cleave. Rarely blastoderm stage is reached. When exposed to 4550 r they likewise complete meiosis. The sensitivity to 50 r and completion of meiosis at 4550 r are evidence against "physiological" causes of death. Preliminary tests indicate that mortality of metaphase I is not reduced by prevention of egg laying, that is, of anaphase, for twenty-four hours.

Whiting, Anna R., University of Pennsylvania, Philadelphia, Pa.: *Temperature effects on sensitivity to x-rays of different meiotic stages in Habrobracon egg.*—Unmated females were kept at 0° C., 13° C., 25° C. and 35° C. for one hour before and one hour after treatment. Except for 0° they were at room temperature for one half minute during exposure to 212 r. Mortality of late metaphase I eggs is lowered significantly at 0°; it is highest at 25°, intermediate for 35°, both significantly different from controls. Mortality of early prophase eggs parallels this but at a level not significantly different from controls. Mid and late prophase graphs are parallel and have highest mortality at 0°, lowest at 35°. The possibility of lowered tension on dyads is suggested for lowered mortality in metaphase I at 0°.

Whiting, P. W., University of Pennsylvania, Philadelphia, Pa.: *Proof of quadruple alleles in sex differentiation of Habrobracon.*—The gene fused, which is sex-linked, *xa/xb*, in one stock, 36-*vl*, has been transferred by crossing-over into an unrelated stock, 11-*o*. Since it proves to be sex-linked in stock 11-*o* also, the sex-differentiating factors of 11-*o* are allelic, *xc/xd*, with (or closely linked with) the sex-differentiating factors of 36-*vl*, rather than independently segregating, *za/zb*.

THE EFFECTS OF ETHER UPON THE DEVELOPMENT OF *DROSOPHILA MELANOGASTER*

Ivor Cornman

Teaching Fellow in Biology, New York University

The common use of ether as an anesthetic to facilitate handling fruit-flies during experiments raises the question as to the effect of the ether itself upon the flies. Moreover, polyploidy can be induced in cells by narcotics, as shown by the work of E. B. Wilson and others. In Drosophila the production of polyploids is of particular interest because a tetraploid race would be a convenient tool for geneticists. Unfortunately, Drosophila has so far responded as do most animals, in that polyploid nuclei result but no wholly polyploid adults.

Experiments were carried out in collaboration with Dr. Harnly in which eggs were exposed to an atmosphere one-third ether by volume for twenty minutes just after laying. They were then removed from the ether chamber and allowed to develop in an incubator. This dose is much in excess of that ordinarily used for anesthesia. Most adult flies are killed by this dose. (Of 140 flies, 15 showed signs of life after one hour, and 4 recovered enough to walk.) This heavy dosage was chosen to obtain a clear-cut ether effect. Under such treatment, the mortality of embryos, as judged by hatching, was 40.5% as against the 8.3% mortality of the controls. The mean hatching time is 21.29 ± .10 hours as against 19.79 ± .06 hours for the controls, a delay of 7.6%. More striking is the fact that the mortality and rate of development are affected adversely during the larval and pupal periods as well. Clearly, disturbances are brought about in the embryo which manifest themselves long after the larva has hatched.

Cytological studies of the embryos carried out in connection with Dr. Huettner give some clue as to the nature of these changes. Most frequently the ether disrupts the mitotic process. Spindles become abnormal in various ways: some merely blunted, some multipolar, and others distorted out of all resemblance to a spindle. Chromosomes may fuse, or, coincident with disruption of the spindle, become scattered. Once the mitotic mechanism is upset, the abnormalities become accentuated with time, so that we find spindles with many poles containing enormous numbers of chromosomes. Pycnotic masses of chromatin and giant nuclei may result. The cytoplasm also is affected, and becomes distributed in abnormal patterns. Complete disorganization shows in eggs that did not hatch, where undifferentiated masses of cells and non-cellular cytoplasm are found. Obviously, interference with the mitotic cycle and other regulating processes in the early embryo disrupts the entire developmental sequence.

In relation to the production of polyploid cells, these multipolar spindles and enlarged nuclei are significant. Beyond any doubt, there has been reduplication of chromosomes within many nuclei, but unfortunately, polyploidy in these embryos was always associated with abnormal nuclei and spindles. No polyploid imago was found among the treated individuals or their offspring. Animals typically differ from plants with regard to maintainance of polyploidy. Even colchicine, which has proved so effective in producing polyploid plants, has not, so far as I know, been used successfully to produce polyploid animals in any species, although many investigators report polyploid nuclei.

There was a definite effect upon the adult phenotype, however. Fifteen per cent of the emerged flies showed deformation of abdominal segments much like the mutation *Abnormal abdomen*. The deformity is not inherited, but nevertheless, must involve some deep-seated mechanism, appearing as it does in an adult from an egg treated just after laying. It is remarkable that the effect of a short ether treatment should show in adult organs after the treated egg has passed through embryonic development, hatching, larval life, pupation, and metamorphosis. Moreover, preliminary experiments indicate that incidence of this abnormal abdomen phenocopy, if it may be so termed, is less frequent when embryos an hour or two older are etherized. This early period of susceptibility to ether is in marked contrast to ultraviolet susceptibility as reported by Geigy. He found irradiation to affect adult structures only when embryos older than seven hours were treated. Work is in progress to determine the precise ether effective period, and, if possible, to trace the induced abnormality back through the pupal and larval stages, perhaps to the cytological abnormalities already observed.

Tracing the history of this phenotypic abnormality is only one direction further investigation might take. A number of other paths should prove fruitful in view of the wide range of effects that ether can produce in *Drosophila* from embryo to adult: developmental, cytological, and morphological abnormalities.

(This article is based upon a seminar report presented at the Marine Biological Laboratory on August 13.)

THE RELATION BETWEEN THE FOUR-CARBON ACID RESPIRATORY SYSTEM AND THE GROWTH OF OAT SEEDLINGS

Dr. Harry G. Albaum and Dr. Barry Commoner
Department of Biology, Brooklyn College and the Department of Biology, Queens College

Auxin produces a number of varied and marked effects on the growth of different parts of the plant, the extent and direction of the effect being closely dependent on the auxin concentration. It has recently been shown by Commoner and Thimann (in press) that auxin participates in the four-carbon dicarboxylic acid respiratory system. It was shown that the stimulation of growth by auxin is enhanced by the presence of salts of these acids (such as malate and fumarate) and that growth is inhibited by the presence of iodoacetate, which poisons this system. Furthermore, it was found that the respiratory effect of malate and fumarate was apparent only in the presence of auxin, and that auxin itself can increase oxygen consumption in the presence of these substances. This work was carried out on a single auxin effect: the elongation of isolated sections of the oat coleoptile. The purpose of the present research was to investigate these relations in terms of the several hormonal actions which auxin exerts on various parts of the intact oat seedling.

The experiments were carried out by growing seedlings in contact with filter paper in beakers containing the desired solution, and studying the effect on coleoptile length, total root length, and root number.

The growth of the coleoptile is stimulated by the auxin contained in the seedling itself. When plants (of the variety Fulghum) were grown in various concentrations of iodoacetate the coleoptile growth was inhibited, the highest concentrations of iodoacetate (.00005 to .0001 M.) resulting in a final size of but 50% normal. The addition of auxin, and to a greater extent, of fumarate, negated the iodoacetate poisoning.

In contrast to the coleoptile, the growth of oat roots is known to be inhibited by the presence of auxin (10 mgm. per liter). In the presence of iodoacetate this inhibition was partially removed, and conversely the inhibition was greatly magnified in the presence of fumarate.

Root number, which like the coleptile length gives a positive response to this concentration of auxin, behaved like the coleoptile length toward iodoacetate and fumarate.

It has been suggested by Thimann that all of these processes actually show a similar response to auxin, the direction of the effect being a function of the auxin concentration. Thus, low concentrations produce a stimulation, higher concentrations resulting in an optimum plateau, and even greater amounts of auxin causing inhibition. The different effect of the same concentration of auxin on these processes is accounted for by the displacement of each of these curves along the auxin-concentration axis, and also by the amount of intrinsic auxin present in the particular species or variety. By testing the effect of various concentrations of iodoacetate on these phenomena, we have been able to confirm and extend this interpretation. When iodoacetate and auxin concentrations are plotted in opposite directions on the same abscissa, and effect on the ordinate, it is possible to produce for the first time in actuality, the hypothetical curves relating effect to the active auxin concentration. The data also give a satisfactory description of the relation between the variety Fulghum (high intrinsic auxin concentration) and the variety Black Norway (lower intrinsic auxin concentration).

(This article is based upon a seminar presented at the Marine Biological Laboratory on August 20.)

SOME REMARKS ON THE MECHANISM OF THE GLASS ELECTRODE

Dr. G. Haugaard
Carlsberg Laboratories, Copenhagen

The glass electrode is of interest to the biologist for two principal reasons. Primarily, the glass electrode has become an important tool for the determination of pH. Secondly, experiments on the glass electrode itself have interest in relation to biological membrane phenomena.

Cremer publishing the first paper on the glass electrode in 1906, was concerned only with this second aspect, namely its use as a model to elucidate certain bioelectric phenomena. The pH scale was unknown at that time.

The most satisfactory glass for the preparation of the glass electrode is that developed by MacInnes and Dole. Therefore this has been used in the present experiments. By electrolysis experiments it is shown that the sodium ion alone is responsible for the passage of electric current through the glass membrane. When a glass electrode membrane is prepared so that one surface has been soaked in water for a long time to establish an equilibrium, the other side never having been in contact with water, the reaction of the

"fresh" surface with water may be studied uncomplicated by reverse effects. Under this condition there is a quantitative relation between the sodium-hydrogen exchange and the potential alteration of the system.

Experiments comparing the uptake of hydrogen ions and water by MacInnes and Dole glass powder show that the ratio of absorbed hydrogen ions to absorbed water is a constant, hence the absorbed hydrogen ions are solvated. In alcoholic solutions it could be shown that the hydrogen ions also carry alcohol.

On the basis of the above experiments, the following picture can be given of what happens when a fresh glass electrode comes in contact with an acid, neutral or weakly basic solution (i.e. within the range where the glass electrode acts only as a hydrogen electrode). At first the glass electrode will take up water and the sodium salt of the silicic acid will dissociate under the influence of this water. Hydrogen ion at the same time is absorbed. In other words the sodium salt of the weak silicic acid is partially hydrolyzed at the surface forming in the surface layer a skeleton of silicic acid. The solvated hydrogen ions react readily with the surface, which affords an easy entrance for the hydrogen ions into the glass. In the middle of the glass membrane there remains a layer of intact sodium salt. This theory is an extension of a theory developed by MacInnes and Belcher and also of an earlier theory by Horowitz.

(This article is based upon a seminar report presented at the Marine Biological Laboratory on August 13.)

ZOOLOGY SYMPOSIA AT THE UNIVERSITY OF PENNSYLVANIA

In connection with the Bicentennial Celebration of the University of Pennsylvania during the week of September 15 to 21, many departments of instruction are sponsoring symposia and round-table discussions in their various fields, including medicine and botany. The department of zoology has organized a series of symposia under the general title: "Cytology, Genetics and Evolution." The traditional interests of Professor McClung and his associates are therefore to be primarily represented. There are four half-day programs, each with three main speakers. Each paper is to be discussed by some one scientist selected in advance. The first two sessions will be presented on the morning and afternoon of Wednesday, September 18, and the third and fourth will be given on the following day. As one of the conveners, Dr. D. H. Wenrich has been responsible for the organization of the zoological symposium. Anyone interested in attending the program outlined below should make application for admission to the Bicentennial Office, Houston Hall, University of Pennsylvania.

CYTOLOGY, GENETICS AND EVOLUTION

I. Chromosomes and Heredity

Chairman, C. E. McClung

"The Nature of the Gene:" *Speaker*, N. Demerec; *Discusser*, H. H. Plough. "The Structure of Chromosomes:" *Speaker*, C. W. Metz; *Discusser*, B. R. Nebel. "Sex Determination:" *Speaker*, Franz Schrader; *Discusser*, P. W. Whiting.

II. Cytogenetics and Evolution

Chairman, Charles B. Davenport

"Chromosomal Interchanges," *Speaker*, A. F. Blakeslee; *Discusser*, R. E. Cleland. "Evolutionary Changes in the Chromosome Apparatus of Drosophila," *Speaker*, Th. Dobzhansky; *Discusser*, Bernard P. Kaufmann. "Evolution of the Germ Plasm," *Speaker*, C. E. McClung; *Discusser*, Curt Stern.

III. Cytology and Genetics of the Protozoa

Chairman, L. L. Woodruff

"Hereditary Status of the Rhizopods," *Speaker*, H. S. Jennings; *Discusser*, D. H. Wenrich. "Nuclear Behaviour and Reproduction in Ciliated Protozoa," *Speaker*, William F. Diller; *Discusser*, Ralph Wichterman. "Heredity in Ciliated Protozoa," *Speaker*, Tracy M. Sonneborn; *Discusser*, Richard F. Kimball.

IV. Physiology of the Nucleus

Chairman, Robert Chambers

"The Physico-Chemical Properties of the Nucleus," *Speaker*, Leon Churney; *Discusser*, John B. Buck. "The Chromosomes of the Amphibian Nucleus," *Speaker*, William R. Duryee; *Discusser*, L. V. Heilbrunn. "Radiation and the Cell Nucleus," *Speaker*, Paul S. Henshaw; *Discusser*, Karl Sax.

CURRENTS IN THE HOLE

At the following hours (Daylight Saving Time) the current in the Hole turns to run from Buzzards Bay to Vineyard Sound:

Date	A. M.	P. M.
August 24	8:39	9:14
August 25	9:26	10:04
August 26	10:17	11:00
August 27	11:17	11:53
August 28	.....	12:13
August 29	12:48	1:09
August 30	1:46	2:01
August 31	2:38	2:52
September 1	3:26	3:42
September 2	4:15	4:32
September 3	5:03	5:26
September 4	5:43	6:16

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

The Collecting Net

A weekly publication devoted to the scientific work at marine biological laboratories.

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HINTS ON PRESENTING SEMINAR REPORTS

DR. CHARLES PACKARD

When Huxley was a very young man he was asked to read a paper before the Royal Society. Being in some doubt as to the way in which he should present his report to so noted a group of scientists, he asked Faraday, the President, for advice. Faraday replied that he should assume that his audience knew nothing about his subject. One who presents a seminar report need not make so broad an assumption, yet the fact remains that not many of his hearers are really familiar with the particular phase of the problem he is working on. But the audience has come to learn something about the subject and they can learn only if he describes his work logically and simply without presuming that his hearers already know as much about it as he does.

In the minds of the audience one of the first questions to arise is why was this work undertaken. Often it has been carried on to test the validity of some hypothesis, or to contribute to our knowledge of some biological process under normal or experimental conditions. Always it is related to some larger problem. What is the larger problem and why is further information about it needed? When these questions are clearly answered, the minds of the hearers will be properly oriented toward the particular topic to be discussed.

Simplicity in the description of methods and in the presentation of results is essential. Only those facts and data should be mentioned which bear directly on the conclusion to be drawn. Should anyone want more detailed information he can ask for it in the discussion period or later. Often a single diagram with one or more curves is all that is essential; or a table with a minimum amount of data. (A table full of typewritten figures discourages the audience.)

A categorical and brief statement of the conclusions rouses interest and discussion, whereas one hedged about with uncertainties is weak and unconvincing.

A speaker who can do without notes altogether, or with only an occasional reference to them, is far more effective than one who reads from a manuscript. He can develop his subject more clearly and can hold the attention of the audience. Reports that are written are frequently prepared in a form situable for publication. That is, they contain all the information that can be squeezed into the allotted space. If such a report is read from the platform it is practically unintelligible. The listeners learn little or nothing from it, and it will be regarded as a failure even though the subject matter is excellent.

To sum up, present only the most important facts; omit all details that are not essential; state the conclusions briefly and clearly, always remembering that the audience is anxious to learn about the topic that is being discussed.

Introducing

Dr. Albert Edward Oxford, Lecturer in Biochemistry, London School of Hygiene, University of London; Rockefeller Foundation Fellow, University of Wisconsin.

Dr. Oxford received his undergraduate and graduate training at the University of Manchester, England, where he received his doctorate in 1927. His work there was concentrated upon pure organic chemistry, his thesis being based on work on the constitution of strychnine under Dr. Robert Robinson.

He then received an appointment as demonstrator in biochemistry at the London School of Hygiene, becoming lecturer there in 1937. About this time last year he arrived in the United States to conduct research at the University of Wisconsin under a Rockefeller fellowship, work to which he will return upon completion of his stay at Woods Hole.

While at the University of London, Dr. Oxford's research work was carried out under the direction of Dr. Raistrick, whose field is the biochemistry of molds. They studied particularly such questions as the metabolism of sugar by molds, the conditions causing maximum absorption, and the products that are formed.

At the University of Wisconsin, Dr. Oxford's work was carried out on growth factors of bacteria, particularly the anaerobic bacterium, *Clostridium acetobutylicum*. Dr. W. H. Peterson supervised this work.

During the present summer Dr. Oxford is working on a problem related to his work in London—the rôle of sulfur compounds in the metabolism of seaweeds, a subject which has hitherto been comparatively neglected.

Dr. Oxford is accompanied in his trip to America by his wife, Dagny, who is also a scientist. A bacteriologist, she worked at the University of Wisconsin during the past winter on the actinomycetes of Lake Mendota.

ITEMS OF INTEREST

DR. A. K. PARPART, assistant professor of physiology at Princeton University, has been appointed director of the physiology course at the Marine Biological Laboratory for 1941, succeeding Dr. Laurence Irving.

DR. ROBERT K. BURNS, associate professor of anatomy at the University of Rochester has been appointed research associate at the Carnegie Institution of Baltimore, replacing Dr. Warren Lewis.

The REV. CHARLES A. BERGER, of the department of biology at Woodstock College, Md., has become head of the department of biology at Fordham University. Dr. Berger worked at Woods Hole in 1938.

DR. ELIZABETH BROGDON FRANSEEN, of the University of Wisconsin, and Miss Jytte Muus, who has the degree of Mag. Sci. at the University of Copenhagen, have been appointed assistant professors of physiology at Mt. Holyoke College.

DR. FREDERICK COPELAND, who received his Ph.D. at Harvard University this June, has been appointed instructor in biology at Trinity College.

MR. GUY M. EVERETT has been appointed instructor in the department of physiology and physiological chemistry in the Baltimore College of Dental Surgery, University of Maryland. Mr. Everett was a member of the physiology class at Woods Hole this summer.

MESSRS. JAMES FOULKS, HOWARD L. HAMILTON and RAY WATTERSON, graduate students in biology at the University of Rochester, will study at the Johns Hopkins University this fall to continue their work with Professor B. H. Willier.

New members of the staff of the Woods Hole Oceanographic Institution include Dr. Maurice Ewing, associate in submarine geology, and Dr. Bostwick H. Ketchum, associate in marine biology.

At the weekly staff meeting of the Woods Hole Oceanographic Institution on Thursday, Dr. G. L. Clarke spoke on "Present Progress and Future Plans in the Study of Georges Bank."

The *Atlantis* sailed Tuesday for a ten-day cruise along the northern edge of the Gulf Stream. Professor A. F. Spilhaus was on board to test several instruments which he has recently designed.

MRS. VIRGINIA WALKER SMITH is leaving the Oceanographic Institution at the end of the summer. She will live in Providence, R. I.

Among persons arriving in Woods Hole recently were: Dr. and Mrs. F. H. Swett, Dr. and Mrs. W. F. Diller, Dr. and Mrs. Hugh H. Darby, Drs. W. R. Coe, Selig Hecht, Richard G. Abell, G. L. Kreezer, Margaret Hotchkiss, Madeline E. Pierce and Miss Margaret Erlanger.

DR. AND MRS. H. B. GOODRICH have recently left for a vacation trip to Maine.

DR. ROBERT W. MACKNIGHT left Woods Hole this week to spend a few days at the Mountain Lake Biological Station. He will return before the Genetics Society meeting.

DR. ELIOT R. CLARK returned yesterday from a trip to Schenectady, New York, where he spoke on the radio on "Studies in Silicosis" Thursday night under the auspices of the General Electric Company; the broadcast was also carried on a short wave program. Mrs. Clark accompanied him.

The following members of the National Academy of Sciences of the United States have been working at the Marine Biological Laboratory this summer: C. E. McClung, University of Pennsylvania; G. N. Calkins, Columbia University; G. H. Parker, Harvard University; L. L. Woodruff, Yale University; F. R. Lillie, University of Chicago; T. H. Morgan, California Institute of Technology; M. H. Jacobs, University of Pennsylvania; E. F. DuBois, Cornell University; W. J. V. Osterhout, Rockefeller Institute; E. N. Harvey, Princeton University.

DR. AND MRS. NORRIS JONES of Swarthmore College, who have worked at Woods Hole in past years, are spending the summer at the U. S. Fisheries Station at Beaufort, N. C. Dr. N. J. Berrill, associate professor of biology at McGill University, and Mrs. Berrill were at the Station during July. Dr. Willard G. Van Name, associate curator at the American Museum of Natural History is also there.

At the conclusion of the summer meeting of the Genetics Society, a conference will be held by geneticists interested in the gene problem. The purposes of the conference are:

(1) To bring together for informal discussion a group of workers actively interested in the gene problem in its broadest sense. (2) To facilitate the consideration and discussion of unpublished material and thus to help to speed up the tempo of the work. (3) To evolve plans for coordinated work on gene problems.

ITEMS OF INTEREST

CHORAL CLUB CONCERT

The Thirteenth Annual Concert of the Woods Hole Choral Club will be presented Monday evening, August 26, at 8:30 P. M. in the Woods Hole Community Hall.

The Choral Club, which is composed in large part of persons connected with the Marine Biological Laboratory, has been preparing a carefully selected program of secular and religious music at the weekly rehearsals throughout the summer. Its director, Professor Ivan T. Gorokhoff, who has led the Club since its organization in 1926, is Director of Choral Music at Smith College, and his daughter, Miss Galina Gorokhoff, will be accompanist. Miss Edith Mitchell, daughter of Professor Phillip I. Mitchell, will sing a solo in the composition, "The Nightingale," by Tschaikowsky. The remainder of the program appears on page 56 of THE COLLECTING NET for this year. Thirty members make up the Choral Club, whose president is Dr. Eliot R. Clark and whose Secretary-Treasurer is Dr. Charles Packard.

The Music Committee of the M. B. L. Club has postponed its Monday evening phonograph record concert until 9:30 p. m. in order to avoid the conflict with the Choral Club Concert. Tickets, which cost 25c and 50c, may be purchased at the door or from members of the Club.

M. B. L. CLUB NOTES

The third rounds of the ping-pong tournament are to be played off by today. There were sixteen entrants for the men's singles, sixteen for the women's singles, and ten couples for the mixed doubles.

A highly successful bridge party was held last Friday at the clubhouse. Seven tables were in play, and refreshments and flowers were provided by the committee. Tallies decorated with algae provided a distinctive note. Prizes were awarded.

Folk dancing was conducted at the clubhouse Wednesday night under the direction of Fred Stone and Jasper P. Trinkaus in the absence of Dr. MacKnight.

Letter to the Editor

To the Editor:

I promised you a note long ago! Frances and I (and son, Jerry) have been at Friday Harbor since July 25. I am making a comparative study of the reproductive systems in the sea-cucumber with special reference to the origin of germ cells. We will be at the Hopkins Marine Lab for the first semester of next year (leave of absence). [On the way west we visited Stone Laboratory, Douglas Lake Laboratory, Lakeside Laboratory (Iowa) on Lake Okoboji, and Wyoming Science Camp (Centennial).] A 3-day trip of dredging (aboard the Catalyst) has provided important material for work here. Shore collecting is an exciting experience for the marine biologist—28" cucumbers, 4 foot jellyfish, 26" starfish!

FRANK KILLE

An opening, for the first semester only, is available in physiology in a southern university. The position involves teaching a course in the physiology of exercise. Candidates may submit a statement of qualifications to "P. N." % THE COLLECTING NET.

The Yorktown Laboratory of the United States Bureau of Fisheries on the York River, Virginia, has been closed and turned over to the newly organized Department of Aquatic Biology of William and Mary College, Williamsburg, Virginia. During the last five years the Bureau of Fisheries has conducted a special investigation at the laboratory on the effect of pulpmill waste on oysters. Dr. Walter A. Chipman, Jr., in charge of the laboratory, has been transferred to the U. S. B. F. station at Milford, Connecticut.

The Desert Laboratory at Tucson, Arizona, has been turned over by the Carnegie Institution of Washington, D. C., to the U. S. Forest Service. The Desert Laboratory was concerned with the study of arid and semi-arid regions which comprise almost a fourth of the area of the continental United States.

At the Detroit meeting of the American Chemical Society in September, the Division of Biological Chemistry will hold symposia on the proteins. Subjects tentatively chosen for discussion are: Aspects of Intermediary Protein Metabolism and Aspects of Sulfur and Protein Metabolism. The usual program on vitamins and nutrition will be held jointly with the Divisions of Agricultural and Food Chemistry and Medicinal Chemistry.

M. B. L. TENNIS CLUB

The finals of the M. B. L. Tennis Club Tournaments were held on the Mess Court yesterday at 2:30. The finalists were T. K. Ruebush who won from Stunkard 6-3, 2-6, 6-4 in the semi-finals, and R. Rugh who won from Williams by a default. A cup was presented to the winner by the retiring club president, Dr. Krahl.

The annual meeting of the M. B. L. Tennis Club was held on August 14. Officers elected were: Dr. D. E. Lancefield, president; Dr. W. R. Duryee, vice-president; Dr. T. K. Ruebush, secretary-treasurer.

DATES OF LEAVING OF INVESTIGATORS

Armstrong, C.....Aug. 22	Evans, D.....Aug. 15
Baker, R. F.....Aug. 16	Hiestand, W. A...Aug. 14
Botsford, E. F.....Aug. 16	Hunninen, A. V...Aug. 14
Buchsbaum, R.....Aug. 17	Korr, I.....Aug. 24
Butler, P.....Aug. 21	Menkin, V.....Aug. 23
Cass, R. E.....Aug. 21	Molter, J.....Aug. 21
Clement, A. C.....Aug. 21	Moser, F.....Aug. 23
Curtis, H.....Aug. 16	Summers, F. M...Aug. 16
Cobb, S.....Aug. 21	

THE ANNUAL MEETING OF THE WOODS HOLE OCEANOGRAPHIC INSTITUTION

C. O'D. ISELIN, *Director*

The Eleventh Annual Meeting of the Board of Trustees of the Woods Hole Oceanographic Institution was held on Thursday, August 15th. Twelve members were present including the President, Dr. Henry B. Bigelow. Besides the ordinary routine business, the Trustees voted to accept the *Anton Dohrn*, a gift from the Carnegie Institution of Washington. This 70 foot power boat was formerly used at the Tortugas Laboratory in Florida and will be converted during the coming winter for work in the coastal waters off New England.

In addition, the Trustees discussed the rôle of modern oceanography in the movement towards increased national defense. It was agreed that the complete facilities of the Institution should be offered to the National Defense Research Committee. Dr. Frank B. Jewett, a member of this committee and also a Trustee of the Woods Hole Oceanographic Institution, explained how a closer cooperation between oceanographers and naval research could be achieved. While it still remains to be decided just which problems will be attacked first, it is clear that Woods Hole will soon become a headquarters for investigations of importance to the national defense and only rather remotely connected with oceanography in its ordinary sense.

The retiring class of trustees was reappointed. These included Henry B. Bigelow, William Bowie, A. G. Huntsman, Alfred C. Redfield, Henry L. Shattuck, and T. Wayland Vaughan. Dr. Vannevar Bush was elected a member of the corporation.

INVERTEBRATE CLASS NOTES

Field trips and more field trips! Three this week to be exact. Monday we went to Lagoon Pond Bridge and spent an enjoyable day digging for worms and collecting scallops with their fascinating blue eyes (first time we had seen them alive.) Dr. Mattox forgot his invertebrate affiliations for a time as he attacked a conger eel with a penknife. An exciting time was had by all, but the eel escaped with minor injuries.

An incident worth noting here happened on our return. One member of our class was walking home on Main Street in her typical field trip attire. As she neared a couple standing on the corner, the woman nudged the gentleman and said in a fine stage whisper, "My God! Look at that!" We admit we may look like sights when we return from a trip, but we try to remedy the situation in short order.

On Wednesday we had a grand long ride to Cuttyhunk, followed by exciting adventures while collecting. Members of Team One and Dr. Lucas found themselves caught in quicksand. A half hour was spent struggling to get free and many specimens and jars were lost from the ark.

The third trip was on Friday to Hadley Harbor. Here Dr. Rankin lost his reputation for being a slave driver for he did not make his team struggle through the mud flats—but Dr. Crowell did. Over 100 species of animals were collected by each team and, upon returning, we exhibited these in the lobby of the main building.

During the little time we spent at the lab this week we studied molluscs. Dr. Matthews introduced us to this phylum Tuesday morning with an excellent lecture and we have been struggling with Busycon, Pecten and many others ever since. On Thursday we started the classic race between Busycon and Pecten, in which Busycon slowly and relentlessly pursues the scallop, planning to devour him. Next morning there appeared three empty scallop shells in the aquarium, each appropriately labeled "In-Digestion", "Out to Lunch" and "Final Fatal Fate."

Saturday and Sunday we kept busy making kymograph records of the effect of several chemicals on the heartbeat of Venus (the clam). We ended up studying the effect of alcohol and nicotine with such startling results that several students swore off smoking and drinking on the spot.

Oh yes! There was a baseball game Saturday evening, wasn't there? Too bad it became dark before we had a chance to show the crew what the "Invertebrates" really can do. But we're looking forward to another battle. —*Grace Coe*

THE FINDING OF A RARE STARFISH

GEORGE M. GRAY

Curator Emeritus, Museum of the Marine Biological Laboratory

On August 7 of this year some collectors of the Supply Department went on a digging trip to Naushon Island or vicinity for worms to be used in the Invertebrate class.

I met them at their boat on their return, and the collector in charge handed me a pail, at the same time remarking, "Something for you." On looking into the pail I was very much surprised to see a Brittle Starfish which practically covered the whole bottom of the pail. I took it to the

Laboratory and placed it in a glass dish, giving it clean sea water. Unfortunately in making the transfer a part of one arm was broken off.

This starfish was quite active and it was wonderful the way it could glide about the dish. On gently touching an arm, it would haul up that arm very quickly. It was very sensitive wherever touched. The general color of the animal was gray or grayish brown, darker on the dorsal surface of the arms.

The disk, or central body part, was pentagonal in shape. It might properly be called a circular pentagon. The arms are very long and slender out of all proportion to the disk, the latter being about 13 mm. across. The arms at the base are only about 2 mm. wide and reach out from the disk a distance of 125 mm. (5 inches) to a fine point or to thin air. Some specimens have been taken having arms about 6 inches long.

Our specimen had the appearance of having had a disastrous argument, for four of the arms, a half or third of the way from the disk, were of the gray or brown color. From that point they changed abruptly to white and continued white to the very tips, with every indication that these white portions of the arms are regenerated parts. This is very likely true as this starfish burrows in the mud but leaves an arm or two arms protruding above the surface which sometimes is eaten by fish or other animals.

This starfish is mentioned by Verrill in his Vineyard Sound Report as the *Amphiaplus abdita* (Verr.), taken in Long Island Sound near New Haven, and at Thimble Islands, (3-6 fathoms, mud.) Rare. Dr. Hubert L. Clark does not mention it as occurring in the Woods Hole Region. Dr. Sumner, in his Biological Survey, mentions three or four places where an arm has been taken. *Fish Hawk* №7776, Repetition made Aug. 6, 1907—*Phalarope* stations 163 and 167, Ram Island, Aug. 1907, collected by Gray. So far as I know, this star has not been scientifically observed since, and is considered rare for this region.

THE FEULGEN AND LIGHT GREEN STAINING TECHNIQUE

Dr. R. Ruggles Gates
Professor of Botany, University of London

The Feulgen and Light Green Stain is one of those advances in cytological technique which enables marked progress to be made with research in a particular field. A specific differential stain for chromatin and nucleolus has long been desired and the need became more acute when it was discovered that the nucleoli took their origin at a particular locus on the satellited chromosomes. By the use of this method, for instance, one may trace in prophase each satellited chromosome with the terminal globular satellite attached by a Feulgen-positive thread to the body of the chromosome. The connecting thread is extremely tenuous and in the case of smaller chromosomes it is frequently below the limits of visibility. With larger chromosomes it can sometimes be seen as a definite spiral, red in color like the satellite and the body of the chromosome.

By the present treatment, the nucleolus can be seen as a green globule underlying or overlying the red thread. The point of origin and attachment of the nucleolus is, generally at least, the tip of the chromosome proper, where the thread, which appears to be a spiral of a lower order than the chromonemata of the chromosome, emerges. The contrasting stain not only makes possible the determination of the exact point of origin of the nucleolus in relation to the chromosome, but it enables this body to be picked out in early telophase as a green pin-point in contrast to the surrounding red chromatin. Indeed, in the root-tip cells of the Crocus and certain other plants such a green granule can be seen to arise in telophase from each of the two chromonemata of which the telophase chromosome is composed. As these two chromonemata are close together the two green granules, when they have grown slightly, fuse by contact into one body which then grows into the fully formed nucleolus.

In anaphase stages the red body of the chromosome is frequently seen to be surrounded by a green-staining sheath or matrix. This appears to be sloughed off in telophase stages, and in several genera of plants an evanescent condition is seen in which this material is scattered through the nucleus in the form of small irregular green masses. This material is apparently used up in the growth of the nucleolus.

The essentials of the method are that the material should first be fixed with Navashin or Levitsky. The chromatin is then stained with Feulgen and the preparations (sections or smears) are then brought down to distilled water. The material is left in 5% sodium carbonate for at least an hour. This mordanting is followed by a thorough washing in water and then a stain for about ten minutes in light green solution in alcohol. The preparations are differentiated in alcoholic sodium carbonate solution and then passed through the alcohols into xylol and balsam. Neither cytoplasm nor karyolymph are stained by

this method, so the preparations show the maximum of clarity and give a brilliant and sharply marked contrast.

In plants, where various polyploid conditions are of frequent occurrence and six or more chromosomes with satellites or secondary constrictions can be found in many species, the study of nucleoli becomes of great value in tracing nuclear phylogeny. The method should be equally applicable to animal species and should be especially useful in tracing the relation of nucleoli to the chromosomes and chromocenters in salivary gland nuclei. It has already been applied in my Laboratory to a comparative karylogical study of the species in quite a wide range of plant genera.

Details of the technique are found in the following papers: Semmens, C. S. and P. N. Bhaduri, 1939, "A technic for differential staining of nucleoli and chromosomes," *Stain Tech., 14*:1-5. Bhaduri, P. N., 1938. "Root-tip smear technique and the differential staining of the nucleolus," *J. Roy. Micr., Soc., 58*:120-124.

Times of mordanting, strengths of solution and the period of hydrolysis for Feulgen staining require slight alteration from genus to genus, but the best methods are soon determined by a little experimentation. It may be pointed out here that the chemical nature of the Feulgen reaction with nucleic acid is still uncertain. It has been supposed to be due to the aldehyde radical in the aldose sugar group, but we have recently shown (Semmens, C. S., *Nature, 146*:130) that some of the purine bases, such as adenine and guanine, give exactly the same red coloration.

THE OFFICIAL MEETINGS OF THE MARINE BIOLOGICAL LABORATORY

(Continued from page 165)

The twelve who were elected this year are: Dr. H. G. Albaum, Brooklyn College; Dr. C. A. Angerer, Ohio State University; Dr. F. A. Brown, Northwestern University; Dr. Leon Churney, University of Pennsylvania; Dr. G. Failla, Memorial Hospital, New York; the Rev. J. A. Frisch, Canisius College; Dr. F. A. Hartman, Ohio State University; Dr. Marie Hinrichs, Illinois Southern State Teachers' College; Columbus O'D. Iselin, Harvard University, Rockefeller Institute; Mrs. Rebecca Lancefield, Rockefeller Institute; Dr. Floyd Moser, University of Pennsylvania; and Dr. Eric Wald, Harvard University.

Candidates for election as Trustees are chosen by a committee made up of both Trustees and Corporation members. The list is then submitted to the Corporation for consideration. Not infrequently, other candidates are proposed at the time of the meeting, in which case election is by ballot. The following Trustees were chosen this year: Dugald E. S. Brown, New York University; H. B. Bigelow, Harvard University; R. Chambers, New York University; W. E. Garrey, Vanderbilt University; S. O. Mast, Johns Hopkins University; A. P. Mathews, University of Cincinnati; C. W. Metz, University of Pennsylvania; H. H. Plough, Amherst College; W. R. Taylor, University of Michigan.

Drs. Caswell Grave, R. G. Harrison and C. E. McClung, Trustees who have reached the age of seventy years, were elected Trustees Emeriti.

At the Corporation meeting memorials to the following distinguished members were read:

Dr. H. McE. Knower, for many years Librarian of the Laboratory (read by R. G. Harrison).

Dr. M. M. Metcalf, Trustee since 1897 (read by R. A. Budington).

Dr. Charles Zeleny, well remembered by the older investigators here (prepared by F. Payne).

Capt. John Veeder, for fifty years connected with the Laboratory, in charge of the boats until his retirement (read by F. R. Lillie).

The chief topic of discussion at both meetings was the new addition to the Library, now actually under construction. The necessary funds for its erection have been given by the Rockefeller Foundation which some years ago generously aided in the construction of the Brick Building. The new structure, 59 × 51 feet in outside dimensions, will have the same height and architectural style as the present building. The four tiers of stacks, corresponding to the present stack floors, will provide space for almost twice as many volumes as we have on hand at present. On all floors reading tables will be provided. The crowding in the reading room should therefore be done away with. On the upper two floors there will be a generous amount of space between the tables and the stacks, so that readers should not be disturbed by those who are moving about in the stacks. A part of the basement will be used for the sterilization of glassware, distillation of water, and other services requiring steam. Two dark rooms are also provided.

This addition to the library comes none too soon. Already the space for books has been exhausted, and the reprints have been crowded uncomfortably. By next summer these troubles will be over and we shall have ample accommodations for books and for investigators who wish to read. For this we are greatly indebted to the Rockefeller Foundation.

THE BIOLOGICAL FIELD STATIONS OF ITALY AND MONACO

Homer A. Jack
Cornell University

On August 10, 1897 Anton Dohrn gave a talk at Woods Hole. He had been requested by friends to tell some of his experiences in establishing the Zoological Station of Naples about twenty-five years previously. He was quoted as describing himself, while a young privat-docent of the University of Jena, as one "with rather more money than he well knew how to spend; with more time than he knew how to use; but with a strong desire to do something of lasting benefit for science." Perhaps the most dramatic experience he recounted to the group of students at Woods Hole is described in the *American Naturalist* (31:962-63) as follows:

> An architect was engaged and the [zoological] station and its aquarial adjunct seemed on the straight road to accomplishment. But this bright prospect soon darkened. The architect, like others of his class, had his own ideas of what a zoological station should be like, although up to the moment of his engagement he had never seen such an establishment, nor had he ever dreamed of one. At last he returned with his plans, Dr. Dohrn glanced at them, saw that they were totally unfitted for a zoological station and pushed them aside on the table, whistling, as he did so, the closing phrases of Beethoven's Ninth Symphony, a reminiscence of a concert of the evening before. The architect rushed from the room in rage, and shortly his representative called upon Dr. Dohrn to make arrangements for a duel.

Dr. Dohrn was spared from this encounter, but only after the architect received a thousand francs for his unusable sketches.

What some believe to be Dohrn's greatest contribution to the biological station idea was the plan of combining a public aquarium with a research laboratory, using the admission fees derived from the former to support the laboratory. The idea entered Dohrn's mind as he rode in the mail coach from Apolda to Jena in January 1870. "It came to me," Dohrn wrote, "like a revelation and a limitless horizon of attainable results appeared to my feverishly working fancy." With this scheme firmly in mind and with experience in establishing a temporary biological station in Sicily with N. N. Mikluho-Maclay, Dohrn began negotiations to establish a zoological station at Naples. The Franco-Prussian War interrupted these arrangements and he was forced to return to Germany. When he came back to Naples in 1871, Dohrn had already presented his plan to the British Association for the Advancement of Science and succeeded in having appointed a committee "for the foundation of zoological stations in different parts of the globe," of which he was made secretary. After prolonged negotiations with the City of Naples, Dohrn was able to secure a site on the Bay of Naples and construction of the aquarium and laboratory began. Two crises, however, threatened to truncate his ambitions. One day the Naples authorities ordered construction on the station to cease because the height agreed to by Dohrn's contract with the city had been exceeded by a few inches. At the same time Dohrn received reports from Berlin that the Academy of Science and consequently the German government were unfavorably disposed to his project and would not support it because his scientific abilities to direct such an institution were unproven. With characteristic energy, Dohrn disarmed the opposition both in Berlin and Naples and in May 1873 was able to write, ". . . dangerous as the aspect of all these critical situations seemed, nevertheless it [the station] has always escaped, and now finds itself in better circumstances than it would have been without them." Indeed, Dohrn soon received word that a group of English scientists headed by Professor Huxley would contribute £1,000 to the station and not long afterwards the German government consented to contribute annually a sum of 30,000 marks. When the station was finally opened in 1874, those at the ceremonies were confronted with a large, four-story building costing 400,000 francs.

From the moment it began, the station at Naples has performed a useful function. While the station is active today, some believe that its period of greatest activity ended with the World War. In the years 1873-1909 almost two thousand investigators occupied its research tables. The largest number were German and Italian, but the list of Americans who occupied tables at Naples is impressive. The year 1893 found G. H. Parker, G. H. Fairchild, and W. M. Wheeler at Naples and the following year the Americans included T. H. Morgan, H. Osborn, C. M. Child, and W. E. Ritter. In 1900 the American investigators at Naples were V. Heiser, B. M. Duggar, T. H. Morgan, C. Mensch, C. F. Hottes, T. B. Sumner,

and W. T. Parker. Up to 1914, as many as five tables were supported by American institutions. Then came the war. Dr. Reinhard Dohrn, who succeeded his father as director, was forced to leave Italy because he was a German citizen. The administration of the station was taken over by a commision appointed by the Italian government and the laboratories were nominally kept open, although work was practically at a standstill. Even after the war was over, several years elapsed before the station's legal position was clear. A royal decree in 1920 attempted to restore the station to Dr. Dohrn, but this was fought in the courts. Finally in 1924 the station was chartered as a special form of an autonomous public corporation with Dr. Dohrn as director. During the past sixteen years Dr. Dohrn has tried hard to build up the institution to its former position. In 1938 research tables were sponsored by 37 governments or institutions and its budget was 900,000 lire (about $47,340). This income is still largely derived from admission fees to the aquarium which about 40,000 persons visit annually.

The Zoological Station of Naples today is housed in the original, four-story building constructed in 1872-74 and in a section added in 1903. The ground floor of these buildings contains the public aquarium, a public museum, and a department for the collection, storage, and sale of biological specimens. The upper floors contain 58 individual research laboratories, four large research laboratories, apparatus rooms, darkrooms, workshops, stockrooms, offices, library, kitchen, and dining room. The library in 1938 contained about 17,000 volumes of bound periodicals, 9,000 bound books, and 46,446 reprints. While the station has a kitchen and dining room, only the noon meal and tea are served to investigators who, in 1939, could obtain board and lodging at nearby hotels for 800 lire a month (about $42.08). The station is open throughout the year to qualified biologists from all countries who desire to pursue any kind of investigation, although in recent years the trend has been in experimental physiology. Investigators residing in countries with organizations or institutions sponsoring a table at Naples (cost: $500 a year) should apply for admission directly through the sponsoring institution. For investigators in the United States or the British Empire, these would be the National Research Council, the Rockefeller Foundation, the British Association for the Advancement of Science, Oxford University, and Cambridge University. Special arrangements are made to accommodate those investigators not connected with institutions or nations sponsoring tables at Naples. Research work originating at Naples is often published in *Fauna e Flora del Golfo di Napoli* and *Pubblicazioni della Stazione Zoologica*, the latter being a continuation of *Mitheilungen aus der Zoologischen Station au Neapel*.

In addition to the Zoological Station of Naples, there are eight other biological stations in Italy. The important ones are located at Taranto in southern Italy, at Rovigno d'Istria on the Adriatic, and at Col d'Olen in the Italian Alps. Small marine stations are located at Messina in Sicily (*Istituto Centrale di Biologia Marina di Messina*), at Cagliari in Sardinia (*Stazione Biologica*), and at San Guiliano near Genoa (*Laboratorio di Biologia Marina per Il Mare Ligure*)—the latter under the able direction of Dr. Alessandro Brian. Italian fresh-water stations are located on Lake Trasimeno near Perugia (*R. Stazione Idrobiologia de Lago Trasimeno*) and on Lake Maggiore near Pallanza (*Istituto Italiano di Idrobiologia Dott. Marco de Marchi*). Near Italy, although a nominally independent principality surrounded by France, lies Monaco where a famous oceanographic museum and laboratory is located.

The Royal Institute of Marine Biology of Taranto (*Istituto Demaniale di Biologia Marina di Taranto*) is located in that southern Italian city. It was founded in 1915 by Professor Attilio Cerruti, the present director, for research in general marine biology and the control of oyster and mussel culture in the waters surrounding Taranto. Since 1931 it has been housed in a new, well-equipped building and within the past year it has been taken over by the Italian National Research Council. Investigators from all countries are invited to make the station their scientific headquarters for biological research on the flora and fauna of southeastern Italy. There are no laboratory fees and the station is open throughout the year. As at most Italian stations, this institution does not furnish living accommodations to investigators. Board and lodging may be obtained, however, at nearby hotels for about 600 lire a month (about $31.56).

The Italian-German Institute of Marine Biology at Rovigno d'Istria (*Istituto Italo-Germanico di Biologia Marina di Rovigno d'Istria*) is the second largest biological station in Italy. It is the scientific progenitor of the Rome-Berlin axis, having been jointly sponsored by Italy (R. Comitato Talassografico) and Germany (Kaiser Wilhelm Gesellschaft) since 1931. There is justification for this international cooperation, because originally the institution was founded by the Berlin Aquarium on Austrian territory, although the region and the station was taken over by Italy after the World War. Today the joint sponsorship extends both to the budget (300,000 lire annually) and to the administration, the directors being Professor M. Sella of Italy and Professor A. Steuer representing Germany.

The Italian-German station is located at the small town of Rovigno, about 75 miles south of Trieste on the Adriatic Sea. It is housed in a four-story stone building which contains a public aquarium, a department for the collection and sale of scientific specimens, offices, and research laboratories. The large library of the station is housed in a separate building which is located in the botanical garden that surrounds the institution. In the harbor the station has two small motorboats and a new, specially-constructed 34-foot vessel for use by staff and visiting investigators. The latter are invited to work at Rovigno and ten laboratory places are available for their use. There are no laboratory fees and the station is open throughout the year. The institution issues two series of publications which contain the results of research often carried out at Rovigno. These are the *Notizen* (or Note) of the institution and the larger serial, *Thalassia*. Other printed material issued includes announcements of research facilities in German and Italian and a price-list of marine animals and plants which may be purchased from this institution.

The only mountain biological station in Italy is the Angelo Mosso Scientific Institute on Monte Rosa (*Istituto Scientifico Angelo Mosso sul Monte Rosa*). The three-story main laboratory building is located on Col d'Olen at an altitude of 9,520 feet in the Pennine Alps. There is also a high altitude annex (*Capanna Regina Margherita*) located at an altitude of 14,944 feet on Punta Gnifetti on Monte Rosa. Both the main laboratory and the annex are operated by the Royal University of Turin under the direction of Professor Amedeo Herlitzka. During July and August independent investigators are invited to work in the laboratories. These are adequate laboratory facilities for ten persons and board and lodging may be obtained at the institution for 150 lire a week (about $7.89). Between 1907—the year the building at Col d'Olen was opened by Professor Angelo Mosso—and 1937, three hundred and twenty-seven Italian investigators and ninety workers from other countries have taken advantage of these research facilities.

Monaco is the site of the internationally-famous casino. Equally renowned to scientists for work in oceanographical exploration, research, and education is the Oceanographic Museum and Aquarium of Monaco (*Musée Océanographique et Aquarium de Monaco*). Founded and endowed by Albert I, Prince of Monaco, in 1899, the institution was originally planned to hold the collections made by the Prince on his numerous oceanographical expeditions. The scope of the institution was soon widened, however, and now includes a public museum showing many phases of oceanography, a public aquarium, a research division, and research accommodations for visiting investigators. In order to provide better working facilities for investigators, an addition was constructed in 1938. Research workers are invited to use these facilities any time between October first and July fifteenth, and the only charges are 140 francs a month (about $3.72) for service.

While Prince Albert endowed the establishment at Monaco heavily, the decline of the French franc during the past decade has made the station dependent upon the admission fees to the museum and aquarium for its income.. This in 1938 was 1,300,000 francs (about $34,450). The scientific work of the station is under the direction of Dr. Jules Richard, who accompanied the expeditions of Prince Albert as early as 1888. The results of the Prince's expeditions and other research work undertaken at Monaco has been issued in two series of publications: *Bulletin de l'Institut Océanographique* and *Les Résultats des Compagnes Scientifiques de S. A. S. Prince Albert Ier de Monaco.*

THE MOLECULAR ORGANIZATION OF PROTOPLASMIC CONSTITUENTS

Dr. Francis O. Schmitt

Associate Professor of Zoology, Washington University, St. Louis

(*Continued from Last Issue*)

Lamellar Structures

The negative form birefringence of the limiting envelope of the cell, the nucleus, the nontractile vacuole and other vacuoles, indicates that these membranes are constructed of submicroscopic protein leaflets oriented in planes parallel to the surface of the envelope.

W. J. Schmidt recently recorded interesting observations on the contractile vacuole of protozoa as viewed in polarized light. The birefringence of the "membrane" waxes and wanes with the cyclic filling and contraction of the vacuole and he has interpreted these phenomena in terms of a reversible dispersion and close packing of the protein leaflets, depending on the local accumulation of water and on the hydrostatic pressure exerted on the interface.

Except in a few cases, the nuclear membrane contains little or no oriented lipide material. The plasma membrane, on the other hand, appears quite typically to contain lipide molecules oriented with long axes perpendicular to the surface of the

envelope. One pictures the lipide phases occurring as characteristic double molecular layers but no crucial evidence is available as to whether all of the lipide is at the surface of the envelope or is intercalated between protein leaflets, as in more complex lipido-protein systems. In the case of the red cell envelope it has been possible to estimate the thickness of the protein and the "lipide" (low refractive index, organic soluble) components by means of the analytical leptoscope. After determining the thickness of the entire envelope, the preparation is extracted in organic solvents and the thickness of the residue determined. The latter value presumably represents protein and the difference in the two values gives the amount of "lipide". The values of lipide so obtained are considerably greater than would be expected from chemical analyses on stromata and it is not clear whether the discrepancy is due to inadequacy of the analytical chemical methods or to the presence of substances of unknown composition.

The leptoscopic data bring out a number of interesting facts about the cell membrane. It appears to be relatively stable in the presence of electrolyte but very unstable in their absence. The degree of this instability depends markedly on the pH. Moreover, the curve of envelope thickness versus pH is characteristic and reproducible for each species so far tried. These properties reflect the stability of the linkages between the lipide and protein components in the membrane and should be useful in providing a physical basis for the specificity of permeability as studied particularly by Dr. Jacobs.

The importance of the lipides in protoplasmic structures has long been recognized but it is only in recent years that quantitative information has been obtained concerning the configuration and orientation of the lipides. Perhaps the most complete information comes from studies of the most highly organized lipide-protein tissue system, the nerve myelin sheath. This appears to be composed of concentrically wrapped lipide-protein layers. The unit layer, which is 170-190 Å thick, contains one, or possibly two, very thin protein sheets intercalated between two double molecular layers of mixed lipides. This structure differs from that of lipide myelin forms chiefly in the presence of the protein layers which, in the nerve sheath, have a maximum thickness of about 25 Å. Considerable water is distributed about the polar interfaces and the specific structure is irreversibly destroyed when this water is removed as by drying.

To obtain further information about such structures diffraction data were obtained in our laboratory by Dr. Palmer and Dr. Bear on a variety of lipides as pure compounds and in mixtures, both dry and in aqueous emulsions, and on artificial lipide-protein mixtures. It was found that mixtures of lipides, as represented by brain extracts, separate out in several phases, each having characteristic identity periods. On the addition of water, however, a mixed-lipide phase is formed with a single identity period for the double molecular layers. A striking characteristic of such emulsions is the great amount of water which may be interposed between the double layers at the polar interfaces. Thus in a 25% emulsion of brain lipide the identity period is 150 Å, of which about 85 Å is due to water between the layers. The forces which cause the lipide layers to remain separated by such long distances are doubtless similar to those which operate in tactoid systems such as tobacco mosaic virus protein and bentonite sols, where the separation may be even much greater. According to Langmuir, the separation is due to a repulsive force which depends on the penetration of water, and is proportional to the osmotic pressure according to the Debye-Hückel theory.

If the lipide is emulsified in salt solutions the water penetration may be greatly reduced. A concentration of about 0.6 M KCl is required to prevent water penetration almost completely whereas only about 0.03 M $CaCl_2$ will produce the same effect. It is obvious from this that lipide systems in the protoplasm of marine forms cannot be highly solvated and dispersed since the salt concentration in such forms is approximately 0.6 M. This factor may be of importance also in determining the type of myelination possible in marine invertebrate nerves.

Even more striking in the flocculation of solvated lipides is the action of basic proteins. As Chargaff has shown, when histone or protamine is added to a dilute cephalin emulsion, an insoluble cephalin-histone complex is formed. From diffraction patterns which we have made of such complexes it appears that monolayers of protein are intercalated between double layers of cephalin, the union being due to salt linkages between the basic groups of the protein and the negative phosphoric acid groups of the cephalin. Similar complexes have been obtained with globin. Indeed, Chargaff finds that cephalin will combine with the globin of hemoglobin, liberating the heme residue. It would seem that cephalin is a rather dangerous character to have wandering about free in protoplasm, particularly dangerous to any enzyme which might anchor its prosthetic groups by salt linkages with its terminal positive group.

Of considerable biological importance is the question of the molecular architecture of the protein leaflets in cellular membranes. It is known that these layers are very thin, possibly unimolec-

ular, in some instances. Polarized light studies show that their optic axes are normal to the planes of the surfaces and that within these planes there is no preferred orientation such as could give rise to intrinsic birefringence. If the leaflets are made of polypeptide chains the orientation of the chains must be random. A higher degree of order would obtain in the case of polypeptide fabrics as pictured by Wrinch, though, of course, the fabric need not have a cyclol structure. As a matter of taste and intuition, such fabrics appeal to me more than do randomly oriented polypeptide chains; but I know of no crucial evidence for or against their existence in cell membranes.

Physiologists traditionally think of cellular membranes as structures whose chief business is the direction of the molecular traffic into and out of the cell or nucleus. Determination of membrane ultrastructure would be valuable, therefore, chiefly in establishing a physical basis for permeability phenomena. But surely the surface envelope of the cell is important also in other ways, such as in determining the shape of the cell, the adhesion or non-adhesion of neighboring cells, in providing a physical substratum for strategically located desmoenzymes, and for other purposes not directly related to its function as a diffusion barrier. It was with the idea of finding structural bases for such phenomena that the analytical leptoscope was originally developed. Leptoscopic examination of the red cell envelope reveals a central region somewhat (ca. 50 Å) thicker than the peripheral region. This central region appears to be made of protein and to be responsible for the characteristic biconcave shape of the erythrocyte. This observation illustrates both the sensitivity of the leptoscopic method in revealing molecular discontinuities in cell membranes and the significance of such molecular discontinuities in determining the specific shape of free cells.

It has never seemed reasonable to me that specific structure in cells should be limited to linear arrays as in chromosomes. There are geometric and chemical reasons to suppose that specific structure in two-dimensional fabrics may be more stable than in fibers. While it may be difficult to get evidence of the molecular nature of such fabrics, it should be possible with the leptoscope to discover in cellular membranes any preferential distribution of groups, such as nucleic acid, which have higher refractive index or greater thickness than the surrounding fabric. In collaboration with Dr. Waugh, experiments along these lines are in progress.

Finally, I should like to emphasize the dynamic nature of protoplasmic structuration. The great importance of solvation processes has already been stressed. But what provides the stimulus for these processes and causes them to occur rapidly yet in orderly fashion? I think we must look to enzymes for the key to the solution. Potent enzymes are known which cause not only hydrolyses (destructuration through addition of water) but also syntheses (structuration through removal of water). One has only to think of the thrombin recently purified by Smith, which can clot a large quantity of fibrinogen in a second, or the enzyme recently described by Cori, which can convert glucose phosphate into high molecular weight glycogen in a few seconds, to realize the extreme efficiency and velocity of such enzyme actions. The phenomenon of blood clotting, in which a structureless sol is converted into a fibrous, highly structured clot through the action of enzymes, kinases, antikinases, and electrolytes, presents an interesting though incomplete analogy to the formation of structure, such as the mitotic mechanism, in protoplasm. Though after many years of careful study, the mechanism of blood clotting is still only very poorly understood, yet the theories may be of use in guiding an experimental attack on the mechanism of protoplasmic structuration, and experiments along these lines are in progress in our laboratory. It seems that the reversible structuration processes in cells must involve a series of enzyme reactions at least as complicated as those of blood clotting and that a solution of the problem will require the cooperation of biochemists, physical chemists, and cell physiologists.

The dynamic nature of structuration is clearly indicated also in the experiments of Schoenheimer and Rittenberg, in which isotopes were used as tracers. They find that not only the smaller organic molecules like the phospholipides, but also the large structural proteins are continually being broken down and resynthesized in the cell. To quote from their recent review: "The fact that the living organism in contrast to the dead material keeps constant the form of cells and organs as well as the chemical structure of the large molecules, has led many investigators to believe that the tissue enzymes, which show their destructive power during autolysis, lie dormant during life and are 'activated' only when their function is required. The results with isotopes make such a supposition unnecessary. The experiments indicate that all reactions, for which specific enzymes and substrates exist in the animal, are carried out continually." Only if he keeps constantly in mind this ceaseless building up and tearing down, this metastable alertness of the cell, can the physiologist or morphologist hope to gain an insight into the true meaning of structure in the living protoplasm.

(This article is based upon a lecture delivered at the Marine Biological Laboratory on August 9.)

THE COLLECTING NET

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THE AMAKUSA MARINE BIOLOGICAL LABORATORY

DR. HIROSHI OHSHIMA
Kyūsyū Imperial University
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Amakusa is the name of a group of large and small islands, more than 60 in number, situated south of Nagasaki, on the west side of Kyūsyū. The islands are famous for their lovely scenery together with the rebellion of persecuted Jesuits which occurred there about 300 years ago.

At the northwest corner of Simo-Zima, the largest island of the group, projects a small peninsula with a narrow neck. On this neck lies the town of Tomioka. There stands our marine laboratory on the south side of the peninsula, facing a picturesque inlet called Tomoë-Wan, which is encircled by a long slender beak of land, clad with pine trees.

The Amakusa Marine Biological Laboratory belongs to the Kyūsyū Imperial University of Hukuoka, and its director is Dr. Hiroshi Ohshima, Professor of Zoology of the said university. Pieces of land about 60,000 square metres altogether in area were donated by the local authorities to the university in 1927, and the laboratory was opened in the spring of 1928. Some more buildings were added later in 1938. Thus, now a wooden laboratory with 6 research rooms, a large working room for students, specimen-room, library and aquarium is at work, besides the pump-house, dormitory, official residence, etc. A 3-horsepower motor and (*Continued on page* 208)

ON DEPENDENT GROWTH AND FORM OF THE TESTES IN VARIOUS SPECIES OF DROSOPHILA

DR. CURT STERN
University of Rochester, Rochester, N. Y.

A powerful tool of the student of causal embryology in the analysis of differentiation has been the study of artificial mosaic organisms; transplantations within developing systems have led to the discovery of interaction of parts. The classical type of such interaction is represented by the term embryonic induction.

One of the geneticist's contributions to the elucidation of development consists in the presentation of genetic mosaics. A study of the influences of hereditarily different parts upon each other complements the study of the interaction between developmentally differentiated parts. Up to some years ago we had to wait for such mosaics to occur spontaneously. More recently, however, an experimental approach to such material became available when Caspari and Kühn, and Ephrussi and Beadle invented transplantation techniques applicable to such genetically accessible organisms as the meal moth Ephestia and the fruit fly Drosophila. It is well known how these investigators transplanted organ anlagen of one genetic constitution into larvae of another constitution; how they could distinguish dependent or independent differentiation of host and implant; and how they succeeded in recognizing and even isolating specific substances produced under the influence of some, and not of other, genetic constitutions. The

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SURF BREAKING OVER SEA WALL AT THE TIME OF THE HURRICANE TWO YEARS AGO

The residence of the Bureau of Fisheries is in the background. The top of the wall was submerged under two feet of water shortly after the photograph was taken. The top of the Homestead appears above the spray at the right.

genetic differences utilized in these experiments were mainly related to pigmentation. It seemed desirable to approach the problem from an angle where a *morphological* difference was involved. Had a case been found in which the genetic basis of such form diversity were known this study could lay full claim to be classified as physiological genetics. As no such material offered itself, form differences determined by the genetically unanalyzed variance between not hybridising species were used. Thus the problem became even more loosely connected to the field of genetics and resolved itself into a strict developmental analysis just as so much other work which uses the term gene at the beginning and then launches into embryological study.

The material for this work consists of the testes of Drosophila. Their shape varies greatly in different species, from slightly elongated ellipsoidal form to spirals of about 1 gyre, and to helices of a few to many turns. Larvae and young pupae of all species possess uncoiled gonads. Final shape is assumed during pupal metamorphosis. It was Dobzhansky (1931) who pointed out that a specific relation seemed to exist between the male duct system and the adult testis shape. The ducts are produced by the genital disc at the posterior end of the individual while the testes are located within the body cavity about one-third of the larval length anterior from the posterior end. Dobzhansky discovered in adult gynandromorphs of *Drosophila simulans* that the testes may be either spirals as in normal males or ellipsoidal bodies, similar to but larger than early pupal gonads. The helical testes had made normal connection with a vas efferens while the ellipsoidal testes due to the specific gynandromorphic condition had not succeeded in joining with a duct. Thus an "organizing" influence of the duct system upon testis form was suggested. Later, confirmation of these findings was obtained in intra- and inter-specific implantations of larval testes into male larvae of six more "spiral" species. As a consequence of the presence in such operated individuals of three gonads but only two ducts, one gonad frequently remains unattached. Such gonads whether of host or implant origin never assume spiral shape. Finally a slight extension of the conclusion reached by these observations was made possible when the internal organization of a male-sterile race of *Drosophila melanogaster*, "sex combless", was studied. Among various conditions the most interesting one consisted in the presence of one or both vasa efferentia which however had themselves remained closed due to absence of a vas deferens. In spite of this abnormal state the gonads if attached were coiled. This shows that the organizing influence of the duct system upon testis shape is dependent specifically on the vas efferens.

With these facts as a basis the following questions were asked: how is the difference in gonad shape conditioned between a species with adult uncoiled testes like *Drosophila pseudoobscura* and one with coiled testes as for example *Drosophila azteca?* What is the nature of the influence of the vas efferens? Do the two specific vasa differ in their organizing potency so that the various forms of gonads are only reflections of duct differences—or are the vasa of all species alike in their power to evocate coiling if only the specific constitution of the gonad is able to respond? In order to answer these questions transplantations of gonads between larvae of species with coiled and uncoiled testes were performed. The result seemed obvious even before the experiment was done. In most previous work in which processes of embryonic induction between organizing part of one species and affected part of another was tested it had been found that the organizers were alike in different species but that the reacting tissues were distinguished by their specific properties. Thus it seemed safe to expect coiled testes from the coiled *azteca* if joined to the vas of the uncoiled *pseudoobscura* and uncoiled testes from *pseudoobscura* even if attached to a vas from *azteca.*

The results, however, were the opposite ones. Whenever a testis of any species became attached to the vas of an "uncoiled species" the testis remained uncoiled; whenever a testis of any species became joined to the vas of a "coiled species" the testis assumed spiral shape. Here then the vasa are not just evocators of specific responses of the testes but are themselves different according to their constitution and true inductors of the final testis shape.

The very unexpectedness of these findings necessitated further anlysis. It became apparent that a striking difference exists between the classical cases of induction and the one followed in the Drosophila experiments. In the former, embryonic differentiation into specific tissues and organs is accomplished, in the latter shaping of an organ already differentiated. A young testis before it is attached to a duct forms a vesicle whose anterior

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end is filled with spermatogonial cells while its remaining main lumen contains later stages of germ cells—mostly spermatocytes and spermatids. A mature testis is distinguished from this early stage by a larger size and the possession of later germinal stages, i.e. spermatozoa in all stages of maturity. The development of spermatocytes to spermatozoa proceeds independent of attachment to a vas: "free" testes of adults may be filled with motile sperm. The influence of the vas then is restricted toward directing increase in size of the vesicle.

This leads to a discussion of the form-determining properties of the testis. Structurally, they reside in the membrane and not in the interior. No parts occur inside to which form-giving properties may be ascribed. On the other hand, the thin testis membrane alone is unable to maintain the form of the testis if deprived of its content. Various experiments, like pricking the membrane, squeezing out of germ cells, treatment with hypo- and hypertonic solutions, suggest that the testis sheath is a somewhat elastic membrane stretched under the influence of internal pressure. The shape of the testis seems the result of internal pressure exerted upon this form-determining sheath.

What change does this sheath undergo from the time before attachment to the vas where it delimits a small ellipsoidal vesicle to the stages afterwards when, in most species, it controls a large coiled form? The answer in general terms is: an unequally distributed increase in surface of the sheath. How is this increase accomplished? Two main alternatives suggest themselves. Either growth occurs over the whole surface of the testis sheath or it is restricted to a growth zone. Three separate lines of evidence point to the second alternative:

(1) A study of the sequence of age stages of the testes of coiled species can best be interpreted in such a way that each successive stage is regarded as consisting of two parts, one equal to that of the preceding stage and the other a terminal addition to it. Starting with an ellipsoidal body at the time of attachment to the vas each following coiled stage seems to be produced not by elongation and curving of the preceding whole but rather by its retention plus intercalation of a new curved section between the former region of attachment to the vas and the vas itself.

(2) A classical method for studying changes in growth and form consists of marking experiments and interpretation of shifts in the position of such markings. While vital staining of parts of growing testes has not been possible the following procedure served the purpose. Implants of testes into male larvae often result in normal attachment of two gonads to the two vasa with the third testis closely applied externally or even partially fused with one or both of the other two gonads. When this condition was found in operated individuals of *Drosophila melanogaster* after metamorphosis, it appeared that the junction of the third testis occurred nearly exclusively within the anterior fifth of the length of the coiled attached testis. Such a phenomenon could either be explained by a specific preference of junction or by the assumption that junction takes place at a time when the coiled growth of the attached testis was still in its beginning i.e. before the later four-fifths of its surface had been added terminally. To test these alternatives larval implantations were made and the resulting pupae dissected before any extensive longitudinal growth of the testis had occurred. It was seen that junction of the third testis with the attached one had taken place already and that no preference exists for such junction to occur near the anterior end of the attached gonad. On the contrary, junction had occurred anywhere from the anterior to the posterior end. Clearly growth over the whole surface of the attached testes would cause the joined testis to be found anywhere along the length of the later coil. The restriction of the region of junction to the anterior portion of the coil is evidence for terminal growth.

(3) The last method employed was that of histological examination. Although perhaps apparent as the most obvious procedure of study it offered particular difficulties due to the minuteness of the structures involved. The adult testis sheath consists of an apparently homogeneous strongly refractive membrane, a fraction of a micron in thickness with very small, flattened nuclei either applied to its inside or possibly a part of it. These will be called the membrane nuclei in the following discussion. Externally a single layer of large, flat pigment-bearing cells is found. They are not responsible for the form-giving properties of the testis sheath as they are slightly ameboid in nature and may even be removed artificially from small areas of the surface without interference with the shape of the testis. This leaves the membranous structure for consideration. In early stages it is not of equal thickness all over the testis but widens into a plasmatic sheath at its posterior end. This sheath is closely packed with a single layer of small, spherical nuclei. It represents either a syncytium or an epithelium without clearly distinguishable cell walls. In counting the number of membrane nuclei in five adjacent equal sized areas from near the posterior end toward the anterior part such numbers as 31, 33, 25, 10, 8 have been found. These five areas extend over a strip of the most posterior quarter of a testis which had just started to coil. A sixth and seventh area, located in the middle and near the anterior end

contained only 3 and 4 respectively. Thus a gradient exists between the densely packed nuclei on one end and the widely spaced nuclei in the remainder of the surface. If, in older testes, areas are investigated which are equivalent in their distance from the anterior end to the areas with high nuclear numbers in the stage just discussed, it is found that they now possess only about 3 nuclei. As it does not seem to be true that nuclei disappear during the growth of the membrane it must be concluded that a large amount of stretching predominantly in the posterior portion occurs which greatly increases the distance between neighboring nuclei. Thus again, growth of the testis membrane is shown by histological analysis to be due to terminal elongation. Whether the growth of the membrane is due only to stretching or whether in addition mitotic divisions play a role is a question which has been difficult to decide. No clear pictures of mitosis have ever been seen. At best they must be rare. If they occur at all they ought to be restricted to the protoplasmatic terminal region of the membrane, for it is improbable that the flat and apparently degenerated nuclei along the major part of the membrane are able to divide.

We may now begin to apply these data to an interpretation of the influence of the vas efferens on growth and form of the attached testis. Part of this influence consists in a stimulation of growth by elongation of the contiguous protoplasmatic region of the testis membrane. This statement, however, leaves out one paramount aspect, the spiral growth of the organ. This involves asymmetrical growth of the membrane, faster on the outer than on the inner rim of each coil. Is this differential growth due to differential stretching or is a difference of the hypothetical mitotic multiplication of nuclei with coinciding increase of cytoplasm responsible? In order to answer this question the number of nuclei along the outer and inner rim of testes in various stages of coiling was determined. Differential nuclear multiplication should result in a larger number of nuclei along the longer outer rim than along the shorter inner rim, while differential stretching should result in equal numbers of nuclei on both rims. The actual results of three different series of such determinations showed consistently a somewhat higher nuclear number along the outer rim, not enough however to account for more than one-fourth to one-half of its larger dimension. There is some reason to suspect that the difference in nuclear number may be due not to mitosis but rather to initial differences of numbers on opposite rims. In any case the data point to differential stretching as one cause of spiralization.

Is this differential stretching an autonomous response of the testis to a general stimulation of growth by the vas efferens or does the action of the vas include the organization of specific differential growth which leads to coiling? An answer is provided by observations which may now be introduced. It has been pointed out earlier that when three testes are present in one individual two generally become attached in a normal way while the third either remains completely free or may become closely joined to the membrane of one of the attached gonads. Free and joined testes alike in some species are ellipsoidal or pear-shaped. In others, however, free and joined testes behave differently from each other. While free testes nearly always are ellipsoidal or pear-shaped, closely joined ones are elongated and, more significant, often curved into semi-circles, complete circles, or even spirals with slightly more than one gyre. Their curvature is turned away from the region of their sideways junction to the "carrier-testis". Thus, the growth-promoting influence of a vas extends even to testes which are not directly attached to it but with which it is connected by the intermediary of a "carrier" testis. In these cases of random junction of a supernumerary testis somewhere along its length to an attached testis there is no reason to suggest that there is any preferred region which invariably enters into junction. In other words, type and direction of curvature of the testis is not evocated by a generalized stimulus, but can be regarded as specifically induced by contact with the "carrier" testis.

All data taken together suggest the hypothesis that the vas efferens of species having coiled testes releases a substance which diffuses by direct contact into the growth region of an attached testis and causes its elongation; that this substance is given off in different amounts to opposite sides of the testis so that it induces different degrees of stretching of the testis membrane at different regions of its terminal growth zone. Nothing is known yet about the nature of this hypothetical substance. A parallelism in its action with the auxins which cause elongation of the cellulose walls of plant cells is obvious although no fundamental similarity need be involved.

Finally let us return to the experiments of interspecific transplantations. The difference in the power of the vas efferens of species having spiral and those having uncoiled testes can now be expressed in terms of production of different quantities of the growth substance or possibly of differences in effectiveness of various growth substances characteristic for each species. The latter alternative although not ruled out may at present be regarded as of less likelihood than the former. It may be asked whether it is not necessary to assume in addition to different quantities of the substance, an equal distribution around the growth zone in uncoiled vs. an unequal distribu-

tion in coiled forms. However, an inspection of a growth series of *Drosophila pseudoobscura* reveals a clear indication of unequal growth even in this species although the curving of the terminal section which is obtained at the end of development is so slight as to be equal only to change of form in *Drosophila melanogaster* after 8 percent of the crucial time of development had elapsed. We have here an interesting example of how genetic changes have played a role in the divergent evolution of these species by being responsible probably for small differences in the quantity of some substance produced by one organ which in turn leads to the induction of very striking specific differences in growth and form of another organ.

(This article is based upon a lecture presented at the Marine Biological Laboratory on August 30.)

IN MEMORY OF DECEASED MEMBERS OF THE CORPORATION OF THE MARINE BIOLOGICAL LABORATORY

Memorials Adopted at the Annual Meeting of the Corporation, August 13, 1940[1]

MAYNARD MAYO METCALF

It is altogether fitting that the Corporation of the Marine Biological Laboratory, at its annual meetings, should pause to pay such salutation and honor as it may to those recently removed by death, and who over many years supported the Laboratory by scientific work, wise counsel, and energetic endorsement.

Such a Corporation member was Maynard Mayo Metcalf, who died last April 19th after a very prolonged illness, which began suddenly while he was at work in this building. His age was seventy-two years.

Dr. Metcalf's chief biological mentors were Prof. Albert A. Wright at Oberlin (Wright was one of the very early workers at Woods Hole), and Prof. W. K. Brooks of the Hopkins, under whom he took the doctorate in 1893. His academic appointments as teacher were as organizer and head of the Department of Zoology at Goucher College, 1893-1906; at Oberlin he reorganized the corresponding department and directed it from 1906 to 1914; from 1926 till 1933 he was research associate with rank of Professor at the Johns Hopkins University. During the year 1924-25 he was chairman of the Division of Biology and Agriculture of the National Research Council, Washington.

Among Metcalf's earliest published studies were some on morphological and embryological features of Amphineura and Gastropods; but thereafter for several years his attention was given to the morphology, physiology, phylogeny, and taxonomy of the Tunicata with major emphasis on pelagic forms. He presented very comprehensive collections of these to the National Museum. His third and most arduous series of studies dealt with the morphology, taxonomy and cytology of the Opalinidae; these led him to far-reaching analyses of specific host-parasite relations, with deductions therefrom as to the ancient distribution of Amphibia, as well as to evidences of former land connections between now-separated continents.

All his life an outstanding characteristic of Metcalf which should be mentioned in any summary of his scientific work was that of giving credit to collaborators. Especially in his later years was assistance necessary; and all such received appropriate acknowlegment in the publications involved.

Metcalf's publications include: papers exceeding 120 in number; a book, "Organic Evolution" (Macmillan); and three large monographic volumes on the opalinids. The most recent of these was issued by the Smithsonian Institution as a Bulletin of the National Museum last spring.

He was elected to membership in 28 American, 3 British, and 3 French learned societies, and was a member of the Authors Club, London. For 45 years he was a summer frequenter of the Woods Hole Laboratories, and a member of the Board of Trustees of the Marine Biological Laboratory from 1896 till his death—44 years. Few men indeed have been as deeply sincere in their solicitude for and belief in the functions of this laboratory as was Maynard Metcalf. Directly or indirectly he assisted many a student, in financial or other ways, to come here for study and research; and mention should here be made of his gift of his large collection of reprints to our library.

As a man he was chronically of discriminating judgment, positive opinions, and uncompromising integrity. He was thoroughly human of the finest grade; an optimist; an idealist; a dispenser of cheer, with rare generosity of spirit, and capacity for friendship. He will not be forgotten.

R. A. Budington

[1] The article read in honor of Dr. Henry McE. Knower was not received in time for publication.

CHARLES ZELENY

Charles Zeleny, Professor of Zoology at the University of Illinois, died at his home in Urbana December 21, 1939. He was born at Hutchinson, Minnesota, September 17, 1878, and spent his early boyhood days there. Later his parents moved to Minneapolis where he entered the University of Minnesota and graduated in 1898. He remained as a graduate student and received M.S. in 1901. The next year he was a graduate student at Columbia University, working with T. H. Morgan and E. B. Wilson, and the following year he worked at the Naples Zoological Station. Returning to America in 1903, he entered Chicago University where he obtained the Ph.D. in 1904. He came to Indiana University as an instructor in the summer of 1904. Here he advanced rapidly and held the rank of Associate Professor at the time of call to the University of Illinois in 1909. Beginning at Illinois as an Assistant Professor, he was promoted the next year to the rank of Associate Professor and in 1915 to a Professorship. Upon the retirement of Professor H. B. Ward in 1933, he was made head of the Department of Zoology and chairman of the Division of Biological Sciences. Because of ill health, he had retired from his executive duties in 1938.

On May 29, 1911, he married Ida Benedicta Ellingson, of St. Morris, Wisconsin. Mrs. Zeleny and a son, Charles, Jr., survive.

Dr. Zeleny's family is unique in that three of his brothers are scientists of note. Anthony Zeleny, now retired, was professor of physics at the University of Minnesota; John Zeleny is professor of physics at Yale; and Frank Zeleny is an engineer with the Burlington Railway.

As is true with every great man, chronological facts such as those enumerated tell but little of the life of Charles Zeleny. They are cold, external. It was the writer's good fortune to have been a student in Dr. Zeleny's first class in embryology taught at the Biological Station in the summer of 1904. For the next three years, our associations were intimate. We worked together, ate at the same table, played together and tramped through the woods and fields together. The fact that one was teacher, the other student entered but little into our thinking. The friendship formed in those early years remained to the end. As a friend he was true, somewhat reserved, seldom talked of his own personal affairs, possessed a subtle, sometimes mischievous, wit, appreciated by those who knew him best. Seldom did he complain about anything. Bitterness, if present, was kept hidden.

As a teacher he was kind, helpful, encouraging, stimulating. As a zoologist his papers in the fields of regeneration, experimental embryology and genetics, speak for themselves. They rank among the best contributions of his time. Originality in thinking stands out prominently in all his work.

In recognition of his attainments, he was elected vice-president of section F of the A. A. A. S. in 1932, and president of the American Society of Zoologists in 1933.

Dr. Zeleny's death at the early age of 61 years is not only a loss to his relatives and friends, but to science.

Fernandus Payne

CAPTAIN JOHN J. VEEDER

John J. Veeder, Captain of the fleet of the Marine Biological Laboratory from 1890 to 1933, was born on the island of Cuttyhunk January 27, 1859. Like all Cuttyhunkers he was accustomed to the management of boats from early years, and acquired a most intimate knowledge of the shoals, tides, currents and weather conditions of Vineyard Sound and Buzzards Bay. He married and moved to Woods Hole in 1881.

The Marine Biological Laboratory was founded in 1888, and as Dr. Bumpus has written me, "The summer of 1890 found the steam launch *Sagitta* proudly added to the fleet of two old green dories that had been inherited from the Annisquam Laboratory." It became necessary to appoint a captain and John J. Veeder was called in for examination by Dr. Gardiner. He was asked to "box the compass." Dr. Bumpus relates, "The speed with which he went through the ritual settled the matter then and there. Captain Veeder was promptly commissioned." For a year, until George M. Gray was appointed, Captain Veeder acted also as collecter; and afterwards collaborated closely with the Supply Department, became thoroughly familiar with the collecting grounds, and located and set fish traps of the Laboratory.

Captain Veeder was in charge of the class trips and picnics, and though many thousands were carried in the years of his service no one was ever lost. He was a past master of the technique of the clambakes which added so greatly to the enjoyment of the picnics. He kept his eye on the weather and he always vetoed a trip if his extraordinary weather sense and wisdom warned him that the trip would be dangerous. I cannot say how many times he came to the rescue of our amateur sailors in distress, when marooned by bad weather or ignorance of tidal currents; and very frequently he and the crew went to the aid of small craft grounded on shoals in the Hole or near the harbor.

He had the good old Cape Cod dignity and self-respect; he was a shrewd judge of men in all walks of life, and met all on an equal basis. He

never regarded his position merely as a job; whatever was "for the good of the Laboratory," as he used to say, was always cheerfully and skilfully performed. He acted as interpreter of the Laboratory to the town folk or in town meetings, and was helpful in maintaining the good relations which we have always valued.

He was retired on half pay in 1933, at the age of 74, and from then until the time of his death on May 3, 1940, kept a friendly eye on Laboratory affairs and was always ready to lend a helping hand. His presence, familiar through fifty years, is sorely missed. F. R. Lillie

PAPERS AND DEMONSTRATIONS PRESENTED AT THE GENERAL SCIENTIFIC MEETING, 1940

Tuesday, August 27, Morning Session, 9:00 A. M.

S. O. Mast and W. J. Bowen: The hydrogen ion and the osmotic concentrations of the cytoplasm in Vorticella sp., as indicated by observations on the food vacuoles.

M. H. Jacobs and W. D. Jones: The reversibility of certain artificially induced changes in the permeability of the erythrocyte.

E. J. Boell, R. Chambers, E. A. Glancy, K. G. Stern, and B. Meyerhof: Oxygen transfer in intact and fragmented cells with particular reference to the cell nucleus.

E. J. Boell and L. L. Woodruff: Respiratory metabolism of mating types of *Paramecium calkinsi*.

Eric G. Ball and Pauline A. Ramsdell: Squid ink, a study of its composition and enzymatic production.

A. E. Oxford: Observations on the occurrence of simple ethereal sulphates in marine algae.

E. J. W. Barrington: Blood-sugar and the problem of the pancreas in lampreys.

A. E. Navez and A. DuBois: Fatty acid compounds in the Arbacia egg.

C. B. Giddings: Quantitative determination of plasmalogen in certain invertebrate forms.

G. H. Parker: Lipoids and their probable relation to melanophore activity.

Samuel Belfer, H. C. Bradley, and Howard Eder: Studies of the distribution of the autolytic mechanism and its significance.

Tuesday, August 27, Afternoon Session, 2:00 P. M.

Carl C. Smith: The effect of various cholinergic drugs on the radula protractor muscle of *Busycon canaliculatum*.

E. J. Boell and D. Nachmansohn: Choline esterase in nerve fibers.

R. G. Abell and Irvine H. Page: Vascular reactions to renin and angiotonin.

J. Crawford, D. Benedict, and A. E. Navez: On the contraction of the heart muscle of *Venus mercenaria*.

Charles E. Wilde, Jr.: Determining factors in the regeneration of *Hydractinia echinata*.

Edgar Zwilling: Time of determination and dominance in tubularian reconstitution.

S. Meryl Rose: A reconstitution inhibiting substance released by Tubularia tissues.

L. G. Barth: The role of O_2 in regeneration of Tubularia.

Harry G. Albaum: The growth of the oat coleoptiles after seed exposure to different oxygen concentrations.

W. Gardner Lynn: Results of transplantation of the pituitary anlage to the thyroid region in Amblystoma.

Wednesday, August 28, Morning Session, 9:00 A. M.

T. C. Evans: Oxygen consumption of Arbacia eggs following exposure to Roentgen radiation.

T. C. Evans: Effects of Roentgen radiation on jelly of Arbacia egg. I. Disintegration of jelly.

M. E. Smith and T. C. Evans: Effects of Roentgen radiation on jelly of Arbacia egg. II. Changes in pH of egg media.

E. P. Little and T. C. Evans: Delay in first cleavage of Arbacia eggs following Roentgen irradiation of zygotes.

Grace Townsend: Concerning susceptibility of cells to X-ray.

Grace Townsend: Laboratory ripening of Arbacia in winter.

Ethel Browne Harvey: A note on determining the sex of Arbacia.

Ethel Browne Harvey: Centrifugal speed and the Arbacia egg.

Ethel Browne Harvey: Colored photographs of stratified Arbacia eggs stained with vital dyes.

Herbert Shapiro: Elongation and return in spherical cells.

Ivor Cornman: Echinochrome as the sperm-activating agent in sea-water.

Teru Hayashi: A relation between the dilution medium and the survival of spermatozoa of *Arbacia punctulata*.

Wm. H. F. Addison: The occurrence of cartilage at the bifurcation of the common carotid artery in an adult dog.

Hope Hibbard: Cytoplasmic morphology in the gizzard of *Gallus domesticus*.

Papers Read by Title

Fred W. Alsup: Further studies of photodynamic action in the eggs of *Nereis limbata*.

C. W. J. Armstrong and Kenneth C. Fisher: A quantitative study of the effect of cyanide and azide on carbonic anhydrase.

Frank A. Brown, Jr., and Alison Meglitsch: Upon the sources in the insect head of substances which influence crustacean chromatophores.

Ralph H. Cheney: Myofibrillar modifications in the caffeinized frog heart.

Leonard B. Clark: Effects of visible radiation on Arbacia eggs sensitized with rhodamine B.

A. C. Clement: Effects of cyanide on cleavage in eggs of Hyanassa and Crepidula.

D. P. Costello: The cell origin of the prototroch of *Nereis limbata*.

James Donnellon: Blood clotting in *Callinectes sapidus*.

Llewellyn T. Evans: Effects of light and hormones upon the activity of young turtles, *Chrysemys picta*.

Llewellyn T. Evans: Effects of testasterone propionate upon social dominance in young turtles, *Chrysemys picta*.

Kenneth C. Fisher and Richard J. Henry: The use of urethane as an indicator of "Activity" metabolism in the sea urchin egg.

MORDECAI L. GABRIEL: The inflation mechanism of *Spheroides maculatus*.

E. A. GLANCY: Micromanipulative studies on the nuclear matrix of Chironomus salivary glands.

JOHN E. HARRIS: The reversible nature of the potassium loss from erythrocytes during storage of blood at 2-5° C.

ARNE V. HUNNINEN AND RAYMOND M. CABLE: Studies on the life history of *Anisoporus manteri* sp. nov. (Trematoda: Allocreadiidae).

CORNELIUS T. KAYLOR: Histological studies on the problem of edema in haploid *Triturus pyrrhogaster* larvae.

BALDWIN LUCKE, ARTHUR K. PARPART, AND R. A. RICCA: Do carcinogenic compounds affect cell permeability?

W. G. LYNN: The development of the skull in the non-aquatic larva of the tree-toad, *Eleutherodactylus nubicola*.

W. G. LYNN: The embryonic origin and development of the pharyngeal derivatives in *Eleutherodactylus nubicola*.

SISTER MARIA LAURENCE MAHER: Preliminary report on effect of indole acetic acid on growth of Chlamydomonas.

H. SHAPIRO: Further studies on the metabolism of cell fragments.

CARL C. SMITH, BLANCHE JACKSON, AND C. LADD PROSSER: Responses to acetylcholine and cholinesterase content of Cerebratulus.

A. J. WATERMAN: Response of the heart of the compound ascidian, *Perophora viridis*, to pilocarpine, atropine and nicotine.

Wednesday, August 28, 2:00 P. M.

Demonstrations

W. H. F. ADDISON: Corrosion preparations of the branchial circulation in the dogfish.

E. SCHARRER: Vascularization of the extramedullary nerve cells of the puffer, *Spheroides maculatus*.

E. R. CLARK AND ELEANOR LINTON CLARK: The microscopic study of living tissues in transparent chambers installed in rabbits' ears.

E. P. LITTLE: Color and luminescence produced by Roentgen rays in glass and chemicals.

E. J. BOELL: The Cartesian diver ultramicro-respirometer.

F. SCHOLANDER, S. W. GRINNELL AND L. IRVING: Apparatus for measurement of respiratory metabolism and circulation changes.

ITEMS OF INTEREST

Construction of a new building to house the biological laboratories at the Johns Hopkins University will begin in October with funds bequeathed to the University by Eugene G. Mergenthaler, totaling nearly $350,000. The hall will bear the name of Ottmar Mergenthaler, inventor of the linotype. The work of the biology departments will also be furthered by a $1,000,000 endowment, half of which was granted by the Rockefeller Foundation and the remainder of which was provided by the University from a bequest by the late Louis J. Boury.

SYMPOSIUM ON HYDROBIOLOGY

A Symposium on Hydrobiology will be held at the University of Wisconsin on September 4, 5 and 6, funds for which have been provided by the Wisconsin Alumni Research Foundation. Forty-two scientific papers discussing the history, geology, physics, chemistry, bacteriology, botany and zoology of bodies of water in all parts of the world are listed in the program.

Among those attending will be Dr. S. A. Waksman and Dr. George L. Clarke of the Woods Hole Oceanographic Institution. Dr. Waksman will present a paper on "Aquatic Bacteria in Relation to the Cycle of Organic Matter in Lakes." Dr. Clarke will lead a round table discussion on "Physical Aspects of the Penetration of Solar Radiation into Natural Water" and at the presentation of volunteer papers on hydrobiology on Thursday will give a paper entitled "A Photographic Method for the Study of the Organisms and the Conditions of the Sea Bottom."

The attention of workers in fields bearing on development and growth who are interested in prompt publication of their work is called to the recent reorganization of the journal "Growth". The scope of the journal has been limited to the realm of biological phenomena. The institution of an editorial Council has been abolished. In the future all actions will be taken by the Editorial Board as a whole. In line with the new course the following men were added to the Board of Editors: H. S. Burr (Yale University), C. H. Danforth (Stanford University), Warren H. Lewis (Carnegie Institution), E. W. Sinnott (Columbia University), K. V. Thimann (Harvard University), Paul Weiss (University of Chicago), B. H. Willier (University of Rochester), Sewall Wright (University of Chicago). Manuscripts should be addressed to: Board of Editors of "Growth", Dairy Building, Cornell University, Ithaca, N. Y.

DATES OF LEAVING OF INVESTIGATORS

Albaum, H. G.	Aug. 27	Henson, Margaret	Aug. 28
Badger, E.	Ang. 27	Herget, C.	Aug. 31
Bliss, C. I.	Aug. 31	Hiestand, W. A.	Aug. 29
Cable, R. M.	Aug. 29	Jakus, M.	Aug. 27
Clark, L. B.	Aug. 24	Jones, N. D.	Aug. 26
Clement, A. C.	Aug. 24	Lucké, B.	Aug. 27
Dressler, Elsie	Aug. 24	MacKnight, R. H.	Aug. 31
Dytche, Maryon	Aug. 23	Menkin, V.	Aug. 23
Egan, R. W.	Aug. 28	Moog, Florence	Aug. 28
Evans, L. T.	Aug. 24	O'Brien, F. P.	Aug. 28
Evans, T. C.	Aug. 28	Sayles, L. P.	Aug. 28
Fisher, K. C.	Aug. 24	Scott, A. C.	Aug. 26
Goodrich, H. B.	Aug. 30	Sheldon, F.	Aug. 26
Granick, S.	Aug. 24	Spratt, N.	Aug. 27
Griffiths, R.	Aug. 27	Willier, B. H.	Aug. 26
Harris, J. C.	Aug. 24	Zorzoli, Anita	Aug. 28

The Collecting Net

A weekly publication devoted to the scientific work at marine biological laboratories.

Edited by Ware Cattell and Robert Chambers with the assistance of Boris I. Gorokhoff and Peggy Browning; Contributing Editor, Homer A. Jack.

Entered as second-class matter, July 11, 1935, at the U. S. Post office at Woods Hole, Massachusetts, under the Act of March 3, 1879, and re-entered, July 23, 1938.

BIOLOGICAL LABORATORIES IN MEXICO

Dr. Enrique Beltran

Professor of Zoology, University of Mexico

Tropical Disease Institute at Mexico City

Last year the Mexican Government, under the Federal Department of Public Health, inaugurated a new Institute, *Instituto de Salubridad y Enfermedades Tropicales*, located at Mexico City. The Institute is located in a new four-story building; the main floor has the administration offices, general services, shops, laundry, kitchen and dining room; on the second floor is located the School of Hygiene and Public Health; on the third floor are the research laboratories; and on the fourth floor is a small research hospital with 36 beds. Investigations are carried on in various fields of public health and tropical diseases, and training in sanitation is offered at the school for physicians and nurses. Research and instruction are independent, and all the investigators are on a full time basis, with no teaching duties. The various departments, and the persons in charge of each one are: Bacteriology, Dr. Alberto P. León; Pharmacology, Dr. Eliseo Ramírez, Director of the Institute; Experimental Physiology, Dr. M. Dolores Rivero; Protozoology, Prof. Enrique Beltrán; Entomology, Dr. Luis Vargas; Helminthology, Dr. Luis Mazzotti; Pathology, Dr. Manuel Martínez Báez; Mycology, Dr. Manuel González Ochoa; Chemistry, Dr. Teofilo García Sancho; Botany, Prof. Esther Luke; Farm and Animal Room, Dr. Juan N. Valencia; Hospital, Dr. Silvestre López Portillo. The School is under the direction of Dr. Angel de la Garza Brito. The Institute has a journal published four times annually, entitled *Revista del Instituto de Salubridad y Enfermedades Tropicales*; the first issue appeared a few months ago and the second is now in press.

Limnological Station at Pátzcuaro

The Division of Fisheries of the Department of Marine of the Mexican Government has established a Limnological Station at the Lake of Pátzcuaro, in the State of Michoacán, Mexico. This station is interesting because the Lake of Pátzcuaro is on a high plateau at an altitude of over 6,000 feet. The work of the station is particularly concerned with the investigation of the facilities of Pátzcuaro as a center of fishing industry, but a general survey of the Lake is part of the purpose of the station. The station is open all year round, and is in charge of Mr. Manuel Zozaya. Dr. Fernando de Buen, formerly of the Spanish Institute of Oceanography, is acting as scientific advisor of the station. A small staff works there, and modest laboratory and living facilities may be given to foreign investigators who wish to work there for some time. The general work of the station is conducted under the direction of a scientific board, whose chairman is Dr. Enrique Beltrán, professor of zoology at the University of Mexico. Persons interested in further details concerning the station and facilities available there, may address inquiries to Mr. Manuel Zozaya, Estación Limnológica, Pátzcuaro, Mich., Mexico.

LETTER TO THE EDITOR

Stazione Zoologica Di Napoli

To the Editor:

I was very glad to receive your letter of May 25th (which reached me only a few days ago) and I am particularly grateful to you for the opportunity of letting have some of our news to the friends of the "Stazione" in your country.

Of course you are aware that the present conditions are a severe handicap for the activity of a laboratory, whose constitutional function—so to say—is to offer research facilities to scientific workers of various countries of Europe and abroad. "Inter arma tacent Musae."

In fact, in the first 8 months of 1939 the attendance was as usual, for the rest of the year only a few foreign scientists found it possible to continue their work. During this year the attendance increased a little, but is of course still rather limited.

We fervently hope that conditions may soon return normal, so that we can again devote ourselves to what has been the program of the "Stazione" ever since 1874: to be a meeting place for the fellowship of learning of men of science of all countries.

Very sincerely yours,

R. DOHRN.

CURRENTS IN THE HOLE

At the following hours (Daylight Saving Time) the current in the Hole turns to run from Buzzards Bay to Vineyard Sound:

Date	A. M.	P. M.
August 31	2:38	2:52
September 1	3:26	3:42
September 2	4:15	4:32
September 3	5:03	5:26
September 4	5:43	6:16
September 5	6:40	7:05
September 6	7:28	8:01

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

ITEMS OF INTEREST

Dr. Donald H. Barron, lecturer in biology at St. John's College, University of Cambridge, England, has been appointed assistant professor of zoology at the University of Missouri. Because of the difficulty of research in England at the present time, Dr. Joseph Barcroft, with whom he worked in England, is sending to Dr. Barron most of his research material.

Dr. Mary Rawles, research assistant at the University of Rochester, has been appointed research associate in embryology at the Johns Hopkins University.

Dr. R. G. Abell, who has been instructor in anatomy at the University of Pennsylvania Medical School, has been appointed associate in anatomy at the same institution.

Dr. S. C. Reed, Lecturer in the Department of Genetics at McGill University, has joined the department of biology at Harvard University as an instructor. Dr. Reed took the invertebrate zoology course at the Marine Biological Laboratory in 1932.

Dr. Max Perrot, who was formerly instructor at the University of Geneva, and who has recently been working with Dr. Fankhauser at Princeton University, has been appointed instructor in zoology at the University of Missouri.

Dr. Karl M. Wilbur, instructor in biology at the University of Pennsylvania, will work at New York University this fall with Dr. Robert Chambers.

Miss Ruth M. Castle, who was assistant in zoology last year at Vassar College and worked at Woods Hole in 1938 and 1939, will study this year at Radcliffe College with Dr. A. B. Dawson under the Farlow Fellowship and the Richardson and Babbitt Fellowship.

Mr. Roger M. Cole, who took the protozoology course at the Marine Biological Laboratory in 1938, has been appointed teaching fellow in biology at Harvard University.

An art exhibit was held by Mrs. Carl C. (Thelma A.) Smith in the Community Hall on Wednesday and Thursday.

During the thunderstorm on August 23, the home of James McInnis, manager of the supply department of the Marine Biological Laboratory, was struck by a bolt of lightning which pierced the roof and ripped plaster off the wall of the living-room, damaging most of the electrical installations.

Dr. Joseph Needham, Sir William Dunn Reader in Biochemistry, University of Cambridge, is planning to visit Woods Hole for a while some time after the middle of September.

Dr. J. McKeen Cattell, editor of *Science*, visited Woods Hole for three days at the beginning of this week.

Baroness Bethsabée de Rothschild, who arrived in the United States recently by Yankee Clipper, is visiting the Marine Biological Laboratory as a guest of Dr. and Mrs. D. Nachmansohn. Baroness de Rothschild has been associated in cell research in Paris with Dr. Louis Rapkine and with Professor René Wurmser.

Dr. Walter A. Chipman, Jr., associate biologist with the Fish and Wild Life Service, is spending the week at the Woods Hole Fish and Wild Life Service, working with Dr. Galtsoff in connection with studies on the respiration of the mollusk.

One hundred and five persons were registered at the summer meetings of the Genetics Society of America by Thursday evening. Four motor boats carried 104 members and guests to Uncatena Island, where a clambake was held. They returned to Woods Hole early in the evening owing to inclement weather which prevented the party from going to Tarpaulin Cove.

The greater part of the excavation work has already been completed for the new wing of the Marine Biological Laboratory, which will contain additional space for the library. A number of large boulders had to be removed in order to make way for cement piles, some of which have already been installed. Meanwhile, a former barn near the southwest corner of the Old Main Building has been torn down to provide additional parking space for cars displaced by the new wing.

The students of the invertebrate zoology course of the Marine Biological Laboratory complete their work today.

At the staff meeting of the Woods Hole Oceanographic Institution Thursday, Dr. Rakestraw spoke on "Experimental Studies Upon the Nitrogen Cycle in the Sea."

The Woods Hole Oceanographic Institution's ketch *Atlantis* returned on Thursday from a ten-day trip along the northern edge of the Gulf Stream. It will leave on Tuesday for a brief trip on which Dr. Edmund Watson will make further observations with the current meter designed by him.

EXTRA-CURRICULAR ACTIVITIES

The winners of the ping pong tournament held at the M. B. L. Club are as follows: Men's singles, T. Hayashi, who won from A. Clark by a score of 17-21, 21-17, 21-17, 23-25, 21-13, 10-21, 21-19. Women's singles, Peggy Browning, who won from Anne Pupchick by a score of 21-14, 21-17, 21-17. Mixed doubles, Kalmanson and Kalmanson, who won from Gorokhoff and Hayashi by a score of 15-21, 19-21, 21-14, 22-20, 21-13.

The clubhouse will close for the season on or about September 11, according to Mrs. M. E. Smith, the club hostess.

Miss Mary Chamberlain will be in charge of refreshments at the dance tonight which will probably be the last of the season.

The Woods Hole Choral Club presented its thirteenth annual concert Monday evening in the Woods Hole Community Hall under the direction of Professor Ivan T. Gorokhoff. Over a hundred people enjoyed the recital.

Dr. T. K. Ruebush was the winner of the men's singles tournament held by the M. B. L. Tennis Club. The score in the finals, which was played with Dr. Roberts Rugh on August 23, was 6-2, 6-1. No other tournaments were held this year.

INVERTEBRATE CLASS NOTES

"All this in one day!" That was the cry as we started work this week with the anatomy of the squid. We managed to finish Loligo by the early hours of Tuesday and stumbled off to bed. A few hardy souls arose early to put finishing touches on their lab records.

With Mollusca completely forgotten, we settled down to learn about the phylum Arthropoda from Dr. Martin and spent the rest of the week dissecting lobsters and blue crabs and watching autotomy in Uca. (Uca see we really worked!)

There were several happenings to lighten our academic life. Wednesday evening was our return baseball match with the Crew—or should this be ignored? We're afraid we must admit defeat and offer in excuse the fact that our laboratory work does not offer opportunity to keep in trim for *physical* combat.

On Thursday there mysteriously appeared on our bulletin board a photograph which some believed to be a picture of the patron saint of the Invertebrate Class. It had a surprising resemblance to Groucho Marx, but under the mustache and other markings one could imagine Dr. Rankin in cap and gown. Perhaps that is the reason said instructor hastily removed the picture. We think a mustache would be quite becoming, Dr. Rankin.

Our regular lab work was interrupted Friday by a dredging trip on the *Nereis*. Three teams went in the morning and the others in the afternoon while those at home studied towing samples. These were rough trips with a storm brewing, but we all enjoyed them. The storm this night conveniently took care of the electricity and this took care of our work—so we held a general sing and ended with a grand feast of *Mytilus edulis*.

Saturday was another day which kept us close to our desks. With saws, bone scissors and crow bars we reached the interior of Limulus (this occupied the whole morning), and we proceeded to find the circulatory, digestive and nervous systems. Late at night we were wearily hunting for the nerves, hoping to finish to have Sunday free for our picnic.

Ah! At last the picnic day. In the *Nereis* and "*Winnie*" we migrated to Tarpaulin Cove. The day's activities began with a hilarious ball game between faculty and students—the faculty emerging the victor. Dr. Martin pitched nobly for the faculty while Bill Putnam tossed for the Invertebrates.

The dinner bell put an end to baseball and everyone returned to the beach to consume a wonderful meal of roast corn, tomatoes, clams, potatoes, roast chicken, cake and coffee. Champion clam eater of the day was Dr. Jones with runners-up Dr. Mattox and Dr. Waterman. Sun-bathing was the most popular sport after this mighty meal.

Late in the afternoon we rode home, sunburned and sandy, and entertained on the trip by acrobatic Dr. Crowell, who did a Tarzan act on the ropes and wires. It was a grand picnic and we wish to thank Miss Belle and Dr. Croasdale for their splendid cooperation.

Back to Limulus Sunday night. —*Grace Coe*

THE RELATION OF POTASSIUM TO THE BIOELECTRIC EFFECTS OF TEMPERATURE AND LIGHT IN VALONIA

Dr. L. R. Blinks
Professor of Biology, Stanford University

The effects of temperature upon bioelectric potential are sometimes sufficiently large to be interpreted as showing the intervention of metabolism, viscosity, etc. Marsh, studying *Valonia ventricosa*, concluded without direct evidence that the temperature effect indicated dependence of the bio-

electric potential upon the oxidation-reduction potential of the protoplasm. The present report instead correlates the bioelectric effects of temperature in this organism with the potassium content of the sea water.

The temperature effect in sea water has a curious curved plot, the potential being lowest between 20 and 25° C., rising sharply above 30° to 35°; but also rising slowly but definitely on cooling to 15°. (Further cooling to 8 or 10° depresses the P.D., sometimes irreversibly).

The magnitude of the potential change produced by altering the K content of sea water (doubling, quadrupling, halving, or abolishing K in artificial sea water) was next studied at different temperatures. This potassium effect was least at 25°, showing the cusped time course described by Damon. It was increased at 15°, with a flat-topped time course. It was greatly increased at 35°, with a sharp short cusp, and subsequent rise. The explanation of these differences in the potassium effect at different temperatures may lie in the speed with which KCl actually diffuses across the surface into the protoplasm, thereby altering the original gradients, as postulated by Damon. Whatever the explanation, however, the size of the potassium effect closely parallels the magnitude of the potential itself in sea water at the given temperatures. This parallel suggests that the K content of the external medium might govern the size of the temperature effect. Cells were therefore allowed to remain in sea waters of different K content, while exposed to temperature changes. It was found that the temperature effects practically disappeared at 0.006 M K or lower, became normal at 0.012 M and were considerably exaggerated at 0.024 and 0.048 M K. It therefore seems that the observed temperature effect is actually that of the KCl concentration potential, or of some metabolic process of which the K ion gives a bioelectric manifestation.

Very similar results were found with the effects of light (which have again been ascribed by Marsh to oxidation-reduction potential changes). In potassium-free sea water there is no effect of light (or even a reversed one), in sea water a small effect, and with doubled or quadrupled K content, a correspondingly increased light effect. Again therefore the K ion seems to give a bioelectric manifestation of the underlying metabolic process, (photosynthesis) probably via an altered entrance and accumulation of potassium in the protoplasm. Light has been shown to affect such accumulation in Valonia itself, as well as in other plants. The bioelectric effects may thus become a useful indicator of the metabolic relations of this remarkable element.

(This article is based upon a seminar report presented at the Marine Biological Laboratory on August 20.)

RESPIRATORY CHANGES FOLLOWING STIMULATION IN NITELLA

R. K. Skow and Dr. L. R. Blinks
School of Biological Sciences, Stanford University

The characteristics of the action potential in Nitella have been clearly established during the past several years by the temporal and spacial relationships of its electrical response. (Osterhout, Hill.) Data have also been obtained relating the resting resistance and capacity (impedance) to that during and following the propagation of an action potential. (Blinks, Auger, Cole.)

Many of these properties Nitella has in common with the action potential of animal nerve. In the latter, in addition, repetitive stimulation (100 to 200 per sec. for several minutes) has indicated that the nerve impulse is associated with an increased oxidative metabolism. The large and comparatively slowly propagated impulse following stimulation in Nitella made it seem ideally suited for metabolic study of the single action potential.

Oxygen consumption was measured in Schmitt's modification of the Fenn respirometer, using a travelling microscope on a micrometer screw mounting, calibrated in microns, to follow the movement of the kerosene index droplet. The resting respiration of the cell (0.015 to 0.02 mm.^{3} O_2 per min.) was increased 50% to 100% during repeated electrical stimulation (once per minute for a ten minute period). Thyratron incremental temperature control to 0.001° C. made it possible to measure the changes following a *single* stimulation. An increase of 20% or 30% in O_2 consumption followed for some 10 or 15 minutes after a *single* propagated action current, gradually returning to the resting rate. Much smaller increases followed action currents restricted to only part of the cell; there was no increase on repeated subthreshold stimulations, nor any volume change on continued flow of much larger currents through a dead cell.

A frequent characteristic of the respiratory response was a temporary *decrease* of the rate of movement of the index drop for about 5 minutes following stimulation, before the increase appeared. This was not a temperature artifact, but

could represent either a momentarily decreased respiration rate, or an R.Q. temporarily greater than unity, (the extra volume of CO_2 being a little too slowly absorbed by the KOH.)

In an attempt to clarify this temporary decrease, an independent method of following CO_2 production, instead of O_2 consumption was employed. This was by $Ba(OH)_2$ conductivity on a micro-scale, which may be useful for other studies. A thin film of $Ba(OH)_2$ on a filter paper strip was brought close to the cell in a closed vessel of small volume. The electrical resistance rise of this film during precipitation of $BaCO_3$ was followed in a bridge circuit using a high gain amplifier and 1000 cycle oscillator. Resting CO_2 production caused a uniform rate of resistance rise. A marked increase of CO_2 production followed *immediately* after a single stimulation, in contrast to the apparent decrease in O_2 consumption suggested by the first 5 minute respirometer interval. The latter may therefore be due to a gush of CO_2 production which is not immediately absorbed by the KOH.

Whether ammonia production is involved in the initial counter movement is still to be answered.

Neither irritability nor its accompanying excess CO_2 production could be abolished within periods up to 24 hours in purified hydrogen.

(This article is based upon a seminar report presented at the Marine Biological Laboratory on August 20.)

DEVELOPMENTAL CHANGES IN APICAL MERISTEMS

Dr. W. Gordon Whaley
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The apical meristem is to be considered as a continuing embryonic area in plants. This is in contrast to most of the seed embryo, which is partly matured before the seed is ripe, and completes its maturation during germination or soon after. In the apical meristem the cell number and the whole volume both increase greatly during early growth, but as the plant gets older both fall off somewhat and stabilize at a relatively constant level. With age, the cell size falls faster than the nuclear size, suggesting that the increasingly small relative amount of cytoplasm is unable to maintain the rate of cell division. There is some correlation between the size of the meristem and that of the organ which it is to produce; large meristems, for instance, give rise to large flowers or fruits. Differentiation of fixed germinal layers was not found to be a constant feature, but often did not appear until the plant had reached a considerable age, if at all. The outermost layer, however, was definitely more tough, the cells more firmly united, than the tissue within. On this basis a differentiation between a firm outer layer and the inner tissue could be recognized even if no three-layer differentiation (dermatogen, periblem, plerome) could be histologically established.

(This article is based upon a seminar report presented at the Marine Biological Laboratory on August 20.)

THE BIOLOGICAL FIELD STATIONS OF SPAIN AND PORTUGAL

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The biological stations of Spain have developed mainly through the efforts of Professor Odón de Buen who was director of the Spanish Institute of Oceanography from its foundation in 1914 until the end of the Spanish Civil War. Field stations sponsored by this institution are located at Santander on the Bay of Biscay, at Vigo on the Atlantic Ocean, at Málaga on the Strait of Gibraltar, at Palma on the Balearic Islands in the Mediterranean, and at Las Palmas on the Canary Islands in the Atlantic. Less important stations are situated at San Sebastian (*Sociedad de Oceanografía de Guipúzcoa*), at Valencia (*Laboratorio de Hidrobiologia*), and at Chico (*Estación de Biología Marítima*). Of the two biological stations in Portugal, that at Dàfundo is the larger. There is also a field laboratory at Porto (*Station de Zoologie "Augusto Nobre"*).

The first biological station to be established on the Iberian Peninsula was at Santander in 1886. It was founded by D. Augusto Gonzáles Linares as the Marine Station of Experimental Zoology and Botany. Since 1914 it has been attached to the Spanish Institute of Oceanography as the chief center of oceanographical research on the Atlantic. Also on this ocean there is a small laboratory at Vigo. This was established in 1934 and was in the process of organization at the beginning of the Spanish Civil War. The third Atlantic station maintained by Spain is on the Canary Islands. This was established in temporary quarters in 1928 for a systematic investigation of the

oceanographic and biological conditions in the vicinity of the Canary Islands.

Perhaps the best known biological station in Spain is at Palma de Mallorca on the Balearic Islands. It was founded in 1906 by the Ministry of Public Instruction through the efforts of Professor Odón de Buen who had previously done research at the Laboratory Arago at Banyuls-sur-Mer, France. By the beginning of the Spanish Civil War, this station had a large physical plant, containing a museum, aquarium, library, storerooms, preparation rooms, photographic rooms, and laboratories for chemistry, biology, and oceanography. The institution had several boats for research purposes and the use of the gunboat, *Vasco Nuñez de Balboa*, for hydrographic expeditions. The work of this laboratory consisted of research in oceanography, public education, the instruction of university students in marine biology, the collection and sale of marine specimens, and furnishing research facilities to visiting investigators. The director of the laboratory in recent years has been Francisco de P. Navarro, although Professor Odón de Buen has done research at Palma de Mallorca almost every year since 1906. In 1914, Dr. de Buen organized the biological station at Málaga which was transformed by him into the International Center for the Study of the Sea in 1935. The following year a large new laboratory building to house this station at Málaga was dedicated in the presence of the First Conference for Spanish-American Oceanography.

The Spanish Institute of Oceanography (*Instituto Español de Oceanografía*), to which most of the marine stations in Spain are attached, was organized in 1914 when Professor de Buen realized the need for a central institution to coordinate the marine researches of Spanish scientists. Sponsored by the Ministry of Marine, this institution was especially concerned with research in general oceanography, oceanographic chemistry, marine biology, and fishery economics. The headquarters of this institution was in Madrid where it maintained research laboratories in addition to its field stations. The serial publications of the Spanish Institute of Oceanography, which contain much of the research work done at the field laboratories, include *Resultados de Campañas y Trabajos, Notas y Resúmenes, Memorias,* and *Boletín de Oceanografía y Pesca.*

The Vasco da Gama Aquarium and Station of Marine Biology (*Aquário Vasco Da Gama—Estação de Biologia Maritima*) is located in the suburbs of Lisbon, at Dàfundo. It was established as a public aquarium in commemoration of the fourth centenary of the voyage of Vasco da Gama to India. In 1908 plans were made to establish a marine laboratory in connection with the aquarium. Because of lack of funds and the World War, a laboratory was not opened here until 1919. Sponsored by the Fisheries Administration of the Ministry of Marine, this station now conducts research in the biology and oceanography of the sea near Portugal and is host to any visiting investigators who may wish to establish headquarters at Dàfundo.

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In describing the biological stations of Spain, it is often difficult to decide whether to use the present or past tense, since the Spanish Civil War greatly affected the work of these institutions and nothing has been heard of them since the war ceased. When the rebellion began in July 1936, Professor Odón de Buen was doing research in the laboratory on the Balearic Islands. For reasons never fully explained to him, he was imprisoned in his own laboratory by General Franco's forces for six months and then had to spend an equal time in a hospital. Through the influence of the British Ambassador and scientific friends in several countries, Dr. de Buen was released during an interchange of prisoners. He went into voluntary exile with his family at Banyuls, France, where he had the opportunity once again to work at the Laboratory Arago.

It was at Banyuls that the author talked with Professor de Buen in the summer of 1938. He told how his two sons, formerly scientists in the Spanish Institute of Oceanography, had positions fighting with the Loyalist armies. He was proud that Professor José Cerezo, who was his colleague as chief of the department of chemistry of the Institute, became acting minister of foreign affairs for the Loyalist Government. He had little news about the five marine laboratories he worked so hard to develop. Word reached Dr. de Buen that the Italians had installed themselves in the laboratory building at Málaga and that the research ship, *Xauen,* had been sunk by the nationalists. Another scientific vessel, the *Tofino,* was in Loyalist hands and still in good condition. He admitted that the scientific work of the Institute had practically ceased since the war began, although its offices had been moved from Madrid to quieter Barcelona. The last issues of the Institute's serial publications appeared during the month that the war began, although research originating from work done at the laboratories appeared in foreign journals as late as 1937. Reminiscing in a small, second-story apartment, Professor de Buen was tired but hopeful, and he talked of building up the Spanish field stations as soon as the Loyalists won —which he knew they must.

The latest word the author has received about Professor de Buen was in a short note from A. Gonzalez Prada in which the latter said that the

great Spanish biologist was still a refugee in France in the summer of 1939. He was in serious financial circumstances and Professors Henry B. Bigelow and Thomas Wayland Vaughan were making monthly contributions on his behalf.

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This series of articles on the biological stations of Europe could not be adequately concluded without a section explaining where interested students and investigators may obtain further information about these institutions. There is, unfortunately, no up-to-date manual on the biological stations of Europe. One of the most complete directories of these institutions is Professor Charles A. Kofoid's *The Biological Stations of Europe* (U. S. Bur. Educ., Bull. 440. 360 pp.). Although this bulletin was published in 1910, much of the material in it is surprisingly correct today. A more recent directory, although limited to marine stations, is Thomas Wayland Vaughan's *Catalogue of Institutions Engaged in Oceanographic Work* (in International Aspects of Oceanography. National Academy of Sciences, 1937, pp. 73-225). Older but often useful accounts of the European stations are those by Bashford Dean (American Naturalist 27:625-37, 697-707. 1893), by René Sand (Revue de l'Université de Bruxelles 3:23-47, 121-51, 203-35. 1898), and by Chancey Juday (Trans. Wisc. Acad. 16:1257-77. 1910). The best manual of freshwater institutions is Fr. Lenz's *Limnologische Laboratorien* (Handbuch der Biologischen Arbeitsmethoden 9:2:1285-1368. 1927). Short notices on the work or personnel of these laboratories have appeared occasionally in The Collecting Net, *Chronica Botanica*, and *Nature*. The most complete list of the biological stations of Europe may be found in the September 1938 issue of *Chronica Botanica* (4:301-83). Finally, mention perhaps should be made of the author's directory of the 263 biological field stations of the world which he hopes to have published soon after the cessation of the current war.

THE AMAKUSA MARINE BIOLOGICAL LABORATORY

(Continued from page 193)

a 4-horsepower oil engine can work with two pumps, which drive seawater up into a water-tank with a capacity of about 20 kilolitres. The tank is placed about 11 metres high about the level of the laboratory and aquarium, and is embedded deep in the earth, so as to keep seawater always cool. For dredging and short excursions a 6-horsepower motorboat is in use, besides several small row-boats for other purposes.

The latitude being 32°32′ N., the climate here is mild thanks to the branch of the warm current "Kuro-Sio" flowing northwards off along the west coast of Kyūsyū. The shores near around the laboratory offer almost every possible variety of biological conditions, such as rocky cliffs, sandy beach with raging surf, quiet inlet where sandy or muddy flats become exposed at low tide, etc.

The marine fauna of the seas surrounding the site of the laboratory is rich. From among the many notable forms known to occur here, the following ones may be worthy of especial remark. *Devonia semperi*, the highly modified bivalve, lives commensally with the synaptid *Protankyra bidentata*. Besides this, the 6-legged crab *Hexapus sexpes* and two species of polychaete annelids live in the burrow of this synaptid. Coeloplana, Kishinouyea, Haliclystus and Olindioides are often found in the eel-grass zone of the shallow part of the gulf. The large solenogastre *Epimenia verrucosa* is not rare in the rough outside sea, while submerged reef of Acropora harbors many coral-reef dwellers. *Branchiostoma belcheri* occurs abundantly in the Gulf of Ariaké, north of the Amakusa-Group.

More than 80 papers have hitherto been published as products of the investigations done here by a few workers, most of them dealing with morphology, embryology and systematics of marine invertebrates. Mr. K. Baba has been staying here since 1932, working a good deal on opisthobranchs and solenogastres. Recently two other resident workers have been added: Mr. S. Miyake of decapod crustaceans, and Mr. S. Murakami of ophiuroids.

The faunistic survey of the locality is still imperfect: the harvest is rich and the laborers are few. Much should be done also in physiological and ecological fields of those marine animals within easy access.