the Uredineae. A summary of each chapter at the end of the book gives the hurried reader a chance to grasp the main features of the work. The book is dedicated to the long and favorably known English mycologist, William P. Grove. Space does not permit a detailed outline of the work, but some general idea of the fungi dealt with can be seen by the following short summary.

The Psathyrella sub-type of mushrooms is illustrated chiefly by *Lepiota cepaestipes* which takes twenty-two pages of descriptive matter, while *Lepiota procera* occupies six more of the first chapter, and *Psathyrella disseminata* takes up the second chapter of thirty-one pages. Chapter III deals with the Bolbitius sub-type, chiefly *B. flavidus,* and a comparison with the fruiting body of the genus Coprinus. The IV chapter treats, in more or less detail, with *Armillaria mellea, Marasmius oreades, Amanita rubescens, Amanitopsis vaginata,* Collybia sps. (chiefly *C. radicata*), *Pluteus cervinus* and *Nolanea pascua.* Chapter V is short, dealing with another sub-type illustrated by Inocybe. Chapters VI to XI, comprising two hundred and thirty-nine pages, treat of the Coprinus like fungi of which details are given of *Psathyra urticaecola, Coprinus plicatilis, C. comatus, C. sterquilinus* (treated in detail), *C. atramentarius, C. stercorarius, C. picaceus, C. lagopus* and *C. micaceus.*

The remaining chapters of this first part deal with the toadstools from a different point of view. For example, chapter XII treats of bioluminescence, giving detailed observations made on *Panus stypticus* form *luminescens,* found in North America, the European representative of this species apparently being non-luminous. A list of eighteen luminescent mushrooms is given and short notes are included on other fungi, bacteria and animals in which this phenomenon has been observed. Chapter XIII deals with fungi parasitic on other fungi, details being given of those agarics found on other agaric species. The final chapter treats of the nocturnal spore discharge of species of Pleurotus and a method of detecting it by an electric hand-lamp.

Part II of the book is comparatively short, dealing with the Uredineae in three chapters. The first of these considers the phenomena of spore discharge as illustrated by species of Puccinia, Endophyllum and Gymnosporangium. Chapter II discusses the teleutospore and the curvature of its basidium in relation to the dispersal of the basidiospores, illustrated chiefly by the germination of *Puccinia malvacearum.* Chapter III concludes the work with a discussion of spore walls and the dispersal of spores by water and wind.

While on the whole these books of Buller's are of chief value to the mycologist, there is much of interest to the general student of nature. Manitoba seems very remote even to an American, yet when an English trained botanist makes it his home and turns out such stimulating and exact work, we realize more fully than ever that the man, rather than the environment, counts most.

G. P. C.

Tales of Fishing in Virgin Seas. By ZANE GREY, author of Tales of Fishes, etc., etc. Harper & Brothers, New York.

ZANE GREY'S "Tales of Fishing in Virgin Seas" is an angler's book de luxe. It is elegantly printed on fine paper in large clear type, with a hundred illustrations, handsome and instructive. It describes in detail a three months' cruise of a three-masted schooner from Nova Scotia, answering to the name of *Fisherman* (née Marshal Foch). The angling described was all for giant fish of the open sea, especially sword-fish, sail-fish, marlins, tunnies and albacores. Incidentally also were taken groupers (garrupa), barracudas, onos (Acanthocybium) papagallos (Nematistius) Cavalla (Caranx), and others of less note and size.

To the ichthyologist the book is welcome as it gives records of these giants in waters which had never been fished before. Of a new species of sail-fish or volador, described by the writer in a paper now in press, a hundred or more were caught by Mr. Grey and his associates, and several excellent photographs are presented. Useful accounts are given of the ways of several of the marlins ("Marlin spike-fish") and of the yellow finned tunnies. A black marlin similar to others of Hawaii and Japan (Makaira mazara) was obtained off Guerrero in Mexico, and a good photograph given. Some other species may be new to science, but without good photographs one can not be sure. It is from photographs only that we can define most of these species, as mounted examples and casts must remain rare, and a black marlin of half a ton or more, or even a sword-fish of half that size, does not rest comfortably in a bottle.

DAVID STARR JORDAN

SCIENTIFIC APPARATUS AND LABORATORY METHODS

OIL-WATER MODELS ILLUSTRATING SURFACE FORCES AND FILMS IN BIOLOGICAL PHENOMENA

THE following models have been found useful as demonstration experiments in connection with the courses in pharmacology in this laboratory. They simulate the phenomena of Brownian motion, ameboid motion, pseudopod formation, contractility, cytolysis, chromatolysis, phagocytosis, anesthesia and selective swelling. The phenomena of adsorption, diffusion, lipoid solubility, competition of solvents, permeability, etc., which are responsible for the kinetic phenomena, are simultaneously illustrated. It is believed the experiments help to visualize cell surface phenomena and illustrate their physical-chemical basis.

The experiments are conveniently demonstrated to groups of students, or the results may be projected on a screen before the entire class. As the experiments can be quickly repeated without trouble, either method is convenient. Students may practice the experiments themselves, but we have found it more satisfactory to demonstrate them. The brief explanations and suggestions accompanying the following directions make no pretense at completion and are included with the hope of stimulating the student's imagination in the application of physical-chemical principles in the fundamental aspects of pharmacological phenomena.

SURFACE FORCES AND FILMS AND ANTAGONISM OF CALCIUM IN CONTRACTILITY

The castor oil used in all the experiments is colored red with 0.5 per cent. of scarlet red.

Three drops of castor oil are placed on distilled water in 4 evaporating dishes and on tap water in one dish; immediate spreading of the castor oil. Then add the following reagents, one to each dish:

(1) *Soap Granule*: Immediate constriction of castor oil drops.[1]

(2) *Turpentine*: Gradual constriction of castor oil drops, which return to previous size as the turpentine film constricts. The tendency to spread in distilled water is less than in tap water or distilled water containing salt. Addition of enough turpentine to make a film over all the water causes permanent constriction of the castor oil.

(3) *Kerosene*: Castor oil drops remain unchanged and kerosene film shows no marked tendency to spread, but when the water phase is stirred the castor oil drops constrict.

(4) *Caprylic Alcohol*: Immediate constriction of castor oil. The caprylic alcohol breaks up explosively, shooting small droplets from its periphery, which spread out, producing streams with definite direction. When the activity is over, the castor oil drops increase to a greater extent than before and show sluggish movements.

(5) *Antagonism of Calcium*: Add a granule or touch a bar of soap to tap water or distilled water containing a little calcium chloride (about 0.0025 per cent.), on which have been spread three drops of castor oil; immediate constriction of oil drops which return to previous size on withdrawal of the soap, simulating recovery from, or relaxation after, contraction. The contraction-relaxation, simulating pulsation, may be repeated several times. High concentrations of soap or calcium tend to obscure the phenomena. Sodium chloride is ineffective. The addition of calcium to the soap-oil experiment in distilled water is ineffective, perhaps owing to unreactivity (insolubility) of calcium in the lipoid soap interface.

At least two explanations of the changes in the castor oil suggest themselves. A drop of oil on water assumes a shape conditioned by at least three factors: (a) Its own cohesive forces, leading to surface tension, which tends to cause it to assume a spherical shape with minimum diameter; (b) gravitation, which tends to flatten out the drop, increasing its horizontal diameter; (c) the cohesive force of the molecules of water, *i.e.*, the surface tension of the water, resisting the deformation of the water surface by the oil drop. The greater this force the less can the drop assume a spherical shape, and the drop must thus acquire a greater horizontal diameter. Accordingly, anything increasing the surface tension of the oil will lead to a decrease in the horizontal diameter, *i.e.*, a constriction, and conversely, anything increasing the surface tension of water will cause a spreading of the oil drop. Thus, the constriction from soap, caprylic alcohol, kerosene and turpentine may be explained as due to their lowering surface tension of water. All the agents used lower surface tension of water, but they do not constrict the oil drops to an equal degree. Therefore, another possibility is suggested, namely, the formation of a film of the added substance upon the surface of the water, so that a lateral circumferential pressure is exerted on the drop. This force is quite conceivable apart from surface tension changes. In fact, the films of soap and kerosene are recognizable with the naked eye.

The changes resulting from withdrawal of the soap in tap water, or distilled water containing calcium, are due to the influence of this bivalent ion, rupturing the film of soap by precipitation, thus liberating the castor oil which spreads. The fact that an excess of soap in tap water, or of calcium in distilled water, may obscure or prevent the spreading phenomenon suggests the importance of an accurate ionic balance and concentration such as exist in finely adjusted and sensitive biological systems. The influence of low concentrations of calcium on the oil drop phenomena suggests further something of the ease with which disturbances in function may be produced by this ion in virtue of surface effects.

[1] The castor oil-soap experiment was suggested to us by Professor Torald Sollmann.

BROWNIAN MOTION, CYTOLYSIS AND ANTAGONISM OF SOAP

(1) *Brownian Motion:* Place a drop of caprylic alcohol colored with scarlet red on water in an evaporating dish; immediate breaking up, shimmering and scattering from the periphery of each droplet in all directions. The constant instability reminds one of Brownian motion. The tendency of caprylic alcohol to break up and shimmer on water suggests lowering of surface tension of the water.

(2) *Cytolysis:* Same arrangement as above. Add a drop of caprylic alcohol to a drop of castor oil on a water surface; immediate breaking up of the oil drop from the bombardment by caprylic alcohol particles and simulating cytolysis.

(3) *Antagonism of Soap:* The addition of caprylic alcohol to castor oil on a water surface containing soap prevents dispersion of the oil, and the caprylic alcohol spreads over the castor oil drops and encloses them like a cytoplasmic covering. Apparently the soap film protects the oil and antagonizes the action of caprylic alcohol, though both soap and caprylic alcohol lower the surface tension of water.

ANESTHESIA AND DIFFERENCE BETWEEN LIQUID PETROLATUM (HYDROCARBON) AND CASTOR OIL (TRUE FAT)

(1) Place a castor oil drop on a water surface and expose to ether vapor by holding the tip of a pipette containing a small drop of ether in close proximity to the castor oil; expansion of the oil drop, simulating relaxation as in anesthesia. When the ether is withdrawn, the drop contracts to its previous size, simulating recovery from the anesthetic. Lipoid solubility with increase in volume of the drop and accumulation of ether at the surface resulting in lowering of surface tension are suggested as the explanation of this phenomenon. This action is counteracted if a granule of soap is previously placed in the water phase. Apparently a soap film is more powerful than the expanding effect of ether, the expenditure of energy in the system being rather marked.

(2) Place a drop of liquid petrolatum on a water surface and expose to ether vapor as above; no alteration in size of the liquid petrolatum, despite the good lipoid solubility of ether in this oil. It may be assumed that a different structure at the liquid-liquid interface has modified the response of liquid petrolatum to ether. Liquid petrolatum being without active polar groups does not combine with the water and adsorb the ether at the interface, while castor oil has active polar groups which combine with the water and with the ether. Apparently not all agents, or contractile tissues, behave alike toward anesthetics.

PHAGOCYTOSIS; AMOEBOID MOTION AND PSEUDOPOD FORMATION

(1) Place a drop of nitrobenzol alongside a drop of colored castor oil spread on a water surface; ingestion of nitrobenzol, suggesting phagocytosis in virtue of lipoid solubility. Then a gradual abstraction of the dye from the castor oil by the nitrobenzol supervenes due to competition of solvent for the dye and simulating exchange of metabolite.

(2) Same arrangement as in (1) above, but with a granule of soap in the water phase. The same phenomenon occurs, but much more slowly. There is an increase in size of the oil drop, suggesting swelling, and alteration in its contour and shape, suggesting pseudopod formation. Here again the opposition of a soap film is demonstrated, this time against the lipoid solubility of nitrobenzol, and swelling.

MEMBRANE FORMATION AND ACTIVITY

(1) Place a drop of nitrobenzol upon a drop of colored castor oil on a water surface. A double ring forms within the castor oil consisting of a pale red outside ring and a deep red inside ring, the latter suggesting membrane formation from concentration of solute. The scarlet red passes into the space surrounded by the deep red ring (competition of solvent), which increases in size until it occupies the whole drop suggesting an active rôle of the membrane which allows a solute to pass through into the cell, and in consequence swelling of and increased pressure within the cell.

(2) Nitrobenzol dropped upon a diffuse drop of castor oil on water concentrates and ingests the oil drop as shown by swelling of the nitrobenzol drop and accumulation of dye within it due to competition of solvents for dye, and lipoid solubility, the oil being dissolved in nitrobenzol and illustrating a type of selective swelling.

NUCLEAR ACTIVITY, CHROMATOLYSIS, VACUOLE FORMATION, AND INTERCHANGE OF PRODUCTS BETWEEN CYTOPLASM AND NUCLEUS (RESPIRATORY ACTIVITY)

Place a drop of colored castor oil on a water surface containing soap. Cover the castor oil drop with caprylic alcohol colored with a little crystal violet. This gives a bluish cytoplasm-like envelope around the drop of red castor oil which acts as a nucleus. Then place a small piece (about ½ mm long) of soap within the caprylic envelope; the soap moves about energetically and vacuole formation and rupture of the nucleus (chromatolysis) are induced. Gradually, the color of the caprylic envelope changes from bluish to reddish blue, the dye passing into the caprylic alcohol in virtue of lipoid solubility and competition of solvent, the whole simulating interchange of products between cytoplasm and nucleus, or respiratory activity.

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A NEW TYPE OF ELECTRON SPECTROGRAPH

THE slit system of the instrument is essentially a Hull magnetron with a very narrow slit in the anode. This slit is parallel to the oxide coated filament which is mounted on the axis of the cylindrical anode and the whole is placed in a uniform magnetic field parallel to the filament. Before the electrons reach the anode they are acted on by both the radial electric field and the magnetic field as in the magnetron, but those which pass through the slit travel in circular paths under the action of the magnetic field alone. The condition for the focussing of the electrons is that they shall traverse a semi-circumference after passing the narrowest aperture in their path, and an analytical consideration of the angles of emergence from the slit shows that in a plane perpendicular to the filament, this condition is satisfied on the line through the filament perpendicular to that joining it and the slit. This focussing is very sharp, even for electrons accelerated by less than 30 volts if small electron currents are used, and it has been suggested that this may furnish an extremely accurate direct method of determining e/m.

With this apparatus, preliminary unpublished work, indicating that commercial photographic emulsions are very insensitive to electrons accelerated by about 30 volts or less, has been confirmed. It has been found, however, that when the emulsion is covered with a very thin film of fluorescent lubricating oil, it is sensitive to electrons of much lower velocities and its sensitivity to those of higher velocities is increased by 40 or 50 times.

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SPECIAL ARTICLES

ILLINIUM

AN important result of the development of Moseley's atomic number rule has been the impetus it gave to the search for missing elements. It is true that later arrangements of the Periodic Table indicated that eka-caesium, eka- and dwi-manganese, and eka-iodine were missing, but there were no theoretical grounds for supposing that eka-neodymium might exist, until Moseley's rule showed that element number 61 was still to be identified. Moseley's work was of inestimable value to one engaged in completing the list of chemical elements for several reasons: first, it gave definite information as to the existence and location of gaps in the Periodic Table; second, it gave a basis for the calculation, prior to its discovery, of the X-ray spectrum of an element and indicated a technique by which lines in that spectrum might be identified; and finally, it gave origin to a method of examination so searching that a mixture of two elements, so closely similar in chemical properties as to be almost inseparable, could be definitely analyzed. Were it not for the work of Coster and Hevesy on the X-ray examination of zirconiferous minerals, the presence in them of element number 72 would probably be still unsuspected and hafnium, or celtium, would still be listed among the rare earths. Chemical tests made on zirconium ores had frequently indicated the non-homogeneity of zirconium, but they could not give the definite proof afforded by an X-ray analysis.

The proof that a rare earth element was missing, whose atomic number would place it between neodymium and samarium, explained the sharp break in the sequence of properties that comes in the rare earth group between those two elements. The differences in solubilities of the double salts formed by rare earth nitrates with magnesium nitrate, appear to be quite uniform, excepting in the case of neodymium and samarium, since fractional recrystallization of that double salt will accomplish a strikingly sharp separation of those two elements. There is the same break in the sequence of solubilities of other salts, in basicity, as indicated by the rate of hydrolysis, etc. It also appears that the absorption spectra show the same general variation, and, as will be shown later, the absorption bands of number 61 seem to fit into the regular sequence.

Because element number 61 might be expected to share the striking similarity in properties and the common occurrence in minerals of the other members in the rare earth group, it seemed logical to institute a search for it in monazite sands, a mineral in which the first members of that family, the so-called cerium earths, predominate. Since that mineral is rich in neodymium, 60, and in samarium, 62, it would be surprising to learn of the absence of 61 there and its presence in a mineral containing little or none of 60 and 62.

The original material used in the investigation was the rare earth residue remaining from monazite sands after the extraction of thorium and part of the cerium for use in the manufacture of Welsbach mantles. It was donated to the laboratory by the Lindsay Light Company, of Chicago. After the remaining cerium was removed by the usual methods, the other rare earths were fractionally recrystal-