A well-regulated power supply and a 1,000-cycle oscillator are constructed on one chassis; a second chassis contains the amplifier and the detecting system. The power supply itself is a conventional full-wave unit with choke input filtering, anti-jitter type of voltage regulator, a Wein bridge-type oscillator, and a single-tube buffer amplifier, coupled to the input position of the Wheatstone bridge. The output of the bridge is connected to the input of a three-stage voltage amplifier, with a degenerative type of step gain control. This degeneration control serves to regulate the amount of deflection on the recording pens per kinetic unit of the bivalve. The voltage at the input of the amplifiers consists of a 1,000-cycle "amplitude modulated" audio note, with its amplitude varying in proportion to the internal movements of the oyster. Amplitude variations are removed by simple detection with dry disk rectifiers, whose output is sufficient to operate the recorder.

The recorders are the Esterline-Angus type with multiple ranges of 1, 5, and 10 ma. At these values the recorder requires a 2-v emf. This is derived from the

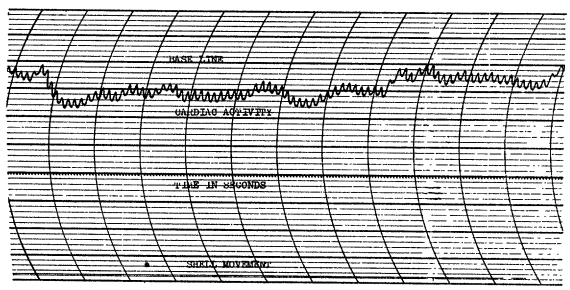

FIG. 3. An ostreodynagraph. The oyster shell is open. Total time of sample record, 3 min.

detector through the final tube of the power amplifier. In series with the recorder is the monitor meter which is used to balance the bridge and bring the output to a value within the range of the recorder.

In operation, the probe and coils are adjusted to fit the individual oyster (Fig. 2). The probe is adjusted so that the balance is slightly in favor of that part resting on the prenacreous membrane. The sensitivity of the pickup mechanism permits detection of slight rotational movements as well as the vertical movements of the probe.

The pen of the recorder can be controlled by the balance unit on the amplifier, allowing a base line to be set in any position. The amplitude of the recording can be regulated by varying the feedback in the amplifier or by varying the milliamperage range of the recorder. The bridge is operated slightly off balance so that the entire motion of a particular organ can be recorded without distortion (Fig. 3).

This instrument has been named an ostreodynamometer (ostreo—oyster; dynamometer—measurement of force). The records obtained are ostreodynagraphs.[2]

[2] Name suggested by S. R. M. Reynolds, *et al. Science*, 1947, **106**, 427.

The range of applications of the ostreodynamometer will have to be determined by use. Various types of strain gages, capillary columns, resistance pickups, or any conversion element changing to electrical impedance, can be substituted for the detector coils.

Its value at the present time lies in the fact that for the first time the encumbrances of the shells have been circumvented, making it possible to study the physiological processes of mollusks with a minimum of injury.

A detailed report of the construction of this unit, including wiring diagrams and drawings, will be made in another journal.

The Osmotic Activities of Sodium Penicillins F, G, K, and X[1]

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By means of surface tension measurements in 1947 Hauser, Philips and Philips (*2*) found that solutions of sodium penicillin G have a high capillary activity, a fact which led them to believe that such solutions are colloidal sols and not true solutions. Woodbury and Rosenblum, however, (*7*), have made conductivity measurements over a range of concentrations of sodium penicillin G and found that the salt behaves as a completely dissociated electrolyte of the 1: 1 valence type, with possible deviations due to ion size and interactions. In 1948 Kumbler and Alpen (*4*), employing both du Noüy's precision tensiometer and the capillary rise method, carried out surface tension measurements on aqueous solutions of crystalline sodium penicillin G and crystalline potassium penicillin G and found that solutions of penicillin G have a surface tension differing only little from that of water. Therefore, the solutions must be true solutions and not colloidal sols.

In the following we shall give an account of some experiments on the osmotic activity of penicillin solutions

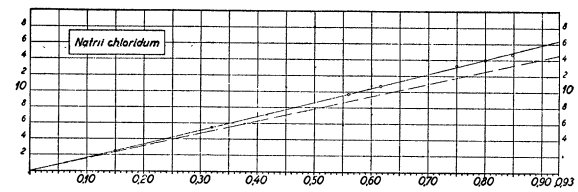

FIG. 1. Freezing point depression in °C (abscissa); concentration in 0.1 per cent (ordinate).

using relative vapor-pressure measurements, in order to throw more light on the subject by means of a third method of measurement, in addition to the two referred

[1] We wish to express our gratitude to the Antibiotic Study Section of the National Institutes of Health, U. S. Public Health Service, for the supply of crystalline penicillins F, G, K, and X used in these studies.

to above. In 1946 we examined the osmotic activity of the commercial penicillin preparations then obtainable, varying widely as they did in purity; pure sodium penicillin G was not available to us at that time (*5*). We had no doubt that a solution of sodium penicillin must be a true solution rather than a sol and would consequently have measurable osmotic activity. Some relative vapor-pressure measurements of pure crystalline sodium penicillins F, G, K, and X were made as follows.

For determining the relative vapor pressure of the solutions we employed Baldes' (*1*) modification of the method described by Hill (*3*). The apparatus consisted of a thermoelement with two small eye-shaped solderings capable of being enclosed in a small metal container, the walls of which are covered with filter paper.

For taking a measurement a small drop of the solution to be tested is placed in one eye and a similar drop of a standard solution in the other; the filter paper on the wall is also moistened with the standard solution. For the standard solution we take whichever concentration of a series of sodium chloride solutions (0–0.5, 1.0, 1.5 to 15.0%) is presumed to have a vapor pressure of the same order as that of the solution to be tested. The thermoelement is then placed in a Dewar flask with water, to ensure that the measurements can proceed at a constant temperature, and connected with a sensitive gal-

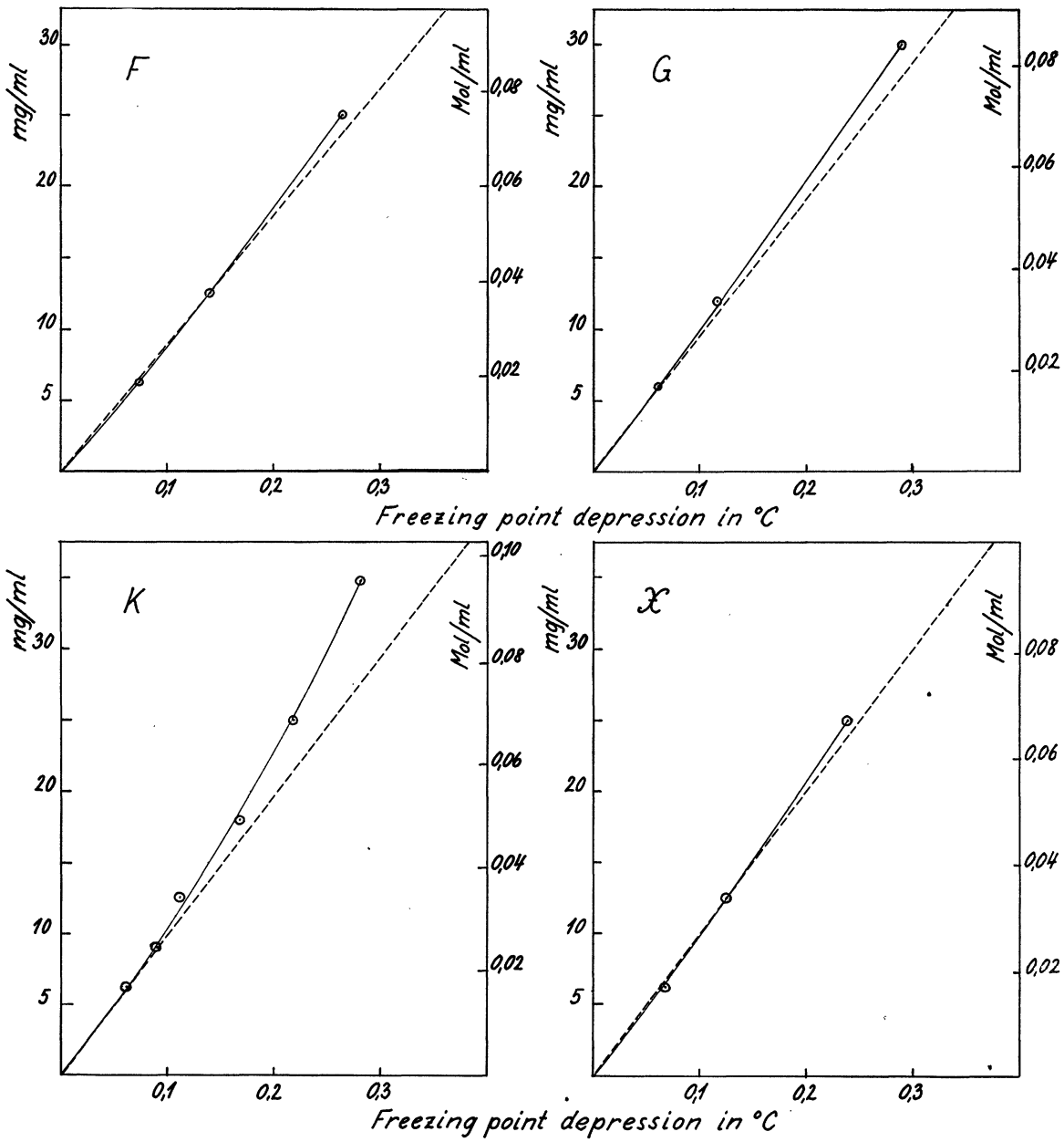

FIG. 2. Freezing point depression of aqueous solutions of sodium penicillins F, G, K, and X.

vanoscope. If the two drops represent solutions of different osmotic pressures, evaporation from the drops will differ. That having the lower osmotic pressure will evaporate more rapidly and thus become cooler than the other. The difference in the temperatures will generate a thermoelectric force which will register on the galvanoscope. By these measurements we then find the two successive standard solutions between which the vapor pressure of the test solution lies, and, with the aid of the registration values, we can by interpolation calculate the sodium chloride concentration that gives the same vapor pressure as the test solution. From this concentration, by employing the relation between sodium chloride concentration and freezing point depression (see Fig. 1) previously described (*6*), we can find the freezing point depression which the particular solution would give. The uncertainty in this determination is about ± 5%.

From the sodium salts of the pencillins we prepared aqueous solutions with 6.25–36.0 mg/ml solution.

In Fig. 2 the results found experimentally and converted to freezing point depressions are plotted as small circles. The continuous curves in the figure are drawn by transferring point by point the straight lines connecting the circles in a double logarithmic coordinate system to the arciform curves seen in the arithmetic system employed in Fig. 2. The relation between the concentration and the molar freezing point depression, calculated by Raoult's law, is shown in stippled curves.

The osmotic coefficients for 0.05 molar solutions of sodium penicillins F, G, K and X are as follows: F, 0.98; G, 0.94; K, 0.88; and X, 0.97. It will be seen that the osmotic coefficients for pencillins F, G, and X amount to 0.94–0.98, which corresponds to that for a 0.05 molar solution of sodium chloride. In a 0.05 molar aqueous solution of sodium penicillin K the osmotic coefficient is lower, 0.88, corresponding to the osmotic coefficient in a 0.05 molar solution of lobeline-hydrochloride. The low osmotic coefficient shown by the K penicillin is possibly due to the long heptyl chain in this molecule.

Not only the high value found for the osmotic coefficient, but also the fact that the osmotic coefficients of the sodium penicillins are of the same order as other dissociated electrolytes of the 1:1 valence type in similar concentrations, shows that these are true solutions.

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(*Continued from page 139.*)

movements of the limbs, causing the horse to roll over and over, were precisely those which are to be observed in the death struggle of a rabbit shot through the cerebellum."

D'Arcy Thompson was made Companion of the Bath in 1898 during Queen Victoria's reign, elected to the Royal Society in 1916, created knight in 1937. He received the degrees of D.Litt. (Cambridge), Hon. D.Sc. (Dublin and Witwaterstrand) and LL.D. (Aberdeen and Edinburgh). He was vice president (1931–38) and president (1934–39) of the Royal Society of Edinburgh. He was awarded the Darwin Medal in 1946. He was foreign correspondent and honorary member of a number of learned societies.

One spring morning in Paris, walking on the crowded boulevard, I heard my name called and saw a towering figure with massive sculptured head and long flowing beard, dart out from the tables of a sidewalk cafe. He greeted my wife, seized our hands, and pushed us into chairs. Seated opposite us, Sir D'Arcy, with no further ceremony, began to read to us a funeral oration that he was working on!

His last visit to this country was in 1936 on the occasion of his delivering six Lowell Institute Lectures in Boston, 79 years after his father had been invited to the same Institute. The subject matter of Sir D'Arcy's lectures is included in his book on Growth and Form. On his leaving New York for Scotland I went to see him off and found him on board with Leo Hendrik Baekeland, of Columbia University, the inventor of Bakelite. During the conversation, Professor Baekeland, who was 74 years of age at the time and only 3 years younger than Sir D'Arcy, remarked on my callow youthfulness in the presence of two septuagenarians. Sir D'Arcy, gazing at the magnificent panorama of New York from the Jersey shore said: "My hope is that I shall die young!"

Happily, he maintained his "youth" and at the age of 86 accepted an invitation to be one of four delegates to the Indian Scientific Congress in Delhi. He had been extremely well and was full of enthusiasm at the thought of ten days in Egypt before flying to India. But on his return the wear and tear of the journey had so depleted his strength that he was unable to recuperate from a protracted siege of pneumonia. He died June 21, 1948.

Sir D'Arcy was a man of the world, at home everywhere and with all conditions of people. He was a man of deep conservatism but with a quality of delightfully disarming revolt against the conventions. He had an inexhaustible sense of humor with touches of the oratorical, and was always an interesting companion and a solid friend.