An Ostreodynamometer for Studying the Activities Inside the Shell of Bivalve Mollusks[1]

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In conducting investigations on the effects of industrial pollution on oysters, it was considered necessary to develop an instrument capable of detecting movements within the shell without interfering with an oyster's normal activities.

The ideal method of recording cardiac, pericardial, visceral, or branchial activity should continuously yield data on the influence of chemical agents on the nature of activity in various tissues and organs. Thus, several indices could be established and compared to the activities occurring in a normal sea-water environment.

The instrument which we have devised (Fig. 1) records such activities electrically. Shell movements are recorded synchronously by a mechanical system. The principle involves the application of the carrier system of electronic amplification to direct recording, as used in strain-gage techniques. The key to the method is the specially

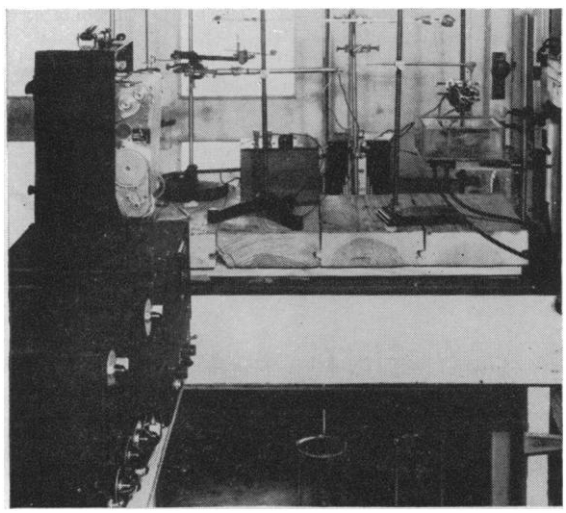

FIG. 1. The ostreodynamometer in working position. Power supply and amplifier (left); pickup device and salt-water distribution tanks (right).

devised pickup by which the imperceptible movements of a probe can unbalance a Wheatstone bridge.

Prior to the actual operation of the instrument, a small hole (1.5 mm) is carefully drilled through the valve of the oyster at the approximate position of the organ to be studied. The oyster is then allowed to recover until the thin prenacreous membrane has been formed. A natural

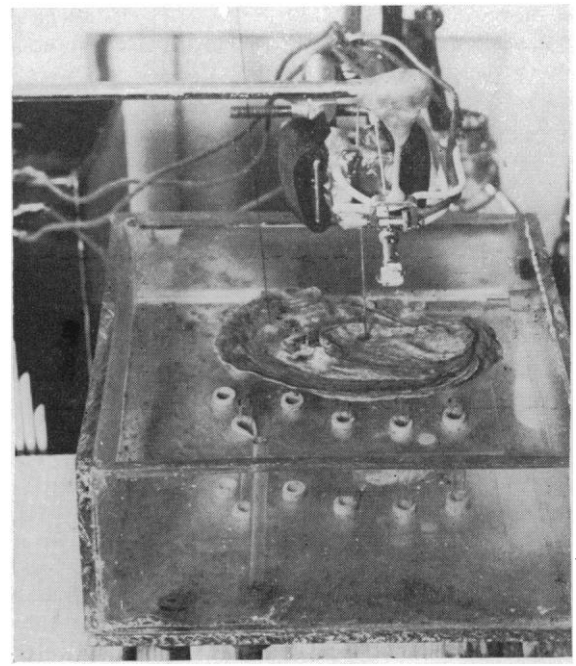

FIG. 2

membrane is thus utilized for the transmission of organ pulsations, e.g. cardiac, to a counterbalanced probe resting on the membrane.

The pickup mechanism in operation is shown in Fig. 2. The probe consists of an aluminum rod to which is attached a 10-mm fragment of silica steel and which, in turn, is counterbalanced by a simple lever. The steel fragment is inserted midway between the core of the detector coils and is equal in length to the thickness of one coil.

Two 6,000-ohm coils, adjacently connected, serve as the basis for the detection of kinetic activity. The fragment of steel transmits the mechanical movements of the probe. The coils are connected in a conventional Wheatstone bridge circuit in such a manner that, as the impedance of one increases, the impedance of the other decreases. The over-all current in the bridge circuit is thus held constant at the generator position, but variations in voltage are present at the detector. Since the impedance of each coil varies with the position of the probe, its fluctuations caused by the organ pulsations are converted into corresponding fluctuations of impedance. Since the current through the coils is constant, in accordance with Ohm's law, there is a fluctuation in voltage at the output of the bridge. This variation in voltage is proportional to the amount of movement of the probe.

Because the coils are adjacently connected, they cancel out stray magnetic interference and changes in impedance caused by variations in temperature.

[1] This instrument is being used at the laboratory of the U. S. Fish and Wildlife Service, Pensacola, Florida, in space allocated to the State of Louisiana for the purpose of conducting independent investigations.

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

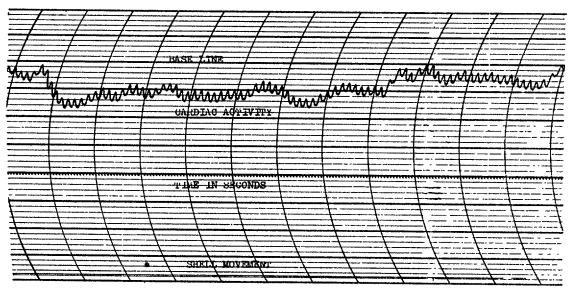

FIG. 3. An ostreodynagraph. The oyster shell is open. Total time of sample record, 3 min.

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

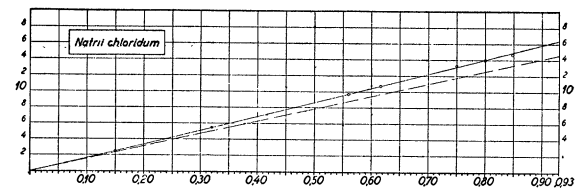

FIG. 1. Freezing point depression in °C (abscissa); concentration in 0.1 per cent (ordinate).

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.