Observations on embryos of Common Loons.—A recent perusal of the late Dr. William Rowan's field notes, which are now housed in the library of the University of Alberta, reminded me of the spring of 1932 when I assisted him in collecting embryos of the Common Loon, *Gavia immer*. At that time Rowan felt that if the loons were direct descendents of *Hesperornis* they might show vestigial tooth buds in their embryos.

Numerous embryos of various stages of development were collected from around the little muskeg lakes in central Alberta. The embryos were fixed in Bouin's fluid in the field and bills of up to 10 mm in length were sectioned serially. Some of the slides are still extant.

The sections failed to show tooth buds or anything unusual, as a recent examination has confirmed. As far as is known Rowan did not publish these negative findings.

These notes are written not only as an historical record but also to show the wider interests of the man who did so much pioneer work in the field of photoperiodism.—ROBERT LISTER, *Department of Zoology, University of Alberta, Edmonton, Alberta, Canada.*

A flight-time integrator for birds.—This note provides a preliminary account of our efforts to facilitate studies of flight behavior by designing and developing a device for measuring the total time spent in flight by birds. In conjunction with our developing interest in studying the bioenergetics of the Laysan Albatross (*Diomedea immutabilis*), we wanted specifically to learn what proportions of the total time at sea were spent in flight and on the water. Our instrument provides this measurement by responding electrochemically during the individual periods when a bird to which the unit is attached rests on the water; these response times are accumulated, or (mathematically speaking) integrated, to provide the total period of activity. Accuracy is increased by a second, continuously operating circuit which records the total time and thus makes calibration possible. Additional information with respect to the time of day during which the recorded activity occurs is, within broad limits, obtainable. The unit therefore provides the following minimum information: (1) the total time of operation (*i.e.*, for our intended use, the total time the birds are away from the nests and out to sea); (2) the total time of daylight (or some preselected level of illumination); (3) the total time spent on the water; and (4) the total time of activity (on-water) with the selected level of illumination (daylight).

Several alternative methods were considered for gathering the desired information and we concluded that the use of a minaturized electroplating system for measuring the time intervals was most promising and least demanding in terms of cost and effort. The principle of operation is based on one expression of Faraday's law which states that the number of ions liberated from solutions of various electrolytes is directly proportional to the total current passing through the solution. That is, if one has an electroplating solution and conducts a current through it, a part of the ions in solution will be deposited on one of the electrodes (the cathode or negative electrode) in an amount related to the current being conducted. If the rate of the current is constant, the deposition of ions will be proportional to the duration of current flow. Hence, the length of time of the current flow can be determined by weight changes of the cathode. With careful weighing, we could obtain 99 per cent accuracy.

Our unit, which we call a flight-time integrator, is composed of several sub-assemblies; each sub-assembly estimates, by the above method, the time involved in one of

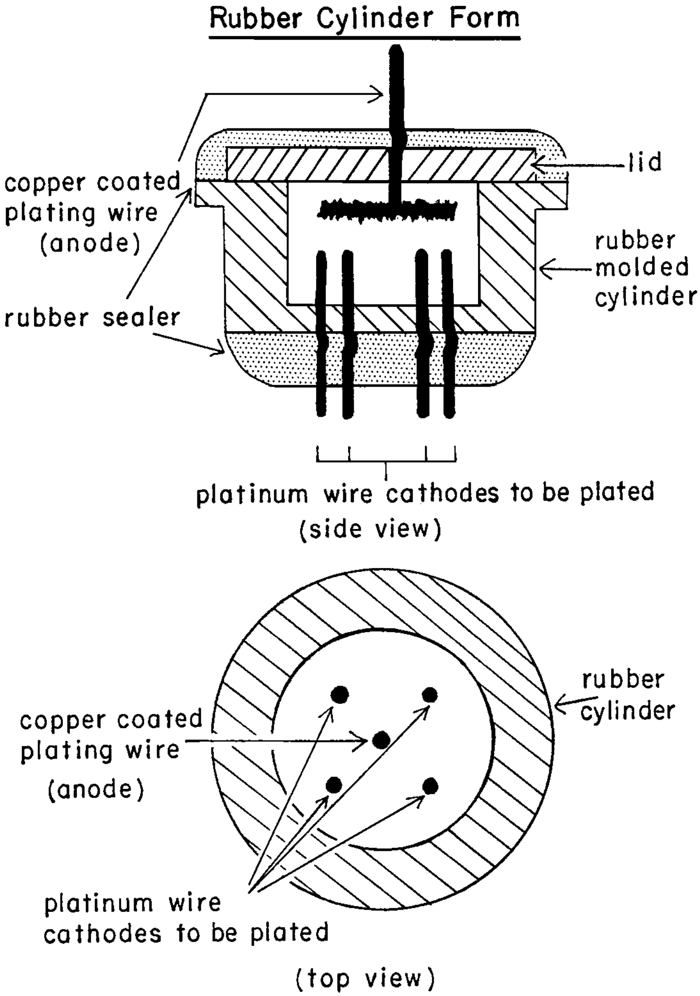

Figure 1. Diagram of the integrator section showing arrangement of electrodes and chamber for electroplating solution.

the activities. The integrator section (Figure 1) for the entire unit consists of a plastic or molded-rubber cylinder containing one, central, copper-coated, platinum electrode (the anode), a copper sulfate electroplating solution (for formula, see p. 33 of D. A. MacInnes, *The principles of electrochemistry*, New York, Dover Publ. Inc., 1961), and four plain platinum wire electrodes (the cathodes for each sub-assembly). In operation, copper ions from the solution are deposited on the cathodes and are replaced by copper ions going into solution from the anode. The determination of ion deposition is made by cutting off the cathodes at their bases. These are then weighed, placed in nitric acid to remove all copper, and weighed again.

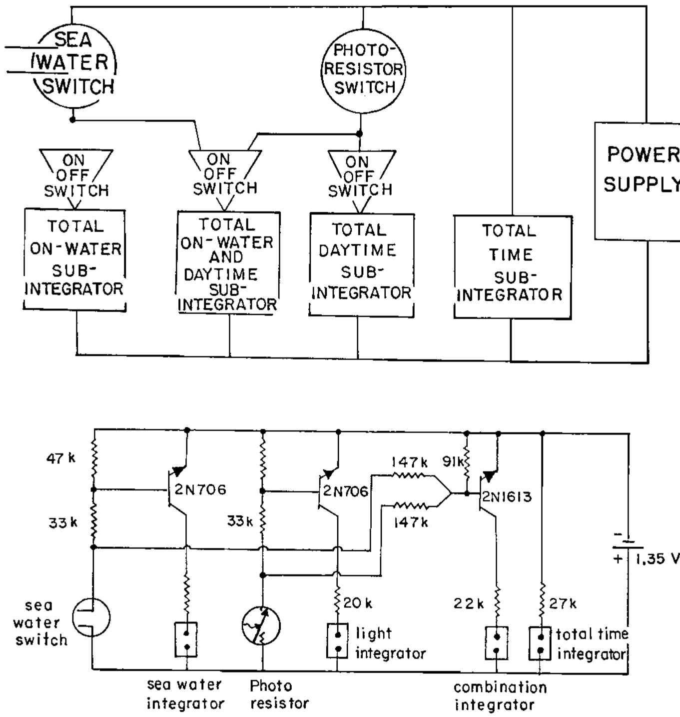

Figure 2. Above, schematic diagram of circuit for flight-time integrator; below, circuit diagram for flight-time integrator, unmodified for temperature sensitivity.

The four factors for which timed intervals were desired are obtained by means of the following circuitry (Figure 2).

The *total time measurement* is obtained by continual plating of one of the cathodes. A small battery provides power for a continuous current, which is kept constant by means of a resistor in the circuit. This measurement provides a means for calibrating the other integrators.

Total daylight measurement is obtained by plating a second cathode which is connected to a circuit containing a photoresistor cell. The photoresistor changes its resistance value inversely with light intensity. The photoresistor cell acts like a switch, and the level of light intensity necessary to activate the circuit can be selected by incorporating the correct amount of additional resistance in the circuit. We integrated only at and above the level of illumination characteristic of post-dawn and pre-twilight conditions. This selection recorded all daylight levels of illumination including that of completely overcast days. The required resistance was determined empirically.

The *on-water circuit* is activated by a sea-water switch consisting of two electrodes protruding beyond the packaging. These conduct electricity, for plating the third cathode, only when the device is in the water. For the albatross and other pelagic birds this appeared to be the easiest way to measure periods of no flight. It is possible to use other techniques to measure flightless periods and the first author is presently developing such a system that should be suitable for either land or sea birds.

The *combination measurement* is obtained by plating the fourth cathode only when the sea-water and photoresistor circuits are activated simultaneously. Hence, the degree of plating represents the time spent on water during daylight.

A small mercury battery supplies the current for the units. To insure that a constant current was maintained, transistors were placed in the circuits, thus the output is kept relatively constant regardless of input variations. Input variations would occur in an untransistorized circuit because changing light intensity and changing mineral content of the sea water would produce resistances in the photoresistor and sea-water switch circuits, respectively. Temperature effects on current flow were also to be expected and the system shown in Figure 2 was quite temperature sensitive. Therefore we have now included silicone diodes to reduce temperature-induced variations. Our modified unit operates from 10°C to 49°C, with a maximum error of less than 10 per cent.

Our complete unit had to be small, light, strong, and weather- and water-resistant. It had to be easy to attach and comfortable to the bird. We finally concluded that the integrator packaged within a 1.5 × 6.0 cm brass cylinder and clamped to the leg with a rubber-coated band would work satisfactorily. Figure 3 shows the linear arrangement of components in the finally designed package. The components were selected to be reasonably small and inexpensive; the total cost for the device was

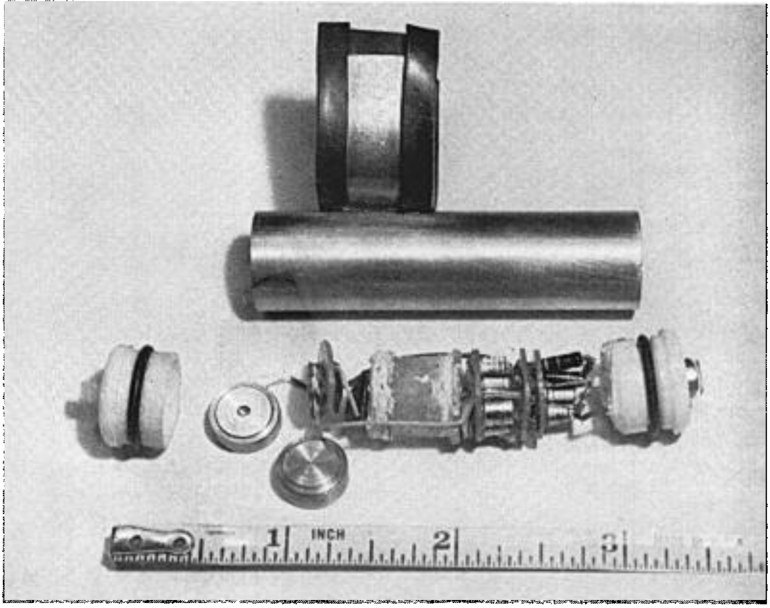

Figure 3. Linear arrangement of components. From left to right: plastic plug and 'O' ring sealer, battery and sea-switch section (opposite ½″–1½″), integrator section (1½″–2″), circuitry sections (2″–3″), and photoresistor cell embedded in a polyethylene plug with 'O' ring sealer. Above is the brass tube with attachment clamp.

approximately 35 dollars. The integrator can conceivably be made smaller by using commercially available micro-modular circuitry and may be suitable for studies for many species.

This instrument has been tested experimentally in the laboratory and on several captive Laysan Albatrosses. We have not, however, had the opportunity to make any actual measurements on free-flying birds. Any investigator having the opportunity to use this integrator is invited to apply to us for a chance to test this instrument. For more complete information on the details of circuitry and assembly, please write to the authors or refer to the technical note by Dorman, Rowley, and Birkebak (*A flight-time integrator for birds,* Heat Combustion Laboratory, Dept. of Mech. Eng., Univ. of Minnesota, Minneapolis).

We should like to thank William Rowley for his technical assistance in constructing and modifying the flight-time integrator. P. L. Blackshear and D. W. Warner are acknowledged for their cooperation on this project. This research was conducted at the Minnesota Museum of Natural History, University of Minnesota, and was supported by NIH Training Grant 5 T1 A1 188, NIH Research Grant GM-07345, and a grant from the Louis W. and Maud Hill Family Foundation, St. Paul.—Eugene A. LeFebvre, *Department of Zoology, Southern Illinois University, Carbondale, Illinois;* Richard C. Birkebak, *Department of Mechanical Engineering, University of Kentucky, Lexington, Kentucky;* and Frank D. Dorman, *Department of Mechanical Engineering, University of Minnesota, Minneapolis, Minnesota.*

Another record of active molt in passerine birds.—G. E. Watson (*Auk,* 80: 486–495, 1963) summarized the existing records of the occurrence of active molt in birds. However, his records for the Passeriformes included only two families, Corvidae and Fringillidae. While examining a specimen of the Slaty Vireo (*Neochloe brevipennis*), of the Vireonidae, I found several juvenal feathers from the interscapular region that had the broken-off caps of the keratinized feather sheath of the new first winter plumage attached to the base of the calamus of the old feathers. (See Figure 1C, p. 488, in Watson's article for a photograph of a similar situation in the Ruddy Sheld-Duck.)—Larry L. Wolf, *Museum of Vertebrate Zoology, University of California, Berkeley, California.*

Organisms consumed by various migrating shorebirds.—In view of the scanty literature concerning genera and species of food organisms of migrating birds, the data in Table 1 may be of some value. These data were gathered in conjunction with a study done in 1960 and 1961 for a Master's thesis at the University of Illinois.

Members of the following 10 species of shorebirds were collected, and the stomach contents analyzed: American Golden Plover (GP in Table 1), *Pluvialis dominica,* 1 specimen; Common Snipe (CS), *Capella gallinago,* 6; Greater Yellowlegs (GY), *Totanus melanoleucus,* 3; Lesser Yellowlegs (LY), *Totanus flavipes,* 9; Pectoral Sandpiper (PS), *Erolia melanotos,* 7; Least Sandpiper (LS), *Erolia minutilla,* 4; Dunlin (D), *Erolia alpina,* 2; Stilt Sandpiper (STS), *Micropalama himantopus,* 2; Semipalmated Sandpiper (SS), *Ereunetes pusillus,* 2; Wilson's Phalarope (WP), *Steganopus tricolor,* 1. All were collected at a shallow, mud-bottom pond near Champaign, Illinois, except the plover, which was taken in a field near Fisher, Illinois. This plover and one snipe were taken in spring, all others during the autumn migration.