Hemiprocnidae.—The first primary is some 3 mm. longer than the second in *H. mystacea* and slightly longer in *H. comata*, but in *H. longipennis* it appears to be slightly shorter than the second primary in most forms, and in *H. l. coronata* it is about equal. In all three species the tail is deeply forked, with the outermost rectrix strongly emarginated. These birds, unlike other Apodi, settle freely on trees and have much less modified wings.

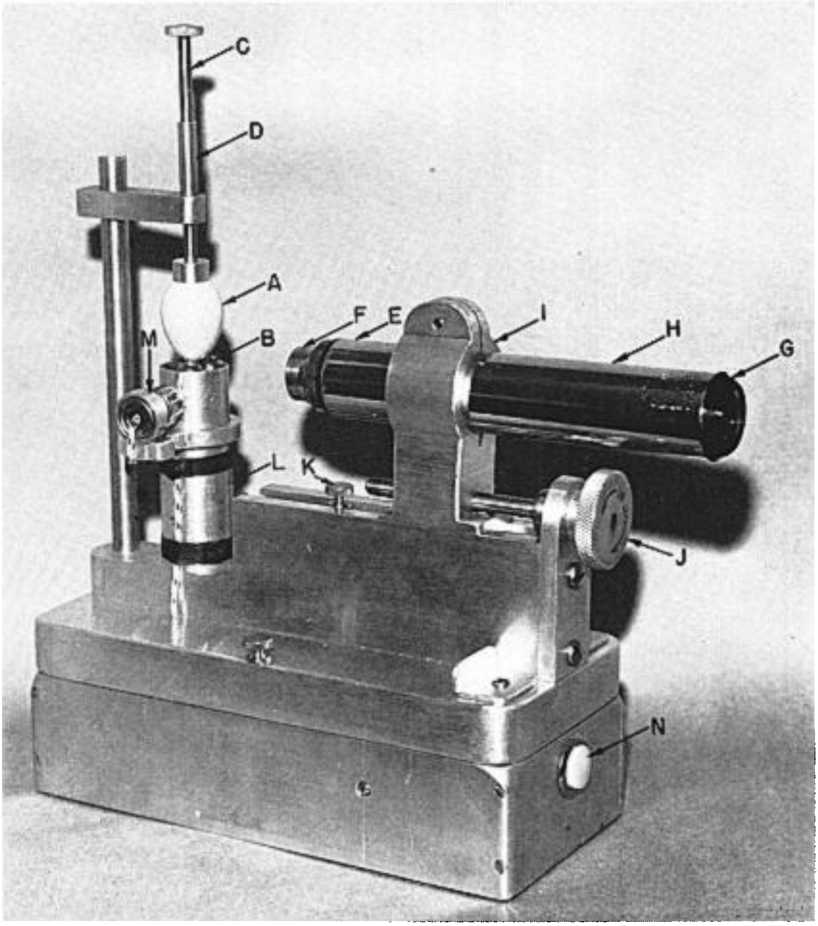
Conclusion.—In all swifts, the first primary differs from the rest in having a pointed, not rounded, tip, due to some emargination of the inner web. Hence by fully spreading the wing, a small gap can be made between the first and second primaries, and I have just been able to see such an apparent gap in a Common Swift (*Apus apus*) in slow flight near me. Presumably this gap functions as a wing-slot, and the difference in length between the first and second primaries, reviewed in this note, is doubtless associated with it in some way. The emargination of the outermost rectrix, where present, may also help in giving greater control in slow flight. Presumably, the difference in length between the first and second primaries is an aerodynamic adaptation, and I had expected that its apparent correlation with the extent of the tail-fork in the species of *Apus* might be repeated in the other genera of swifts. The present survey shows, instead, that the condition is complex. A detailed study of the flight actions of different types of swift will probably be needed before the differences described in this note can be satisfactorily interpreted.—DAVID LACK, *Edward Grey Institute of Field Ornithology, Oxford University, Oxford, England.*

Two New Devices for Measuring the Shapes of Birds' Eggs.—I have described previously (Auk, 70: 160–182, 1953) a device for copying the profile of an egg and so obtaining a complete description of its size and shape. This apparatus yields information of great accuracy, but in too complicated a form to be useful in routine work. M. E. Gemperle and I have also described (Auk, 72: 184–198, 1955) an apparatus for measuring the length, maximum breadth, and curvature of the two ends. In the last application this is a special form of spherometer. The apparatus works well for fairly large and robust eggs, but the pressure exerted by the plunger of the dial gage is too severe for small eggs, which are distorted or even crushed by it. This happens even with the finest jewel-bearing dial gages. It is, however, in regular use at Carnegie Museum for measuring the eggs of the larger species.

To deal with the eggs of the majority of the passerines and other small species, two new devices were added to the battery of instruments. One of these is an optical spherometer for measuring the curvature of the ends of eggs; the other is an automatic electrically operated machine for measuring length and breadth. A brief description of each follows.

Optical spherometer.—The "key move" in any spherometer for measuring birds' eggs is to set the egg upon three hard steel ball bearings arranged in an equilateral triangle. Upon these very smooth, highly-polished surfaces the egg will seat itself correctly; it will not seat itself properly on an ordinary "ring" or "tripod" type of spherometer. The steel-ball seat was used in the instrument previously described and also in the present instrument. Plate 16 shows an egg (A) of the European Starling (*Sturnus vulgaris*) seated, pointed end down, on the three steel balls (B) and held in place by the weight of a light aluminum shaft (C) sliding freely in a fixed sleeve (D).

The gap between two of the three steel balls faces the microscope (E), which has a long "working distance," i.e. a long distance between the object glass (F) and the object under scrutiny, in this case the end of the egg. It has also a fairly long "eye-



OPTICAL SPHEROMETER FOR MEASURING CURVATURES OF THE ENDS OF RELATIVELY SMALL OR FRAIL BIRDS' EGGS.

point," i.e. the distance between the human eye and the eye-piece (G) of the microscope.

Inside the microscope tube at a point represented approximately by the arrow (H), at the common focus of object glass and eyepiece, is a reticule which reads vertical distances to 0.001 inches. The zero point of this scale is adjusted to correspond with the center of the horizontal triangle represented by the highest points of the three balls, the "reference plane." An infinitely large egg, if it can be imagined, would therefore read zero. The adjustment is made by passing a needle point up between the three balls until it touches an optical flat resting on the three balls; the flat is then removed, the needle remaining in place. The carriage (I) which holds the microscope is then traversed by the screw (J) until the needle is in sharp focus, and then locked permanently in position by the lock screw (K). The height of the pedestal (L) that carries the three balls is now adjusted until the top of the needle reads zero on the scale. The calibration is checked by setting steel balls of known diameter on the other three and observing that the image of the lowest part of these balls comes to the calculated place on the reticule.

A small electric lamp (M) throws a beam of light horizontally through a small hole in the pedestal below the level of the steel balls, and a stainless steel mirror set at 45° to the vertical axis reflects this light vertically upwards so that it strikes the apex of the egg. This causes the image of the egg to appear white against a dark background. The boundary between light and dark is conspicuous and easily read in the microscope, which has a magnification of 40 diameters. The light is off except when the button (N) is pressed, connecting flashlight batteries, in the base of the instrument, to the bulb.

The instrument is "direct reading," the zero being permanently in place, and only one reading is necessary to determine the "sagitta" or "sink," from which the curvature can be obtained directly as explained in a previous article (Auk, 72: 184–198, 1955).

The steel balls are 10 mm. in diameter. The instrument scale reads in thousandths of an *inch*, but the curvature can be looked up in a table and read directly in millimeters.

The microscope is a standard instrument made by Bausch and Lomb; the mechanical parts of the instrument were made by Mr. George Wiest of the Preston Laboratories.

Automatic Measuring Machine for Birds' Eggs.—This machine, as mentioned above, is intended to measure the length and breadth of eggs that are too small and frail to stand the pressure of the dial gage plunger. It is suitable for eggs up to an inch (25 mm.) in length or a little more, but could readily be adapted to larger eggs. However, eggs larger than this are usually robust enough to be measured with the direct piston pressure on the instrument described earlier. Plate 17 is a front view of the instrument, with an egg of the Starling (*Sturnus vulgaris*) in place.

The plunger travels somewhat more than 25 millimeters, but the first digit (the number of centimeters, 0, 1, or 2) is not read from the dial, which reads in millimeters (up to ten) and hundredths of millimeters. There is no difficulty in estimating the number of centimeters and inserting it in the result.

The base of the instrument is a massive aluminum box, filled with heavy machinery, the details of which do not concern us here. It is supported on four legs or pads and is lifted by the handles (B). It operates on a 110-volt, 60-cycle circuit, like that of the ordinary domestic power lines.

The dial gage (C) is supported rigidly from a massive pedestal (D) at the back. The spring pressure of the piston (E) is taken up on a yoke (immediately below the arrow, E) attached to another piston (H), passing vertically through the pedestal (I), and this piston (H) is moved up and down by an electric motor in the base.

Below the piston is connected a hollow, cylindrical, plastic cage (F), through the bottom of which there passes a thin platinum needle or feeler (G). This floats in the cage and is connected by a very fine spiral wire, inside the cage, to the piston above.

The egg to be measured is placed on the top of a pedestal (K), around whose top is a sort of saucer (L) lined with velvet, to catch the egg if it should slip off the pedestal.

There is still another pedestal (Q) through which passes a manually operated piston (P), to whose top there is pivoted a horizontal arm (M) whose weight is just sufficient to keep the largest eggs we intend to measure from slipping out of position. When the weight of this arm is not being carried by the egg it is carried by the electric contact (N), which is connected by the wire (O) with the works in the base.

R is a 20-millimeter steel ball, used to check the calibration. With the ball substituted for the egg, the dial is required to read zero when it stops automatically.

S is a coarse manual adjustment for raising or lowering piston (P), and T is a fine adjustment. In practice T is used virtually all the time and S very little.

The method of operation is as follows. From a plug at the rear the instrument is connected to the electric mains and the "power on" switch is turned on. This lights the little glow lamp to the right of the switch. Push the "reset" button: the piston of the dial gage travels to the top of its stroke and cuts off its own activating power. Turn knob (T) to rack plunger (P) high enough to place the egg under arm (M); then lower arm, by means of knob (T), until it touches the egg. The light marked "level" will be on until we lower the piston (P) to a point where the pressure is taken off N and transferred to the egg. When this happens, arm (M) is level and the light goes out. The moment it goes out it is time to cease turning knob (T).

Assuming that the egg has been correctly positioned (vertical in the case shown), we are now ready to measure its length. Press the "start" button. The dial gage piston (E), cage (F), and platinum feeler (G) descend, very rapidly at first, the needle of the dial gage spinning around too rapidly to be seen. But as the feeler nears the arm (M), a differential gear is thrown into the system and the speed drops to one fifth. The instant the feeler touches a thin platinum disc soldered to the top face of arm (M), an electric circuit is completed and the motion stops dead. The dial gage now gives directly the length of the egg.

We may repeat the measurement by first pushing the "reset" button to raise the piston, and then the "start" button to lower it. The instrument will repeat to about 0.001 mm., which is 1/25,000 of an inch or two wave lengths of yellow light. There is, however, no point in recording to more than the second decimal place (0.01 mm. or 1/2,500").

The platinum feeler, being of negligible weight and floating freely in the plastic cage, exerts no significant pressure on the egg, and the arm (M) is also very light—just heavy enough to support an empty egg-shell. It will, of course, not support an unblown egg.

The instrument is probably delicate enough to measure the thermal expansion of egg shells, their variation with humidity, and any change arising with the passage of time, such as might occur from the drying of the protein or the recrystallizing of the inorganic fraction. On some of these matters we may report later. It will be used at first for the simple purpose of measuring egg sizes in a routine manner. —F. W. PRESTON, *Preston Laboratories, Box 149, Butler, Pennsylvania.*