GENERAL NOTES

An optical scope for examining nest contents of tunnel-nesting birds.—Demographic studies of tunnel- or burrow-nesting species have often suffered because devices used to collect data from within nest chambers have been relatively unsophisticated or lacking. We have brought optics into the design of such instruments. While we have used our optical scopes to aid in studies of breeding ecology of 3 tunnel-nesting birds (the Bank Swallow, *Riparia riparia*, and 2 African Bee-eaters, *Merops albicollis* and *M. nubicoides*), we suggest they are adaptable for a wide range of animals.

Analogous scopes, dubbed "Ripariascopes," have been mentioned in the literature (Peterson, Ph.D. thesis, Univ. of Wisconsin, 1953; Svenson, Vår fågelvarld 28:236–240, 1969), but in neither case were lenses employed. Without lenses, resolution of detail is impaired. With the scopes described here, it is possible not only to make egg, hatchling, and early nestling counts, but also to make out such fine details as the presence of small insects within the nest chamber and cracks in eggs. In addition, one can age nestlings because the various stages of feather tract development and pigmentation are easily recognizable.

Basically, the scopes are constructed of aluminum tubing, 25 mm in diameter, which is cut to the desired length. Illumination is provided by two 6-volt, .2 amp. miniature light bulbs (General Electric No. 328) which are mounted at the terminal end of the tube, distal to an elliptical mirror (2 cm × 3 cm) which is set at a 45° angle to the axis of the scope. The end of the tubing is partially cut away to allow light from the bulbs to reach the nest chamber and to be reflected by the mirror back along the axis of the scope to the observer's eye. Wires run from the bulbs along the exterior of the Ripariascope to a 6-volt battery which is suspended from the user's belt. Battery life is prolonged by a switch which activates the lights when desired.

We have built scopes of 2 optical designs. Fig. 1 illustrates a lens system which transmits an image equal in size to the object being viewed. The scope has a length approximately 4 times the focal length (hereafter abbreviated f.l.) of the field lens (lens 3). Hence, by appropriate selection of lenses, a scope of any desired length can be assembled.

Three lenses of the same small (30–55 mm) f.l. and a single longer f.l. field lens are required. Positioning of the lenses is shown in Fig. 1. Lens 1 focuses the image of the nest contents in the plane of lens 2, and lens 3 transfers the image to lens 4, the ocular.

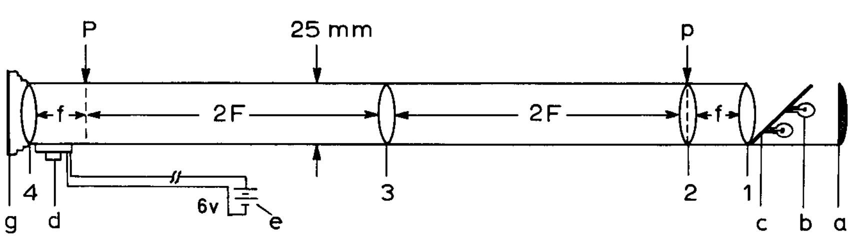

FIG. 1. Generalized Ripariascope lens system. Lenses 1, 2, and 4 are identical lenses of small focal length f (30–55 mm). Lens 3 is the main field lens of focal length F; a = protective endpiece, b = light bulbs, c = mirror, d = switch, e = 6-volt battery, g = rubber eyeguard, p and P = focal plane. Field lenses should be of the achromatic type to insure optical quality.

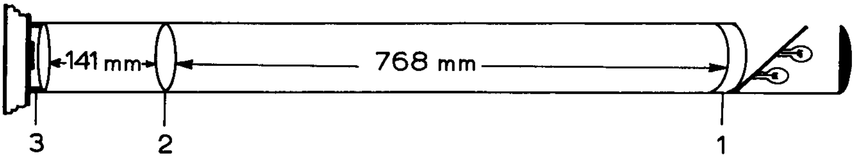

FIG. 2. Design for wide-angle viewing scope: 1 = –17.5-mm f.l. lens, 2 = 120-mm field lens, 3 = 20× eyepiece.

Since the field lens has a f.l. approximately ¼ the scope length, a field lens of f.l. 250 mm is suitable for a 1 m Ripariascope while a 600-mm lens makes a scope 2.4 m long. (Carmine Bee-eaters nest as deep as 3 m).

When looking into large nest chambers or examining large nestlings, it may be desirable to increase the field of view at the expense of magnification. We found a second scope design optimal for these purposes (Fig. 2). It incorporates a wide-angle lens (f.l. = –17.5 mm) as the first lens, a 20 × microscope eyepiece (f.l. = 12.5 mm) as the ocular, and a 120-mm f.l. field lens. The lenses are positioned according to the optical equation for magnification ($m = d_1/d_2 \times f.l._2/f.l._1$) in such a way as to reduce the final image to one-quarter size and increase the field of view 4-fold.

It is possible to extend the length of this one-meter scope by applying the principles illustrated in Fig. 1. For example if a scope of overall length of 1.6 m is required, a 600-mm extension must be added. To do this, position a 150 mm f.l. lens 2 focal lengths (300 mm) beyond where the ocular is located in Fig. 2. The microscope ocular is then mounted another 2 focal lengths away from this field lens.

We advise mounting the ocular lens in its own tube, the outer diameter of which matches the inner dimensions of the Ripariascope proper. Sliding adjustment of the ocular then permits accurate focusing. A very long scope will suffer light loss due to extraneous reflections unless the inside of the tube is coated with flat black paint. A rubber eyeguard also improves viewing by allowing accommodation of the eye to the light level within the scope. One final tip: we are careful to make the exterior of our scopes as round and smooth as possible. This minimizes the potential damage to a hole that can occur by accidental dislodging of dirt.

Once the nestlings begin to approach full size, the Ripariascope is no longer the optimal instrument. By this time, the entire field of view is filled by only a part of a single nestling's body. At this point, direct visual observation is preferable and we found that a headlamp held in the hand affords the best manipulation of light for peering down a long hole. With these 2 approaches, one is well-equipped to collect accurate data on all stages of the breeding cycle of tunnel-nesting birds.

We wish to thank James Ahlstrom, Bradford Howland, Robert H. Pohl, and Donald K. Riker for design suggestions.—NATALIE J. DEMONG AND STEPHEN T. EMLEN, *Section of Neurobiology and Behavior, Division of Biological Sciences, Cornell Univ., Ithaca, NY 14853.* *Accepted 26 Feb. 1975.*