bird arrived, and no calls were given (Bergstrom 1982). Thus the communication required for this cooperation must occur away from the nest, perhaps at the feeding ground.

Three ultimate explanations focus on the fact that a 24-hr pattern, with the sexes incubating at different times of day, could make the parental effort per unit time on the nest unequal in the two sexes. Females can recover energy spent on eggs most efficiently if males are on the nest when food is most available, allowing females to feed at those times (Miller 1977). The energetic costs of incubation probably differ between night and day, and this would affect the parental effort per unit time on the nest (Miller 1977), but these costs are known only for arctic shorebirds. The risk of predation while incubating may differ between night and day (Mundahl 1982), but very few data are available on this point. None of these three hypotheses are exclusive, but measurements of daily patterns of (1) food availability, (2) costs of incubation, and (3) predation rates could be used to test their predictions.

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VIREO: PROCEDURES AND SERVICES FOR THE ORNITHOLOGICAL COMMUNITY[1]

J. P. MYERS, R. F. CARDILLO AND F. B. GILL
Academy of Natural Sciences, 19th and the Parkway, Philadelphia, Pennsylvania 19103 USA

Key words: VIREO; photographs; slides; archives; Visual Resources for Ornithology.

In 1979 the Academy of Natural Sciences founded Visual Resources for Ornithology, VIREO, as a photographic analog of the traditional skin collection. The specific aim of the program is to make bird photographs available to ornithologists for research and teaching. Toward this end, during the six years since its founding VIREO has built a collection of over 90,000 photographs. At the same time, we have developed and implemented curatorial procedures to ensure the long-term safety of the collection. This article briefly describes basic principles governing the program and summarizes VIREO services now available to the ornithological community.

Why archive ornithological photographs? Photography plays a central role in the study of birds. Photographs document facts, reveal detail, convey information, and portray habitats and methods as well as the birds themselves. Yet of the countless bird photographs that have been taken during the last hundred years, relatively few are available for scientific study or teaching. Most lie buried in small boxes on dusty shelves in forgotten closets, functionally inaccessible even to the photographer after a few years.

Bringing disparate collections together into a central archive enables access to these photographs. Centralization has the additional beneficial effect of bringing the photographs into proper storage conditions. While some films

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are more stable than others, all slowly degrade with time even if stored in the dark. Age and use damage color emulsions. High temperatures, humidity, and projection hasten the decay.

VIREO METHODS

Three aspects of VIREO maximize accessibility of photographs while also ensuring their preservation:

(1) Archival storage conditions. VIREO houses original photographs and prime duplicates in refrigerators held at 1°C and 25 to 30% relative humidity. Prime duplicates are first-generation, reproduction-quality duplicates of images for which the originals are not in VIREO's possession. The storage conditions follow recommendations pioneered by Henry Wilhelm (Industrial Photography 27: 32–35), as modified by C. H. Greenewalt, E. S. Preisendanz, and E. B. Snell (pers. comm.). As calculated from Kodak extrapolations, this treatment extends the effective lifetime of the emulsions by more than 100 years.

(2) A working collection of duplicates for research. Of the 90,000 photographs in VIREO, we have duplicated approximately 3,600 and placed them in VIREO's working collection. This collection provides immediate access to the image content of the photographs without jeopardizing the safety of originals. Organized in taxonomic order, all working-collection slides are available for study at the Academy of Natural Sciences in Philadelphia. Duplicates of all but a few can be purchased for study or projection (see below).

(3) Computer management of associated data. Each slide in the working collection is described in a microcomputer data base in which various descriptors of slide content and source are recorded. Computer searches can be run by photographer, species, age, sex, plumage, behavior, social context, location, etc. Not all information is available for every slide because the quality and consistency of data varies widely among photographers.

THE COLLECTION

VIREO's working collection consists of four main subdivisions: Birds, Habitats, Methods, and People. Each of the parts is eclectic within its topic. Our accessioning goals are to attract materials that will be useful not only now but also through the next century.

Birds constitute the majority. As of 31 January 1985 the collection contains at least one slide of each of 3,300 species. Many species are covered by many more than one slide. All orders and 173 families are represented. As with a traditional skin collection, series of similar photographs facilitate comparisons for subtle patterns.

VIREO's coverage reflects geographic and taxonomic interests of contributing photographers. Well-covered are hummingbirds (C. H. Greenewalt), storks and flamingos (M. P. Kahl), penguins (R. T. Peterson and O. S. Pettingill), raptors (National Wildlife Federation's Raptor Information Center collection), North American songbirds (H. and A. Cruickshank, R. Hansen, E. Porter, B. Schorre, J. R. Woodward), Neotropical passerines (J. Dunning, C. H. Greenewalt, Louisiana State University Museum of Zoology, C. Munn), Australia/New Guinea forest birds (C. H. Greenewalt and W. S. Peckover), Swedish birds (C. H. Greenewalt and V. Hasselblad), and shorebirds (various). Gaps in our collection include Asiatic passerines, pigeons, and pheasants, flying waterfowl, Pacific alcids, and Spoonbilled Sandpipers. Our coverage can be expanded and improved for virtually every species, some more easily than others.

The photographic quality of bird photographs in VIREO ranges dramatically. On one extreme lies work of artistic elegance and technical excellence; on the other and more utilitarian side lie photographs that lack esthetic excellence but demonstrate scientific facts, document particular data, or illustrate esoteric identification points. This gamut of quality is essential to VIREO's collection.

Photographs of hand-held birds constitute an important but small component of the total collection. These come chiefly from banding stations and research ornithologists who handle large numbers of live birds. Their photographs often come with detailed histories of individual birds within the photograph.

The remaining parts of the working collection, Habitat, Methods, and People, all emphasize ornithological subjects. These currently total under 1,000 slides. The principal purpose of these parts is twofold: (1) to provide a depository for voucher and historical photographs in birding and ornithology, and (2) to offer a source of materials for teaching about birds and bird studies.

VIREO SERVICES

VIREO offers several distinct services to ornithologists. The working collection is open by appointment for review and study during normal working hours. No access fee is charged for scholarly, educational, or conservation work in ornithology.

Images in the working collection can be obtained as duplicate transparencies, except for a small number restricted by a few photographers. The current price is $2.00 per duplicate with a minimum order of 5 slides. No slides are loaned and no duplicates may be reproduced subsequently in any form. Special orders for prints can be made.

A list of North American species in the VIREO collection is available. This includes choices for most species of plumage, sex, age, and activity. More specific requirements, including species from outside the North American continent, should be requested by letter.

VIREO also sells one-time reproduction rights for many of its images. A review fee usually is waived for first-time users, and our commercial fees are competitive. VIREO images have appeared widely in natural history publications. Fees for reproductions in scholarly journals are minimal, to cover costs only.

Two additional services offered by VIREO focus on our role as an archival center: (1) In collaboration with ornithological journals, VIREO archives voucher photographs documenting critical points of published papers. Authors using this service can include VIREO accession numbers of specific photographs within their publication. Then if questions are raised in later years about the habitat conditions prevailing at the site when the original study was done, the photograph can be retrieved easily through its accession number or via the citation, which is cross-referenced in the VIREO data base. (2) VIREO and the American Birding Association have organized a centralized repository for photographs documenting distributional changes in North American birds. This program emphasizes birds at the extremes of their ranges, rarities, and especially those new to North America. The objectives are threefold: to make these documentary photographs available for objective review by the community; to place them in the public domain for the interest of birders; and more broadly, to develop standards and procedures by which such photographs can become part of the scientific data base through which distributional changes are documented.

CONTRIBUTING SLIDES TO VIREO

Ornithologists interested in contributing slides to VIREO should contact the authors. VIREO accepts black-and-white or color negatives or transparencies. If the contributions are originals, VIREO will provide the contributor with a reproduction-quality duplicate of the original, if needed. Our duplicates, made in-house, are equal to the

highest quality obtainable commercially and are virtually indistinguishable from the originals in terms of color and contrast. If the contributor prefers to retain the original, then we will make a reproduction-quality duplicate to house in archival storage.

Originals are stored in archival conditions and never handled by users unless they are essential for commerical reproduction; no commerical agency does more than VIREO to protect originals. Depending upon the terms of the contribution, commercial income can be shared by VIREO and the photographer.

VIREO was conceived and launched with the foresightful generosity of Crawford H. Greenewalt, for which we are deeply grateful. C. Wanton Balis, George Clark, John Dunning, John and Marjorie Foster, Helen Hauser, The Institute of Museum Services, Julius A. Rosenwald, Marilyn Steinbright, and The Women's Committee of the Academy of Natural Sciences have also generously supported this program. We thank members of VIREO's Advisory Council for guidance: J. Boswall, C. H. Greenewalt, P. S. Humphrey, S. Oresman, R. T. Peterson, S. D. Ripley, and J. A. Rosenwald. Our colleagues at ANSP, particularly R. S. Ridgely, M. A. Robbins, G. Lebaron, and D. Brauning, have devoted considerable time and effort to ensure the scientific accuracy of the collection. Finally, we are grateful for the collaboration of VIREO's many contributing photographers, whose efforts and involvement make VIREO possible.

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FOOD TRANSIT RATES IN CAPE GANNETS AND JACKASS PENGUINS[1]

RUDIGER C. LAUGKSCH AND DAVID CAMERON DUFFY
Percy Fitzpatrick Institute of African Ornithology, University of Cape Town, Rondebosch 7700, South Africa

Key words: Food transit rates; seabirds; carmine red marker.

Food transit rates in the Jackass Penguin (*Spheniscus demersus*), a piscivorous seabird, are slower (Duffy et al. 1985) than rates of birds with other diets (Warner 1981). However, digestive performance by the Jackass Penguin may not be typical of fish-eating seabirds. Food transit rates through the digestive tracts of volant seabirds might be faster than those of flightless species, since meals would represent a considerable addition to the body mass that would have to be lifted during flight. Rapid digestion and extraction of water from prey would reduce meal-mass (Ashmole 1971). We tested this hypothesis by comparing transit rates through the digestive tracts of Cape Gannets (*Morus capensis*) with existing data on Jackass Penguins and Cape Gannets (Davies 1956, Duffy et al. 1985).

MATERIALS AND METHODS

To measure transit time through the entire gut, the methods of Duffy et al. (1985) were followed. Four captive adult Cape Gannets were maintained on a diet of thawed Cape pilchard (*Sardinops ocellata*) supplemented by vitamin and salt tablets. Live fish (*Tilapia sparminii*) were injected intramuscularly with 0.5 ml of 10% carmine red solution and killed two hours later. Live pilchard were not available. Two experiments of 24- and 43-hr duration with two and three birds, respectively, were conducted. In both experiments the birds were starved for 24 hr to ensure empty stomachs and were then fed 10 *Tilapia* each. The average meal size per bird was 263 g (10% of gannet body mass, 2.6 kg) and 183 g (7% of gannet body mass) for the 24- and 43-hr experiments, respectively. Wilson et al. (1985) concluded that meal size did not affect digestion rate of Jackass Penguins, so we assumed that that the difference in meal size did not affect digestion by Cape Gannets.

During the experiment, individual birds were kept on a wire-mesh grid and the feces collected on plastic sheets beneath the cages. The sheets were changed every hour. The methods of Duffy et al. (1985) were slightly modified during preparation of the samples to ensure a more rapid stabilization of the color of the solution: the feces were washed off the plastic sheets with distilled water and passed through a small meshed sieve. The resulting solution was made up to a constant volume (300 ml). Samples of the solution were analyzed for the red color of carmine using a spectrophotometer set at 520 nm.

Data were expressed as cumulative percentages hr^{-1} of the total amount of marker recovered in 24 and 43 hr and the time taken for 5%, 50% and 95% of the marker to be recovered. The mean retention time (t) was calculated:

$$t = \sum_{i=1}^{n} x_i t_i / \sum_{i=1}^{n} x_i$$

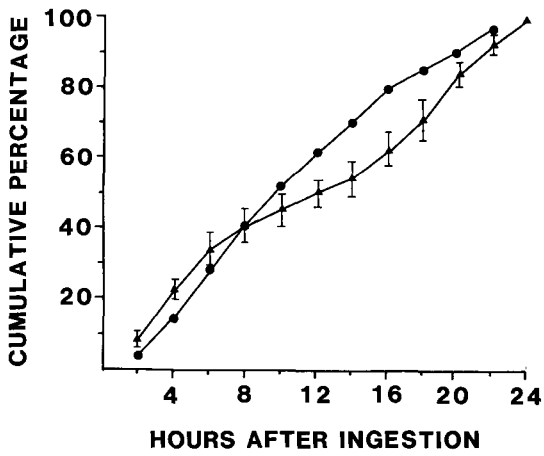

FIGURE 1. Cumulative percentage of carmine from *Tilapia* meals excreted by Cape Gannets (▲; $n = 5$) and Jackass Penguins (●; $n = 6$; Duffy et al. 1985) over 24 hr. Vertical bars are standard deviations.

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