FOX, A. D., J. MADSEN, AND D. A. STROUD. 1983. The summer ecology of the Greenland White-fronted Goose *Anser albifrons flavirostris*. Dan. Ornithol. Foren. Tidsskr. 77:43–55.

FOX, A. D., D. A. STROUD, AND I. S. FRANCIS. 1990. Up-rooted common cotton grass *Eriophorum angustifolium* as evidence of goose feeding in Britain and Ireland. Bird Study 37:210–212.

HOCHBAUM, H. A. 1955. Travels and traditions of waterfowl. Univ. Minnesota Press, Minneapolis.

JOHNSON, J. C., AND D. G. RAVELING. 1988. Weak family associations in Cackling Canada geese during winter: Effects of size and food resources on goose social organization. Pages 71–89 *in* Waterfowl in winter (M. Weller, Ed.). Univ. Minnesota Press, Minneapolis.

LAZARUS, J. 1978. Vigilance, flock size and domain of danger in the White-fronted Goose. Wildfowl 29:135–145.

PHILLIPS, J. C. 1916. Behavior and make up of the migratory flocks of Canada Geese. Auk 33:24–27.

RAVELING, D. G 1979. Traditional use of migration and winter roost sites by Canada Geese. J. Wildl. Manage. 43:229–235.

RUTTLEDGE, R. F. 1929. The birds of Loughs Mask and Carra and surrounding district. Ir. Nat. J. 11: 223.

RUTTLEDGE, R. F., AND M. A. OGILVIE. 1979. The past and current status of the Greenland White-fronted Goose in Ireland and Britain. Ir. Birds 1:293–363.

SCOTT, D. K. 1978. Social behaviour of wintering Bewick's Swans. Ph.D. thesis, Univ. Cambridge, Cambridge.

SCOTT, D. K. 1980. Functional aspects of prolonged parental care in Bewick's Swans. Anim. Behav. 28:938–952.

WARREN, S. M., A. D. FOX, A. J. WALSH, O. J. MERNE, AND H. J. WILSON. 1992. Wintering site interchange amongst Greenland White-fronted Geese *Anser albifrons flavirostris* captured at Wexford Slobs, Ireland. Bird Study. In press.

WILSON, H. J., D. W. NORRISS, A. WALSH, A. D. FOX, AND D. A. STROUD. 1991. Winter site fidelity in Greenland White-fronted Geese *Anser albifrons flavirostris*: Implications for conservation and management. Ardea 79:287–294.

Received 26 December 1991, accepted 3 August 1992.

The Auk 110(1):148–150, 1993

Intergradation Between the Bush-Tanagers *Chlorospingus punctulatus* and *C. ophthalmicus* in Western Panama (Aves: Thraupidae)

STORRS L. OLSON

Department of Vertebrate Zoology, National Museum of Natural History, Smithsonian Institution, Washington, D.C. 20560, USA

The taxa included under *Chlorospingus ophthalmicus* (Common Bush-Tanager) show complex geographic variation throughout the vast range of the species from Mexico to Argentina. For example, there are 10 named subspecies divided into at least 14 discrete populations in Colombia and Venezuela alone (Olson 1983). Three taxa in this complex have been named from western Panama. One of these, *C. punctulatus* Sclater and Salvin 1869, found in the provinces of Veraguas and Coclé (Fig. 1), is sufficiently distinct from the others in its very dark cap and more intense coloration that it has almost always been given the status of a separate species (e.g. Hellmayr 1936 [and all previous authors], Eisenmann 1955, Storer 1970), or has been maintained as its own subspecies "group" (AOU 1983).

The subspecies *C. o. regionalis* Bangs 1906 ranges from the mountains of Costa Rica to the western slope of the Volcán de Chiriquí in Panama. Although its distribution had previously been misunderstood, the population known as *C. o. novicius* Bangs 1902 was shown to occur (Olson 1981) only on the eastern slope of Volcán de Chiriquí (Fig. 1), mainly in the vicinity of the town of Boquete. This form is decidedly more richly colored than *C. o. regionalis* and was considered to show some approach to the coloration of *C. punctulatus* (Olson 1981).

These bush-tanagers are common and conspicuous where they occur and the absence of specimens between western Chiriquí and central Veraguas is probably an artifact of collecting due to lack of roads in the mountains in the area. Construction of an oil pipeline and an accompanying highway (often known as the Fortuna or "*oleoducto*" road; Ridgely and Gwynne 1989), from Gualaca on the Pacific slope of Chiriquí to Chiriquí Grande on the Caribbean slope of Bocas del Toro, provided access to mountainous habitats some 25 km east of the Boquete area. Birds of the *C. ophthalmicus* complex were observed along this road and referred to the subspecies *novicius* by Ridgely and

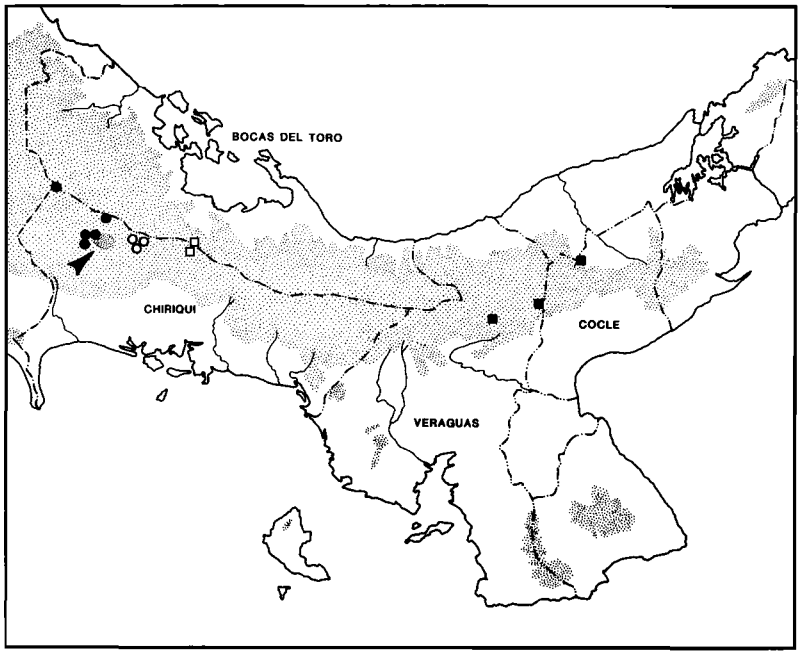

Fig. 1. Map showing known distribution of *Chlorospingus ophthalmicus* in western Panama. *C. o. regionalis* (solid circles); *C. o. "novicius"* (=*regionalis* > *punctulatus* intergrades; open circles); *C. o. punctulatus* > *regionalis* intergrades (open squares); *C. o. punctulatus* (solid squares). Stippled area indicates elevations above 200 m. Darker stippling indicated by arrow shows location of Volcán de Chiriquí. Names provided for provinces mentioned in text.

Gwynne (1989:405), most likely on geographical grounds. In 1990, I examined a specimen of this species labelled "Fortuna" in the Gorgas Memorial Laboratory in Panama City, collected 13 February 1976 by Rodolfo Hinds, that I recognized as distinct from *novicius*. Smithsonian field parties then obtained additional specimens near Fortuna in 1990 and from just over the continental divide in Bocas del Toro in 1991.

In general, these specimens are intermediate in plumage characters between *punctulatus* and *novicius*, but are more similar to *punctulatus* in having the crown and sides of head very dark. The crown color varies individually, with some being more brown, although the crown is never as blackish as in *punctulatus*. The throat and chin are more heavily speckled than in *novicius*, but less so than in *punctulatus*, and the bases of the feathers are paler, more whitish, than in *punctulatus*, thus approaching *novicius*. The lower throat and upper breast are less intensely orange than in *punctulatus*, but not as dilute as in most specimens of *novicius*.

The population of bush-tanagers reported here is more similar to *C. punctulatus* than to the less-intensely colored forms *novicius* and *regionalis*, found only 25 to 30 km distant on the slopes of Volcan de Chiriquí. Although the species has not yet been collected anywhere between Fortuna and Veraguas, birds from most of this area will probably prove to be similar to or inseparable from *punctulatus*. Thus, the transition from dark-capped *punctulatus* to light-capped *regionalis* takes place abruptly over a narrow band probably less than 50 km wide, within which complete intergradation may be expected. Thus, the population to the west known as *"novicius"* and the newly sampled populations to the east reported here probably represent the extremes, both morphologically and geographically, of this narrow band of intergradation.

From the evidence presented here, it seems clear that *punctulatus* is not specifically distinct from other forms of the Common Bush-Tanager occurring to the west and north, and should be regarded as a subspecies of *C. ophthalmicus*. Although the birds from the Fortuna area are distinguishable from other named subspecies, I believe that it is best to regard this population and that represented by *"novicius"* as part of a steep cline of intergrades between *C. o. punctulatus* and *C. o. regionalis* that do not deserve separate nomenclatural status.

Material examined.—*C. o. regionalis*: see Olson (1981).

C. o. "novicius" (=*regionalis* > *punctulatus* intergrades): see Olson (1981).

C. o. punctulatus > *regionalis* intergrades: BOCAS DEL TORO: Continental Divide on Gualaca/Chiriquí Grande road, USNM 608226–608229; CHIRIQUI: 12.6

road km N of Los Planes on Gualaca/Chiriquí Grande road, USNM 607627–607629; Fortuna, GML 068767.

C. o. punctulatus: VERAGUAS: Cordillera del Chucú, USNM 62013 (syntype); Santa Fé, AMNH 187972; Chitra, AMNH 246541, 246552, 246553, 246556, 246561. COCLÉ: Cascajal, USNM 150875.

I am indebted to the Instituto Nacional de Recursos Naturales Renovables (INRENARE) of the Republic of Panama for issuing collecting and export permits, and to personnel of the Smithsonian Tropical Research Institute for greatly facilitating research in Panama. For help in collecting specimens, I am grateful to Judith A. Blake, Michael J. Braun, Gary R. Graves, and Thomas J. Parsons. Smithsonian collecting expeditions were supported in part by Mrs. Alexander Wetmore through the Alexander Wetmore Fund of the Division of Birds, National Museum of Natural History (USNM), and by the Research Opportunities Fund and the Molecular Systematics Laboratory of the Smithsonian Institution. For lending specimens I am grateful to: Allison V. Andors, American Museum of Natural History (AMNH), New York; and Eustorgio Méndez, Gorgas Memorial Laboratory (GML), Panama City.

LITERATURE CITED

AMERICAN ORNITHOLOGISTS' UNION. 1983. Check-list of North American birds, 6th ed. Am. Ornithol. Union, Washington, D.C.

EISENMANN, E. 1955. The species of Middle American birds. Trans. Linn. Soc. N. Y. 7.

HELLMAYR, C. E. 1936. Catalogue of birds of the Americas, part 9. Field Mus. Nat. Hist., Zool. Ser. 13(9):1–458.

OLSON, S. L. 1981. Systematic notes on certain oscines from Panama and adjacent areas (Aves: Passeriformes). Proc. Biol. Soc. Wash. 94:363–373.

OLSON, S. L. 1983. Geographic variation in *Chlorospingus ophthalmicus* in Colombia and Venezuela (Aves: Thraupidae). Proc. Biol. Soc. Wash. 96:103–109.

RIDGELY, R. S., AND J. A. GWYNNE, JR. 1989. A guide to the birds of Panama, 2nd ed. Princeton Univ. Press, Princeton, New Jersey.

STORER, R. W. 1970. Family Thraupidae. Pages 246–408 *in* Check-list of birds of the world, vol. 13 (R. A. Paynter, Jr., Ed.). Museum of Comparative Zoology, Cambridge, Massachusetts.

Received 6 January 1992, accepted 12 March 1992.

The Auk 110(1):150–152, 1993

Effect of Handling Time and Freezing on Catabolic Enzyme Activity in House Sparrow Pectoralis Muscle

TIMOTHY P. O'CONNOR[1] AND TERRY L. ROOT[2]

[1]*Department of Biology, University of Michigan, Ann Arbor, Michigan 48109, USA; and*

[2]*School of Natural Resources, University of Michigan, Ann Arbor, Michigan 48109, USA*

Activities of certain catabolic enzymes have been used as indicators of the metabolic capacity of a tissue (Marsh 1981). For example, citrate synthase (CS) activity has been used to indicate the capacity for oxidation of acetyl-CoA in the citric acid cycle, and β-hydroxyacyl CoA-dehydrogenase (HOAD) has been employed as an indicator of tissue capacity for fatty acid oxidation (e.g. Bass et al. 1969, Marsh 1981, Wickler 1981, Marsh and Dawson 1982, Yacoe et al. 1982, Olson 1987, 1990, Carey et al. 1989). In some studies enzymatic-activity determinations have been carried out on freshly dissected tissues (e.g. Bass et al. 1969, Marsh 1981, Marsh and Dawson 1982, Yacoe et al. 1982, Carey et al. 1989). In others, tissues were dissected out of the organism, frozen, stored at approximately −70°C, and then later thawed and analyzed (e.g. Olson 1987, 1990, Olson et al. 1988). The latter protocol allowed investigators to capture and dissect organisms in the field, and then store tissues for subsequent analyses. One of the variables inherent in such a protocol is the handling time between tissue dissection and freezing. We refer to this period as the "time to freezing."

Another variable is the extent to which freezing affects the enzyme activities. Srere (1969) reported that more CS can be extracted from frozen than fresh tissue. In order to address these variables, we examined the relationship between time to freezing and the activity of both CS and HOAD in the pectoralis muscle of the House Sparrow (*Passer domesticus*). We also compared the enzymatic activities of freshly dissected tissues with those of tissues that had been frozen for storage.

We mist netted 19 House Sparrows in Ann Arbor, Washtenaw County, Michigan in October 1989. Within 4 h of capture, individuals were sacrificed by thoracic compression, and pectoralis muscles were quickly removed. Once removed each muscle was arbitrarily placed into one of six experimental groups. Each group was composed of five pectoralis samples, with muscles from the same individuals being placed in different groups. Five of the experimental groups included muscles that were frozen, while the sixth group included freshly dissected muscles. The freshly dissected muscles were homogenized immediately, and the homogenate was then sonicated in order to lyse