Journal of Field Ornithology

J. Field Ornithol. 83(4):403–406, 2012 DOI: 10.1111/j.1557-9263.2012.00390.x

A simple and effective air shotgun for collecting small birds and other vertebrates at close range

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Received 13 April 2012; accepted 7 June 2012

ABSTRACT. Scientific collections are important sources of material for many areas of ornithological research. Although firearms (particularly shotguns) have been the standard for avian scientific collecting for more than 100 years, their use is restricted in many areas of the world. We describe a cheap, relatively silent, and effective air shotgun for collecting birds weighing up to 50 g at distances up to 4 m. This air shotgun is capable of shooting birdshot, uses hollow metal rivets connected to plastic straws as shot shells, and represents a simple adaptation of any 0.177 or 0.22 cal single-shot, break-barrel air rifle with at least 25 joules of muzzle energy. This air shotgun will be especially useful for focused sampling of birds (and other small vertebrates) in situations where firearm use or transport is restricted.

RESUMEN. **Arma simple de aire comprimido efectiva para coleccionar, a cortas distancias, aves pequeñas y otros vertebrados**

Las colecciones científicas son una fuente importante de material para muchas áreas de investigaciones ornitológicas. Aunque las armas de fuego (particularmente las escopetas), por más de 100 años, han sido la herramienta estándar para las colecciones científicas de aves, el uso de estas está restringido en muchas partes del mundo. Describimos un arma de aire, de bajo costo y silenciosa, efectiva a una distancia de unos 4 m, para coleccionar aves hasta 50 g de peso. Esta arma de aire, capaz de matar aves, usa (a modo de cartuchos) pedazos de metal hueco colocados en sorbetes plásticos lo que representa una adaptación simple para cualquier rifle de aire de calibre 0.117 o 0.22, con al menos 25 julios de potencia energética. Este rifle de aire es útil, para muestreos particulares de aves (y otros pequeños vertebrados) en situaciones en donde el uso y transporte de armas de fuego esta restringido.

Key words: Scientific collection, air shotgun, avian museum specimens, small vertebrates

Avian museum specimens are essential for studies of diverse topics, including systematics, phylogenetics, sexual selection, social behavior, and many others (Remsen 1995, Vuilleumier 1998). Museum collections are also sources of information for general audiences, (e.g., field guides), and can be important for conservation planning (Remsen 1995, Vuilleumier 1998, Collar 2000). Despite the efforts of collectors over the last few centuries, taxonomic, geographic, population-level, and temporal gaps in current collections can place limits on the ability of investigators to address important questions in areas such as phylogeography and systematics (Stoeckle and Winker 2009). Specimens can be regarded as renewable resources (Remsen 1995), and collecting birds has a negligible demographic impact (Remsen 1995, Vuilleumier 1998, Winker 2000, Winker et al. 2010). In addition, declining populations of many species of birds and the increasing difficulty of obtaining permits make current collection efforts very important (Edwards et al. 2005). Excellent discussions of bird collecting, including ethical and social questions, can be found elsewhere

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(Remsen 1991, 1995, Vuilleumier 1998, Collar 2000, Winker et al. 2010).

Bird specimens can be obtained using firearms, traps and mist-nets, or by passively salvaging dead birds (Winker 2000). Firearms are especially useful because they permit coverage of large areas (Piacentini et al. 2010), can be used to collect birds from any forest stratum, and are often more efficient for focused sampling (e.g., phylogeographic studies or studies of species limits). Shotguns are the most commonly used firearms by bird collectors, especially 12, 16, 20, and 36 (or 0.410) gauges (Winker 2000). Smaller shot shells designed for rifles, e.g., 0.22 caliber, are often used with auxiliary barrels in the larger gauge shotguns to collect small birds at close distances. Many different sizes of birdshot are also available, and the most useful for collecting birds range from #1 (~4.1 mm) to #12 (~1.3 mm). Selection of shotgun gauge and birdshot size combinations must balance instant and humane sacrifice with the need to minimize damage to the specimens (Winker 2000). Despite their proven efficiency as collecting tools, firearms may be difficult to obtain for bird collectors in many parts of the world. Air rifles may be a useful alternative for collecting small passerines because they are easier to purchase and transport than firearms in many countries (e.g., Brazil). The most common air rifle sizes are 0.177 cal (4.5 mm) or 0.22 cal (5.5 mm). Modern models can be relatively silent and very powerful, and are often capable of propelling pellets at very high speeds. However, practice and considerable skill are required to successfully collect birds with a single pellet, especially for small, highly mobile species. In addition, air rifle pellets are often very destructive to small specimens.

We describe a cheap and effective air shotgun for collecting small birds and other similar-sized vertebrates. This air shotgun is intended to fill the gap between regular air guns and standard shotguns. It can be used to collect small birds (≤50 g) with birdshot at close range (up to 4 m), is relatively quiet, and causes little damage to specimens.

THE AIR SHOTGUN

The air shotgun can be built by simply removing the rifling from any 0.177 or 0.22 cal single-shot break-barrel air rifle. This step can be performed by any experienced gunsmith. Rifling refers to the spiral grooves cut into the bore of the barrel of rifles that are designed to improve ballistics and shooting accuracy (Heard 2008). In contrast, shotguns are usually smooth-bored (Heard 2008), and rifling can severely affect shotgun shot patterns (see detailed examples in Haag and Haag 2006). Thus, we emphasize that removal of rifling is crucial. In addition, we strongly recommend use of air rifles with at least 25 joules of muzzle energy because their higher power allows heavier shot loads, resulting in better shot patterns and increased lethality. We used a very powerful model, the CBC Nitro-X 1000 0.22 cal (CBC Brazil, Ribeirão Pires, Brazil). This air rifle uses a nitrogen piston (gas-ram) that produces 42 joules of muzzle energy, and is capable of shooting pellets at speeds up to 305 m/s. Other powerful models are available from several manufacturers, e.g., Gamo (Gamo Outdoor USA, Ft. Lauderdale, FL), Hatsan (Hatsan Arms Company, Izmir, Turkey), Crosman (Crosman Corporation, Bloomfield, NY), and Remington (Remington Arms Company, Madison, NC), and are sold at prices starting at ~$220 (U.S.) in the United States.

PREPARING SHELLS

Shells are made of hollow (i.e., tubular) metal rivets, plastic straws, birdshot, and soft paper (see Fig. 1A for an example using 0.22 cal). Custom-sized hollow metal rivets made of several types of metal (e.g., we used iron) can be ordered at specialist shops. If custom manufacture is not an option, then similar-sized rivets can be used, provided the outer diameter is 0.2 mm smaller than the rifle's caliber (4.3 mm for 0.177 cal, or 5.3 mm for 0.22 cal). In addition, the head diameter must be considerably larger than the outer diameter to hold the rivet in the air shotgun when shot (we used 8.0 mm). To allow loads of reasonable amounts of birdshot, the rivet is connected to a plastic straw (available at most supermarkets), with an outer diameter of ~4.5 mm for 0.177 cal or 5.5 mm for 0.22 cal. The total length of the shell is adjusted to 40–60 mm by cutting the straw (Fig. 1A) based on the desired amount of birdshot. We used a 40-mm section of straw for 3 g of birdshot in the 0.22 cal, but longer sizes will be necessary in the case of 0.177 cal. About 1 cm^2 of paper tissue is inserted into the shot shell from its posterior end

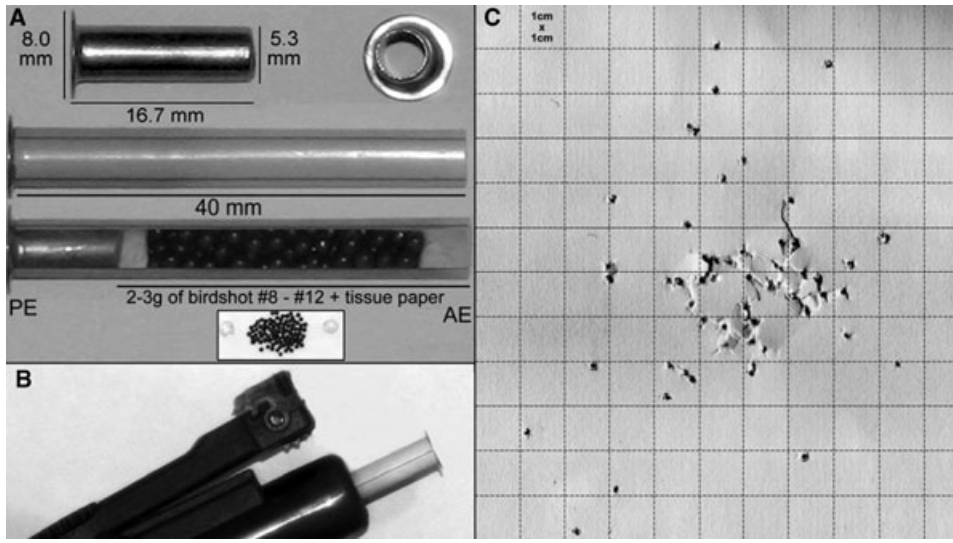

Fig. 1. Description of the 0.22 cal shot shells and illustration of the efficiency of the protocol. (A) Lateral and upper view of the hollow metal rivet (above), lateral view of the complete shotshell (middle), and cut-away view of complete shot shell (bottom). AE = anterior end; PE = posterior end. (B) Air shotgun being loaded with shot shell. (C) Illustration of paper carton shot from 3 m using ~3 g of #8 birdshot.

towards its anterior end and pressed several times against a hard surface using a 100-mm-long wood stick or similar tool, until a compact wad is formed (Fig. 1A). The shell is then partially filled with lead birdshot (ranging in size from #8 to #12, depending on the size of the bird to be collected; see below). In the case of the 0.22 cal 40-mm shot shell used here, ~3 g of birdshot can be conveniently obtained by eye by filling the plastic area of the shot shell not in contact with the rivet (Figs. 1A and cut-away view). The shell is then closed by pressing another plug of paper tissue into its posterior end and against the birdshot until another compact wad is formed (Fig. 1A). Finally, the shell is ready to be loaded into the breach of the air gun (Fig. 1B) and shot. After the shot, the metal rivet can be removed and reused.

The air shotgun we describe will be most useful for focused sampling of passerines or other small birds that respond well to playback, especially in countries with restrictive firearm regulations or in densely populated areas. We have collected hundreds of specimens using this method, ranging in size from small hummingbirds (e.g., Minute Hermit, *Phaethornis idaliae*, ~3 g) to larger specimens ranging from 19 to 50 g (e.g., Spot-backed Antshrike, *Hypoedaleus guttatus*, and Crescent-chested Puffbird, *Malacoptila striata*). An earlier prototype was also used to obtain most of the samples for a phylogeographic study (~80 antbirds, Amaral et al., unpubl. data) in the densely populated Brazilian Atlantic Forest, illustrating its usefulness for focused collecting in areas where the routine use of firearms would have been difficult. Shot shells should always be shot dry, and discarded if wet. We have found that 1–3 g of birdshot #8 (50–70 pellets) works better for medium-sized passerines, whereas 1–3 g of birdshot #10, #10.5, #11, or #12 (90–120 pellets) is suitable for small passerines or hummingbirds. We also stress that birds heavier than 50 g (e.g., trogons) or further than 4 m from collectors should not be collected using this method because the probability of injuring, but not killing, the bird becomes high. Finally, we do not recommend use of the air shotgun with regular pellets due to the potential loss of accuracy associated with lack of rifling

To our knowledge, only three commercial versions of air shotguns have been widely marketed to date: Gamo Viper Express, Gamo Maxima Express, and Gamo Shadow Express. Although these commercial options may be useful for collecting birds, we believe that our air shotgun

and shells are superior in cost, versatility, and efficiency. For example, the air shotgun we describe can be made using any 0.177 or 0.22 cal single-shot, break-barrel air rifle with 25 joules of muzzle energy or more. In addition, the barrels of commercially available air shotguns are much wider, and designed to use plastic shells purchased exclusively from the manufacturer. Those commercial shells cost at least $0.25 (U.S.) per shot, whereas ours cost less than $0.05 per shot, including the metal rivet that can be reused. In addition, the most powerful air rifles available in the market can be modified to make an air shotgun, permitting heavier shell loads than those used in commercial models. Finally, with our design, shell loads can be adjusted for varying sizes of birdshot (#8 –# 12).

Although initially designed for collecting birds, the air shotgun we describe may be useful for collecting other small vertebrates such as lizards, snakes, mice, and bats. In addition to birds, we have successfully collected specimens of a teiid lizard (*Cnemidophorus* gr. *ocellifer,* up to 100 mm long), and we believe that other species of lizards ranging in length from 100 to 200 mm (e.g., *Tropidurus* spp.) could also be collected. In addition, although passive-collecting methods (e.g., pitfall traps) are traditionally used for collecting small terrestrial vertebrates, using an air shotgun may, in some cases, be more efficient and less time consuming, especially for abundant species.

ACKNOWLEDGMENTS

Many thanks to C. Miyaki for financial support of field trips (funded by FAPESP, CAPES, and CNPq). We also are grateful to all members of the labs of C. Miyaki (IB-USP), L. F. Silveira (MZUSP), and M. Raposo (MN), as well as R. Gaban-Lima (UFAL), J. Montesanti (UNIFESP), A. Bianco, and J. Vitto for extensive testing and criticism concerning earlier prototypes. C. Biondo, G. M. Kirwan, K. C. M. Pellegrino, G. Ritchison, K. Winker, D. Lane, and two anonymous reviewers provided insightful comments and corrections on an earlier version of this manuscript. Specimens were collected under ICMBio permits 14637, 15636, 18921. The authors received funds from FAPESP, FAPERJ, CAPES, and CNPq.

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