Mary-Jacque Mann,[1] M.F.S. and Edgard O'Neil Espinoza,[1] Dr.P.H.

The Incidence of Transient Particulate Gunshot Primer Residue in Oregon and Washington Bow Hunters

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ABSTRACT: The interpretation of GSR/PA (gunshot primer residue particulate analysis) results in an alleged firearm violation of bow hunting regulations is complicated by the theoretical presence of contaminant GSR from prior legitimate shooting incidents. A total of 120 samples representing field collections from thirty Oregon and Washington bow hunters were analyzed for the presence of particulate gunshot residue in order to assess the level of contamination that may be present in this population. Of the bow hunters sampled, 50% stated that they shoot guns; 80% of the shooting group stated at the time of the GSR field collection that they were wearing the same outer clothing or driving the same vehicle, or both, when they last handled and fired a weapon. Analysis of the 120 samples resulted in the detection of one tricomponent particle of GSR.

KEYWORDS: forensic science, gunshot residue, particle analysis, bow hunters, criminalistics

Due to the specificity and sensitivity of particulate analysis of gunshot primer residue (GSR) by scanning electron microscopy/energy dispersive x-ray microanalysis, hereafter referred to as GSR/PA, sport shooters and hunters as well as police officers and active duty military personnel are among those who may test positive for particulate GSR. The interpretation of GSR/PA is therefore relevant to individuals with recreational or professional exposure to firearms.

Primary transfer particulate GSR originates from the exterior of a fired weapon or as a result of direct deposition of particulates onto a surface coincident with the firing of a weapon. Secondary transfer of GSR results from contact with the recipient surface of a primary transfer. Secondary transfers are facilitated by the persistence of GSR on undisturbed surfaces. Particulate GSR can persist on effectively static surfaces for extended periods of time. Wolten et al. [*1*] reported that particulate GSR was detectable on the skin of a suicide victim five days after the fatal shooting took place. Zeichner et al. [*2*] observed that clothing is generally considered to retain GSR longer than skin. Secondary transfer of GSR from clothing has been documented in a recent study by Garofano et al. [*3*]. This study documented secondary transfer of particulate GSR from the clothing of an indoor range shooter to the closet where he stored his range clothing.

The use of specialized or favored items of clothing or motor vehicles or both, is relatively common in recreational shooting populations. This practice theoretically promotes re-

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[1]Senior Forensic Scientist and Chief, respectively, Criminalistics Section, National Fish and Wildlife Forensic Laboratory, Ashland, OR.

tention and secondary redistribution of particulate GSR. A secondary transfer of particulate GSR under these circumstances could present a misleading positive analytical result.

The use of modern firearms in seasonally designated bow hunting areas is forbidden in most United States game jurisdictions. GSR/PA has been proposed as a method of detecting the use of a firearm in suspected violations of bow hunting regulations. Because bow hunters may also be recreational or professional shooters, field samples from bow hunters were collected and analyzed for the presence of particulate GSR.

Materials and Methods

Sample Population

Samples were obtained by voluntary consent from 30 1990 Fall season bow hunters stopped for random permit checks by game officials in or near bow hunting areas. The hunters were on foot, in their vehicles or at camp sites in forested or partly forested areas of Jackson County in southwestern Oregon and in similar areas of Skamania and Cowlitz Counties in southwestern Washington State. The temperatures in the sample collection areas were cool (0° to 12°C) and all hunters were wearing appropriate types of warm outer clothing.

The sampled hunters were male. Although primarily blue collar workers (70%), the hunters' occupations ranged from administrative to mechanical. The sample also included students, a temporarily unemployed worker, and retired persons (20%). Half of the sampled hunters had facial hair and approximately 17% were wearing camouflage face paint. Their time in the field ranged from just arrived to 12 h with a 3.5 h mean stay.

Sample Collection and Preparation

Samples were collected using a National Fish & Wildlife Forensic Laboratory fabricated collection kit. The collection kit consisted of a labelled plastic zip bag containing four individually labelled plastic stoppered glass vials and one pair of disposable plastic gloves. A 19 mm Cambridge style carbon SEM stub was attached to each plastic stopper via the stub pin. The flat surface of the stub was covered with an approximately 14 mm by 13 mm strip of 3M 665 double sided adhesive tape. One corner of each adhesive strip was marked with a small dot of SPI conductive carbon paint.

Unused kits were kept separate from used kits. All samples were collected by one of the authors (MJM) while wearing gloves. The gloves were discarded after each kit was executed. Four samples were collected from each hunter to maximize the capture of adherent particulates: right hand back and web, left hand back and web, right side of the face and left side of the face. The collected area was repeatedly dabbed with the stopper mounted stub until the adhesive surface no longer felt tacky.

Each stub was coated with carbon using a BioRad Model E1600 evaporation unit prior to GSR/PA examination.

The corner of each stub showing the carbon painted dot was micrographed digitally in the SEM at 17X in the automated start position and the X-Y stage coordinates were noted for stub identification and for the optional relocation of detected particles.

Analysis

A CamScan Series 4 tungsten filament scanning electron microscope with a Kevex 8000 energy dispersive x-ray spectrometer was used in this study. The SEM was equipped with an automated particle analysis system that performs a grid search of 65 536 independent coordinates within a 12 mm by 10 mm search zone on each of four sequential specimen stubs as described by White and Owens [*4*].

A total of 120 sample stubs were examined in this study. Each stub was manually searched using backscattered imaging at X500 to X1000 for 10 to 15 min prior to initiation of the automated search program. Ninety-five to 100% of the automated search zone of each sample was examined as suggested by the findings of Owens [*5*]. The run time per sample was approximately 3.5 h.

System Optimization

The SEM was allowed approximately 20 min of console electronics warm-up time plus approximately 10 additional min for filament stabilization at the start of every operational day. Filament saturation was checked twice daily. EDX calibration using an Al/Cu standard was performed monthly.

A positive control standard, upon which the system was originally optimized, was routinely reanalyzed every 3 to 4 kit runs (12 to 16 stubs). This standard was obtained by tape dabbing the right hand of one of the authors (MJM) after three sequential test fires of a .380 Beretta pistol loaded with Winchester-Western ammunition. This standard contains unique tricomponent and supporting binary and monomer particles ranging in size from <1 μm to >20 μm.

Results and Discussion

Fifteen of the bow hunters sampled for this study claimed that they also shoot firearms (Table 1). This figure includes 14 recreational shooters and one hunter who stated that he used a nail gun at work. The alleged behavioral proclivities of recreational shooters relative to wearing apparel and vehicle preferences were confirmed in this group. Eighty percent of the bow hunters-shooters responded that they were currently wearing the same clothes or driving the same vehicles, or both, as when they last fired a weapon. With the exception of the hunter who used a nail gun and two others who preferred to target shoot

TABLE 1—*Bow hunters exposed to a shooting environment.*[a]

Number[b]	Gun Used	Same Clothes	Same Vehicle	Last Fired
103	.280	No	Yes	1 Year
104	.257/.22	No	Yes	1 Year
110	12 Gauge	Yes	Yes	24 Hours
112	n/s	No	Yes	1 Year
113	n/s	No	Yes	1 Year
115	.410/12 Gauge	No	Yes	<12 Hours
120	7 mm/160	No	Yes	1 Week
121	Nailgun	n/s	n/s	1 Week
122A	.357	No	No	3 Days
124	7 mm	Yes	Yes	n/s
127	.30–06/.30–30	Yes	Yes	2 Weeks
128	.30–06	Yes	No	n/s
129	.30–06/.30–30	Yes	No	n/s
132	7 mm	No	No	n/s
133[c]	.30–06	Yes	No	n/s

[a]n/s = information not supplied.

[b]Non-shooting companions (111 and 114) of bow hunters 110 and 115 although present when guns were being fired also tested negative for the presence of GSR.

[c]One unique GSR particle was detected on this subject's left hand sample. All other bow hunters sampled in this study were negative for the presence of particulate GSR.

with hand guns, the remaining combination hunters in this study listed rifles, primarily 7 mm and the .30 calibre range, and shotguns as their preferred firearms. The time frame given by the combination hunters for their last exposure to a shooting environment ranged from approximately 12 h to one year.

The presence of a favorable GSR retention matrix would theoretically promote secondary transfer of GSR to bow hunters-shooters. This was not the case. Of the admitted combination hunters, only one individual was found to be positive for the presence of particulate GSR. A single 5 μm unique GSR particle, without supporting particles, was detected on the left hand sample of combination hunter 133. While he did indicate that he was wearing a jacket normally reserved for outdoor activities, including hunting with a .30–06 rifle, hunter 133 did not respond to the question concerning any recent experiences with firearms. All of the samples from the self-proclaimed nonshooters were negative for the presence of detectable GSR.

The failure of this study to document a high incidence of particulate GSR in a theoretically vulnerable population may result from the relatively inferior nature of long arm GSR deposition. Andrasko and Maehly [*6*] and the Aerospace *Final Report . . .* [*7*] observed that long arms deposit less particulate GSR than hand guns. Preliminary studies of long arm particulate GSR deposition conducted by the authors support these observations.

The authors' study (Table 2) includes samples from shooters of five rifles and two shotguns. While this data does not constitute a significant sample amd will be expanded as the study progresses, the preliminary findings are interesting. The firearms were

TABLE 2—*Detectable GSR from clean longarms, immediate collection.*[a]

Number/Shots Weapon Ammunition	E	RH	LH	RF	LF
R104/3 Shots HK91A2 .308 SA NATO 7.62mm	N/A	0	0	0	0
R109/2 Shots Win .223 Bolt Rem.	1 GSR	3 GSR	0	0	2 Pb
R122/2 Shots Win. .348 Lever Win.	1 GSR	0	0	0	0
R114/2 Shots Ruger M77 .270 Bolt Win. Super X	1 GSR	5 GSR 1 Ba/Pb	0	0	0
R118/2 Shots Win. .30-06 M54 Bolt Win. Super X	0	0	0	0	0
R107/2 Shots Win.M12 12ga.Pump Win.Super X Mag.	0	0	2 GSR 1 Ba/Sb 1 Sb/Pb	0	0
R115/2 Shots Rem.M870 12ga.Pump Win.Super X Buck	0	1 GSR 1 Pb	2 GSR 1 Ba/Sb	0	0

[a]E = right and left eyebrows; RH = right hand back and web; LH = left hand back and web; RF = right side of the face; LF = left side of the face.

cleaned thoroughly internally and externally using commercially available gun solvents prior to use. The shooters' faces and hands were sampled by tape dabbing immediately after firing two to three shots in an outdoor range. Two of the weapons, a Winchester .30–06 bolt action rifle and a HK .308 semiautomatic rifle deposited no detectable particulate GSR on the shooters' skin. Of the shooter samples that did test positive for GSR, the particle populations were low. No more than seven unique and/or supporting particles were detected in any shooter collection.

The inference that can be drawn from the results of the bow hunter study is that even though the behavior of recreational shooters and the persistence of particulate GSR in fabric and on static surfaces may facilitate the transfer of transient GSR particulates, the actual incidence of secondary transfers is low. The reason for this apparent contradiction may be related to the quantitative inferiority of primary particulate GSR transfers from cleaned long arms.

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Address requests for reprints or additional information to
Mary-Jacque Mann
National Fish and Wildlife Forensic Laboratory
1490 E. Main St.
Ashland, OR 97520