WORKING PAPER

Christer Holmgren 2019-01-17

Position and Comments from Svenskt Forum concerning The European Chemical Agency's Annex XV Investigation Report

The Swedish Forum for Hunting, Shooting and Weapon Issues (Svenskt Forum) notes the failure to meet requirements for reasonable objectivity and the lack of technical insight into weapons and ammunition and solid scientific foundations for various standpoints in crucial parts of the European Chemical Agency's (ECHA) Annex XV Investigation Report.

Svenskt Forum's general understanding is that, to a large extent those activities undertaken on issues regarding lead ammunition both in Sweden and Europe as a whole have a direct political agenda intended to support hastily concluded policy decisions in order to achieve a 'non-toxic' environment. In its first draft report on phasing out lead in 1990, the Swedish Chemicals Agency (KEMI) adopted the mantra, "Lead is directly dispersed in nature by use of lead shot and petrol"; obviously at that time with the belief that a complete discontinuation of lead shot would provide major positive health and environmental effects. The same short sighted attitude is still apparent today and now also covers rifle ammunition. [1]

Introduction

The political goal in Sweden and Europe in general that, in the long term, all use of lead should cease is, even taking a very long perspective, purely wishful thinking. The culture and technological development we currently enjoy are in practice an effect of the fact that over 6,000 years ago humans learned to extract metallic lead for a variety of technical purposes, and to produce various lead compounds that even today – unless the immediate future sees some hypothetical and revolutionary technological leap forward – remain crucial to the production of a wide range of consumer goods and electronic products. We are of course talking about the world's fifth most used metal. This is why, despite reams of research 'results' over recent years, policy makers have had every reason to demonstrate considerably greater humility and consideration when faced with the overall issue of how, whether and indeed if lead ammunition can be equated with considerably more hazardous, easily dispersed man-made substances and materials that people in general are entirely unaware of and have no idea how to protect themselves against.

Lead in focus

In Annex XV, the ECHA explains its focus on lead thus: "Lead-based ammunition is considered to be the most significant unregulated source of lead deliberately emitted into the environment in the EU."

In this context, the term *considered* should reasonably be interpreted as expressing doubt, although it lies in the nature of things that the amount of metallic lead used for hunting and shooting can indeed be assessed with reasonable certainty based on available manufacturing figures. The same applies to the many millions of tons of lead sheathed electrical and telecom cables buried beneath the ground which, at least in the case of recent installations, can be followed up via drawings.

Meanwhile, other airborne emissions of largely non-metallic lead from industry, such as lead additives, can be found in enormous numbers of products in all conceivable applications and their

actual dispersion to all sectors of society is incalculable and unforeseeable, both in terms of area and quantity. So, would it not be reasonable to also classify the deliberate distribution of products containing some form of lead compounds to all potential markets and individual consumers irrespective of geographical location as an “unregulated source of lead deliberately emitted into the environment”?

Roughly calculated, approximately 80% of lead ammunition manufactured is used for shooting activities. The use of this ammunition – and therefore the dispersal of metallic lead – is deliberately confined to purpose-designed locations and limited geographic areas. Naturally, the local concentration of metallic lead in bullet traps and deposition areas for shot is high. In practice, these can be viewed as deposits that can be cleaned up as necessary or, depending on the soil conditions, treated and covered up in the event of lead compounds leaching from corroded bullets into surrounding soil. [2)

Studies carried out of Swedish military shooting ranges have not demonstrated any notable leaching from bullet traps, whether into adjacent soil or groundwater, as the triggered lead compounds quickly build insoluble complexes in close proximity to corrosive lead projectiles This is a very well-known scientific phenomenon that ought to lie with the ECHA’s area of expertise. Naturally, shooting and clay pigeon ranges should be located on suitable terrain. [3].

A realistic perspective on the health risks of lead

The toxicity of lead compounds and the various degrees of health risk dependent on levels of exposure are well known, indeed Ancient Greek physicians wrote about it as early as 300 BCE. In modern times, it has been described in detail and placed in context in a balanced manner in a great many serious-minded scientific articles. Considering the scope of serious articles already published, it is pathetic to see so many new articles written by individuals, obviously lacking in clinical experience of the damaging effects of lead, incessantly restating the effects of chronic or acute exposure to absorbable lead on human health. Although this has been known since antiquity, acute lead poisoning is relatively rare in our modern society and can seldom be linked to lead ammunition as a realistic threat to public health.

These articles are exemplified by long, graphic descriptions of the symptoms of acute lead poisoning and generalised claims, such as arrested development and reduced cognitive capacity in children, for example due to eating game meat, without compare this, perhaps possible not chronic, exposure with a wide range of real chronic lead sources such air, water and other foodstuffs consumed on daily basis. These extended, bombastic texts are simply padding for studies that in practice have limited concrete knowledge-enhancing content but are intended to influence and manipulate readers who have a limited knowledge of the topic, by constantly repeating what are sometimes entirely false claims solely aimed to deceive; a familiar method employed by lobbyists that should definitely have no place in the on-going debate on lead.

Even if lead compounds have certainly been handled carelessly for thousands of years, given the growth in global population over recent centuries it is highly improbable that metallic lead, or indeed the nonorganic lead compounds that have been widely used for millennia, can have had any decisive impact whatsoever on human reproductive capacity in the manner suggested by the Swedish Chemical Agency’s inquiry into the matter.
The study was only able to distinguish a single case of reproductive toxicity, which has now been adopted by the ECHA. The cause of this individual’s extremely high blood lead level was not reported and after adequate treatment the person concerned regained their reproductive capacity.

Svenskt Forum's position is therefore that both national and supranational authorities should, at least in a rudimentary manner, embrace the practical and fully apparent reality in order to draw their own conclusions on this.

The practical reality

Since the phasing out of *organic* lead compounds in petrol, a general and dramatic decrease has occurred in lead exposure at population level in all countries that have implemented the measure. Tetraethyl and tetra alkyl lead are highly toxic *organic* lead compounds developed and put into production in the 1920s as an antiknock agent in petrol engines. Unlike non-organic lead compounds and metallic lead, these substances can also be absorbed by humans directly through the skin. Despite widespread knowledge of the enormous risks and know impact on population posed by organic lead compounds, leaded petrol was not completely banned in the EU until 2002.

The direct effect of phasing out leaded petrol has been demonstrated, including in a long-term study of children living in Landskrona and Trelleborg municipalities in Skåne, southern Sweden (n = 4,050). In 1978, the average blood lead level (B-Pb) was 60 µg/L. As the mixture of organic lead compounds in petrol decreased, so too did the average B-Pb and by 1996, when leaded petrol was completed phased out in Sweden, the average level was 22 µg/L. By 2010, average B-Pb was ≈ 12µg/L and, disregarding other forms of exposure, it continues to decrease. [4]

The logical conclusion is that the Swedish population's average exposure to lead – including all other forms of exposure – is broadly speaking one fifth of what it was 30 years ago and still decreasing. This demonstrates that there is no pressing need to implement any ill-considered measures, particularly with regard to lead ammunition, given that the potential benefits are in no way proportional to the extensive negative consequences of the measures proposed.

Hidden health and environmental issues

In only a few decades, industrialised society has developed and produced almost unimaginable quantities of more or less toxic and environmentally hazardous substances to which humans, animals and the environment are constantly exposed –a state of affairs that no public authority can claim in all seriousness to have complete control over.

The standard scenario seems to be that a substance produced for a specific purpose, and that may prove to be extremely useful to this end, over a relatively brief period proves to be extremely hazardous to humans, animals and the environment. One example of this is provided by PCBs (polychlorinated biphenyls), a collection of 209 different highly soluble, persistent and hazardous chemical compounds. PCBs have been in use since the 1920s as flame retardants in a large number of applications. They remain in circulation all around us and are highly toxic in marine environments. Houses built between 1956 and 1972 still contain large amounts of PCBs in sealants and other building materials, which continue to leach into the soil and air via landfills and incineration.

PCBs and dioxins (formed in the production of chemicals containing chlorine) are environmentally persistent pollutants that affect the brain and nervous system and may lead to behavioural changes and impaired learning ability (reduced IQ), exactly the claims levelled regarding exposure to high levels of lead. They are also suspected of damaging the immune system and reproductive capacity and interfering with hormones, as well as causing cancer.
Foetuses and infants are particularly susceptible to dioxins and PCBs, which are transferred to the foetus via placental transfer and infants during breastfeeding. The use of PCBs in new products was

prohibited in Sweden in 1978 and all products containing PCBs in 1998. Investigating all possible dispersion routes for existing PCBs and assessing where in society potential exposure risks exist can only be viewed as an impossibility. [5]

PCB and other toxic substances in marine environments

In the 1950s, populations of white-tailed eagles (*H. albicilla*) and seals in the Baltic began to collapse, something that can be directly linked to high levels of PCBs and DDT in the marine environment. This pollution impacted the entire food chain as these substances are highly soluble and accumulate in especially large quantities in oily fish. Although white-tailed eagle and seal populations have recovered following the prohibition of these substances, a study conducted by the Swedish Museum of Natural History in 2015 demonstrated that white-tailed eagle eggs in the county Västernorrland at Sweden´s east coust, still contain high levels of PCBs and DDT. These levels remain at or above the critical level for negative impact on reproduction as calculated for white-tailed eagles native to the Swedish coast. [6]

A further example is provided by perfluorooctanesulfonate (PFOS) and similar persistent, highly-fluorinated substances that do not occur naturally and are not environmentally or biologically degradable, in other words,-*persistent*. Since the 1950s, PFOSs have been one of the most widely used and dispersed chemicals globally, with an extremely broad area of use in fire extinguishers, cleaning agents and various waxes, and in making clothing, textiles and leather products dirt and water resistant. These perfluorides are all around us and are toxic, reprotoxic and toxic to aquatic organisms. They dispersion is enormous and they are found in high levels in the muscle tissue of creatures from tropical marine mammals to polar bears. One might reasonably assume that mussels, which obtain nutrition by sieving seawater over many years, will build up high levels of these substances that will then be passed on along the food chain to mussel-eating mammals and birds. [7]

The main producer of PFOSs began to phase out production in 2000. How this will affect environmental levels is unclear. While the manufacture of PFOSs is decreasing, comparable substances are still being produced that may have similar properties and that, in some cases, may even break down into PFOSs. [8]

EFSA has now made a new preliminary assessment of PFOS and PFOA. This means that EFSA lowers the so-called tolerable weekly intake (TVI) for the substances. TVI is the amount you can get in every week throughout your life without risk to health. EFSA also writes that a final assessment will not come until 2019. In the final assessment, several PFAS substances, including PFOS and PFOA, should be included. [9]

The white-tailed eagle

It is unlikely that the environmental catastrophe caused by PCBs and DDT that befell the white-tailed eagle and seal populations along the Baltic coast of Sweden in the 1950s is an isolated incident. The same conditions might reasonably be considered to apply to all Baltic countries. It is not unlikely that birds of prey and carrion-eating birds will consume metallic lead from wounded game; however, the scope of contamination and the actual impact on populations in relation to the widespread and general impact of accumulated environmental toxins that have clearly existed and continue to exist in all of their natural prey, and that cause reproductive disorders, has seldom been placed in context. The likelihood of any reasonably large population being supported solely by wounded game and waste products from abattoirs is remote. There are known cases of birds of prey being found containing lead. Only a small proportion of dead eagles found in Sweden have been discovered to have elevated levels of lead. Interest should be focused on the cause of death

of the vast majority. A similar study in Norway using isotope calculations confirmed that only in isolated cases could the presence of lead in eagles be traced to lead ammunition.

Immediate challenges

Considerably more alarming from a Swedish standpoint is that, in many locations, populations of the diving ducks, particular eider **(** *Somateria mollissima***)** that are natural prey for white-tailed eagles have been almost wiped out. And this have nothing to do with use of lead ammunition. Researchers from Stockholm University and the Swedish National Veterinary Institute have shown a direct link between thiamine (vitamin B1) deficiency and the population decline in the common eider in Sweden. An absence of or deficiency in thiamine has a number of negative effects on the brain and central nervous system, which in turn have a negative impact on reproduction and behaviour. [10]

The common eider normally feeds on blue mussels, (*Mytilus edulis*) in practice the only source of thiamine available to the bird. We know that large areas of the Baltic Sea suffer from anoxic bottom waters. The most important habitat for blue mussels is among bladder wrack, (*Fucus vesiculosus*) a brown algae that is a key species in the Baltic Sea in creating biodiversity on the shallow rock and cliff bottoms where eider feed. It is an undeniable fact that bladder wrack, both in the archipelagos and out to sea, has largely disappeared as a result of eutrophication and chlorate emissions from the paper industry, to a large extent eradicating the eider's natural feeding resource. As a result, an increasing population of white-tailed eagles in Sweden is facing starvation as the number of brooding eider hens plunges, together with available easy prey for eagles in the form of eider chicks.

Svenskt Forum is sympathetic to the plight of the many researchers who – rather than attempting to understand correlations in large, complex, anthropogenic disruptions to the ecosystem as a whole – choose to focus on an easily distinguished, populist subject for their projects. The task is however unlikely to be that simple. Svenskt Forum's standpoint is that any discontinuation of lead ammunition is highly unlikely to make a measurable difference to the development of wildlife populations or to the welfare of wildlife.

Lead in the environment

Lead is a common element to which all living creatures have been exposed since ancient times and will continue to be exposed to forever, even if we were to revert to a Stone Age culture.

Depending on where measurements are taken, the accessible parts of the earth's crust are estimated to contain an average of 13 ppm (mg/kg) of lead-bearing minerals. Across most of Sweden, the lead content in the ground within half a metre of the mineral soil, primarily in the form of the mineral galena (PbS), is approximately 23 ppm. In round figures, this equates to at least 230 kilograms of lead beneath our feet for every hectare of land. For Sweden as a whole, this means approximately 800,000 tonnes of naturally occurring lead beneath the till. There are of course large local variations; however, to the existing deposits of lead-bearing minerals must be added atmospheric fall-out that has been dated all the way back to the Roman Bronze Age and Sweden's domestic mining activities, both during antiquity and modern times. Not to mention the at least 600 tonnes of organic lead compounds that are calculated to have contaminated large areas of land prior to the prohibition of leaded petrol and it still there. [11-12]

When discussing the environmental impact of metallic lead from ammunition, it is also reasonable to take into consideration the amounts of lead that have contaminated the battlefields of Europe since the late sixteenth century. During the First World War alone, in the region is estimated that around 50 billion cartridges were discharged from machine guns and small arms. At least as many rounds were fired during the Second World War estimated from US manufacturing statistics. The accumulated weight of just the lead of these conflicts together can be estimated at one million tonnes or more. To this can be added the musket and pistol balls from the previous three hundred years of hostilities. The majority of these rounds remain in the ground we cultivate and live on without any researcher attaching notable importance to this from a general environmental perspective. In comparison, the amount of lead dispersed in nature from hunting ammunition is modest and, in terms of presenting a hazard, no different from the lead dispersed in conjunction with military conflicts for over five hundred years.

Lead and its salts are non degradable, although depending on geochemical conditions and soil acidification caused by sulphur emissions they may be transformed into other lead compounds. There is scientific consensus that lead compounds formed from corrosive metallic lead quickly form insoluble complexes, including with humus and soil particles as well as iron and manganese and that, once bound, lead is unlikely to leach into groundwater. There is a case for studying whether atmospheric particles actually reach the till layer and can generally be included in the aforementioned 23 ppm.

The difference between lead and lead

The most remarkable aspect of the ECHA's, and indeed a great many researchers, argument regarding sources of exposure to lead is the general failure to make any differentiation whatsoever between bio-accessible lead compounds and metallic lead in solid form in terms of creating danger.
The only conceivable reason to equate water-soluble lead compounds with metallic lead kilo for kilo is a conscious desire to produce a result that can be used in various studies in order to attract the attention of political decision-makers. [2]

In Sweden during the 1990s, for example, the environmental impact of 600 tonnes of tetraalkyl lead was directly compared by weight to deposits of lead shot and bullets, without regard to the actual bioavailability of the environment, animals or humans. Any honest scientist should realise the difference and this kind of frequently occurring argumentation is not simply misleading, it is clearly fraudulent. It must be viewed as highly remarkable, if not impossible, that a large number of serious researchers and authors of 'scientific' articles should fail to grasp the factual differences between water-soluble lead compounds and solid lead in terms of potential risk and impact. In so doing, they forfeit the credibility of the published articles.

Provided that the *Scientific Opinion on Lead in Food* issued by the European Food Safety Authority (EFSA) in 2010 can be considered credible, there is no difficulty for any literate individual to understand the necessary conditions and chemical form required for lead to be absorbed by the human body via oral intake. Generally speaking, attacks on hunters and shooters regarding their use of lead ammunition have completely disregarded this information. Whether this has been a deliberate ploy or a result of a failure to grasp the obvious is unclear. [13]

Quotes from EPA 2007:

The bioavailable fraction or "oral absorption fraction" is defined as, and equal to, the fraction of an ingested bioaccessible dose that actually crosses the gastrointestinal epithelium and becomes available for distribution to internal target tissues and organs. This in turn varies with the water solubility of the present lead salts released.

Exposure to lead in foodstuffs

“Overall, cereals, vegetables and tap water were the most important contributors to lead exposure in the general European population.” [14]

Something that researchers and public authorities forget, or choose to ignore, when calculating lead loads or the creation of danger is that all limit values published for lead in foodstuffs are not in metallic form but rather in directly bio-accessible lead ions – with the exception of meat from game, where finds of metallic lead are considered to be fully bio-accessible, something that is completely erroneous.

One experimental in vitro study (Qvarfort and Holmgren) demonstrates that the bio-accessibility of lead in game meat varies between 1 to 2% of the total content, depending on the size of fragments around the wound channel and taking into account normal variations in gastric pH level. If one knows the actual amount of metallic lead in, for example, minced meat, it is a simple matter to use the Carlisle and Wade empirical equation for dietary exposure to calculate the impact of a given amount of orally ingested metallic lead on B-Pb compared to other foodstuffs (EFSA 2010, p 99).

Lead fragments are primarily found in a 65 to 80-millimetre diameter around the wound channel. Extremely small particles may be found in blood clots in the chest cavity. Larger particles are naturally found in the tissues around the exit wound. With normal butchering and wound cleaning, the vast majority of metallic lead will be removed. [15]

Microscopic fragments of lead have a microscopic impact

Over recent years, it has been claimed that a complete cleaning of the wound is impossible and that there will always be microscopic lead particles left in the tissue that are invisible to X-rays and that fragments may be found much further away from the wound channel, something that can be taken with a pinch of salt.

It is in the nature of things that tiny amounts of metallic lead can only be transformed into very tiny amounts of bio-accessible lead compounds. Nor is it technically possible for extremely small, low-mass particles to deviate over a few centimetres from the path of a bullet’s motion and penetrate deep into undamaged muscle tissue, thus contaminating the entire carcass.

In the event of a direct hit in dense bone, such as the humerus or scapula, the wound channel will be considerably larger over a short distance than a comparable hit in the ribcage. Due to the violent transfer of energy when a bullet strikes dense bone, the wound cavity will also be much larger in surrounding tissue. Small bullet fragments may then radiate and contaminate crushed tissue on the interior of the wound channel, or follow the blood pressed in between the muscle groups as they are torn apart by the large pressure. Larger fragments will follow the bullet axially and lodge in the tissue around the exit wound, unless they pass straight through.

It is not difficult for anyone with experience of butchering to handle this type of wound. In the case of smaller cloven-hoof game, the entire shoulder or chest will simply be discarded.

Exposure to lead in game meat

A large number of studies have been conducted over recent years with the stated aim of in some way proving that there are major health risks associated with eating meat from game shot with lead ammunition, particularly in the case of children and in societies where game is an important food source.

There are few people, even among hunters, eating enough poorly prepared game in such large amounts for this risk to even approach that posed by exposure to bio-accessible lead resulting from the ingestion of common basic foods such as cereal products, beer, potatoes, root vegetables, vegetable products, leafy vegetables, wine, pork, coffee, sugar and, not least, tap water – all of which contribute in the range of 3 to 6.8% of total exposure to lead.
According to EFSA, game meat as a separate foodstuff contributes 0.12% of total exposure (cf. p 11, EFSA Scientific Opinion on Lead in Food, 2010) on population level.. Certain dietary supplements and so-called natural remedies may contain extremely high concentrations of bio-accessible lead, up to 8,2 mg in a single tablet which has resulted in several cases of acute lead poisoning.

At population level, the consumption of game meat is negligible; in Sweden at most approximately one kilogram of boneless meat per person and year of the total amount of cloven-footed game harvested each year. If one takes only households containing a hunter (approx. 1.6 million individuals), this figure rises to 7-8 kilograms of boneless game meat per person and year. Depending on the method of cooking, this is enough for one portion of 150 grams per week over the course of a year. For a family of four, it would require two wild boar with a live weight of 50-55 kilograms, alternatively two 18-month-old fallow dear or four roe dear, per year to achieve these quantities.

The EU limit for bovine meat is 0.1 mg/kg and this in the form of bio-accessible lead ions rather than fragments of metallic lead that first to some degree will be dissolved in the gastrointestinal tract before a certain degree of the dissolved lead ions can be absorbed by the human body.

In order to achieve a comparable level of exposure from metallic lead – even using a generous calculation of 2% of metallic lead being transformed into bio-accessible lead compounds in the intestinal tract [15] – every kilogram of game meat would have to contain a minimum of 5 mg of metallic lead, an entirely unreasonable proposition if the carcass is handled professionally. As a rule, any large fragment weighing a few hundred milligrams that does slip through and ends up on the plate will generally be discovered. If swallowed it will not result in chronic exposure, although it may lead to a temporary rise in B-Pb for a couple of weeks.

Existing studies of B-Pb in various population groups with varied consumption patterns of game meat have not demonstrated any notable differences that specifically point to game meat presenting a health risk in terms of lead exposure.

This is understandable as in practice large variations may occur in external exposure to lead depending on parameters such as living conditions, drinking water supply and patterns of consumption of other foodstuffs, high consumption of bivalve molluscs, wine and beer that cannot be weighed into results with any precision. It is notable that in one oft cited US study, no consideration was given to lead exposure from aging buildings in which internal painting had been executed with lead-based paint (containing lead carbonate, which is now banned in Sweden). Whether this omission was intentional or not is unclear; either way, the results are misleading.

High lead levels in German wild boar

The German Federal Institute for Risk Assessment (BfR) states that wild boar is the most lead-contaminated game meat in Germany, with an average of 4.7 mg/kg, while EFSA states an average of 3.15 mg/kg. One must assume that this refers to metallic lead, given that these levels of bioaccessible lead in muscle tissue would require that an animal weighing 60 kilograms consume very large amounts of lead. The distribution of absorbable lead to muscle tissues relative to liver uptake is only one fifth.

Wild boar consume large amounts of soil while rooting for food during the autumn and spring, so it is not unreasonable to assume that wild boar living close to industrial areas, where levels of lead in the soil layer may be very high, may consume considerable amounts of lead while rooting. Data exists suggesting that in certain areas there may be up to 60,000 mg/kg of lead in soil dry matter adjacent to foundries and similar industrial plants. [14] Even a level of 2-3,000 milligrams of anthropogenic lead per kilogram of soil could be sufficient to contribute to the high levels of lead measured in wild boar and other species.

As far as is known, there is no major research activity underway to more accurately monitor lead exposure in wildlife populations in areas with known major and widely dispersed industrial lead contamination and where wild animals have their habitat and feeding grounds.

Svenskt Forum believes that such research would be of great importance in scientifically establishing the basis in reality of this one-sided focus on lead ammunition as the only reasonable cause of a wide range of issues.

The objectivity of certain methods for measuring lead in game meat, and the results obtained, can be considered highly dubious and undoubtedly damaging to the credibility of the debate and the results of various studies. A document published by BfR refers to a 2010 EFSA report containing the astonishing information that in 1997, a maximum lead value of 19,300 mg/kg was recorded in wild boar. This is 19.3 grams per kilogram, which for a boar weighing approximately 48 kilograms carrying approximately 17 kilograms of meat would require contamination from all of the metallic lead from 54, 6.5x55 calibre rounds. No published reaction to this clearly unreasonable claim has been noted; the information simply continues to circulate and is occasionally cited as an argument against the use of lead ammunition. [14]

Measurement and investigation methods

It is a fairly widely held belief that lead fragments from bullets cannot be entirely removed when cleaning the carcass. It is also assumed that fragments can penetrate deep into tissue, contaminating the entire carcass, and that fragments can disperse widely from the wound channel.

First and foremost: lead fragments are always located on the periphery of the wound channel and in limited areas around the wound channel where muscle tissue has been broken down. Removing a generous area around the wound channel will remove the vast majority of lead fragments. Admittedly, small fragments may stick to the knife blade and be transferred to undamaged areas, although this is easily avoided by the simple expedient of cleaning the knife regularly while butchering. That said, such fragments are incapable of producing amounts of bio-accessible lead compounds in the stomach any larger than a few percent (1-2) of their own weight.

By using standard X-rays, studies often draw the erroneous conclusion that fragments can travel radially several decimetres for the path of the bullet. With a diagonal shot, fragments will be found along the full length of the inner surface of the wound channel. If there is a considerable distance

between entry and exit wounds, the fragments visible on a standard X-ray may appear to have spread radially from the wound channel, although this is not the case. It only shows that the shot has been taken from a poor angle. An animal's shoulders are moveable. If, for example, the animal's front legs are not arranged in the position they were in at the moment the shot was fired, a standard X-ray will show a misleading projection of wound channel that suggest that fragments are present where they are in fact not. Furthermore, all fragments are viewed from the direction of the image is taken from in the same focal plane, providing an incorrect image of extreme concentrations without showing the actual physical distance in depth between individual fragments.

If one is interested in obtaining a correct and credible image of how lead fragments appear around a wound channel, where bleeding occurs between muscle groups and how smaller fragments have travelled in the chest cavity and organs when the lungs collapse, it is necessary to use computed tomography (computer-processed combinations of many X-ray measurements taken from different angles to produce cross-sectional images. [15]

The primary prerequisite for correct CT images is that the un-butchered animal, with all organs and intestines in the correct place, hung up immediately after the shot in some form of cradle, with the front legs, neck and head in particular fixed in their position when the bullet impacted. When rigor mortis has set in, the entire animal should be frozen in the correct position to await imaging. By waiting a couple of months before taking samples, it can be easily confirmed that lead fragments do not disperse soluble lead and contaminate tissue other than that directly adjacent to the fragment. If all large samples are taken with the aid of CT images while the object is half thawed – instead of taking random biopsies weighing a few grams from a physically unmanageable test material, the results of which may vary between zero and several thousand mg/kg – there is a considerably greater chance of establishing accurate actual total lead level in the sample by ashing, where bigger tissue samples used, that could be expected to contain all sizes of fragment including on X-ray invisible lead dust. [15]

The results reported in various studies show clearly that testing of random biopsies has been used, often without reporting how and where animal samples were taken.

The health effects of game meat

On the whole, Svenskt Forum considers the ECHA's report to be a generally partisan account following on from decades of discussion clearly intended to promote a prohibition on the use of lead ammunition for hunting and sports shooting, without any consideration for either the technical aspects of weapons and ammunition or applicable legislation.

The majority of studies and reports used to promote the issue of a ban can without doubt be considered as having been commissioned from students seeking socially engaged, if not downright populist, assignments that can easily gain ill-considered support from environmental and animal-rights organisations without any requirement for factual objectivity.

The argument levelled at hunters that a ban on lead ammunition is a measure designed to protect the health of them and their families is a direct and undue infringement on the personal sphere.

Irrespective of the existence of any limit on lead in game meat or any safe minimum level for lead intake, any such consumption is a private matter. This can be stated against the background of a lack of any EU-limits or restrictions on the private use of tobacco or alcohol, both of which cause several millions of fatalities annually and place an enormous financial burden on society, not only in the form of direct costs for treating a wide range of severe medical conditions but, in the case of

alcohol consumption, enormous secondary costs of a social nature and in terms of accidents and criminality.

It is also noteworthy that there is no safe limit for the consumption of alcohol or smoking, whether for adults or unborn children. Unlike lead, alcohol is an acute lethal neurotoxin when "over dosing" – a property that should be placed into context when discussing a ban on lead ammunition from a perspective of human health.

Alternative materials for bullets and shot

Section 27 of the Swedish Hunting Act (SFS 1987:259) states: *"Hunting shall be conducted such that game shall not be exposed to unnecessary suffering and so that people and property are not put in danger."*

The full implications of that brief text are extensive and individuals with no expertise in the field have failed to understand the full consequences of the application of this legislation, something that is also evident from the ECHA's views on alternative ammunition.

The term *unnecessary suffering* as applied here must be considered from two principal aspects:

- Which hunting methods may be used in various contexts.
- How weapons and ammunition should be designed from an animal welfare perspective in order to immobilise quarry and ensure the most pain-free death possible from the wounds inflicted by the equipment used.

The provision that people and property should not be put in danger in connection with hunting activities also contains two aspects: Firstly, it can be seen as a requirement on the hunter to display general consideration for residents of the area, to prevent hunting dogs from inflicting harm on domestic animals and to avoid damage to crops, for example by trampling or unnecessary use of motor vehicles. Secondly, and with far more serious and far-reaching consequences, it refers to the discharge of weapons that is inevitable if the hunter is to catch her or his prey.

The meaning of the legislation is that, in conjunction with firing a weapon, there should not be any risk whatsoever that people or property will be exposed to danger. It is the hunter who bears the responsibility for ensuring that when discharging their weapon, they have a sufficiently effective bullet trap to eliminate the risk of ricochets from hard surfaces. A direct shot at a person or property is purely a behavioural issue with nothing whatsoever to do with the hunter's choice of equipment or ammunition. When using standard expanding lead bullets, the risk of ricochet is considerably more predictable than when using over-penetrating, monometallic bullets of copper or brass. Ricochet characteristics of monometallic bullets vary widely depending on the choice of material, calibre, grain and muzzle velocity but always more unpredictable then lead bullets. This relationship has been constantly ignored by those lacking technical insight who drive the issue of a ban on lead ammunition citing the responsibility of the individual hunter. This is true if the hunter themself chooses to use bullets with completely different characteristics to standard lead-tipped bullets, irrespective of calibre.

In the event of an imposed prohibition on lead bullets and direct recommendations or requirements from various public authorities that, for example, copper or brass bullets specifically must be used for hunting, an entirely different legal situation arises with regard to responsibility or risks for injury that may result from the choice of ammunition with different and more hazardous characteristics than consumers are accustomed to, and that they have little opportunity to foresee.

Within insurance law, this could be viewed as a systemic failure and responsibility for injuries then rests with the party imposing the mandatory requirement.

Thus far, the reaction of public authorities and other stakeholders has been to refer to the fact that hunting is a voluntary pursuit and that the products used must not cause injury to people or the environment. In the event of a general and complete transition to the use of monometallic bullets, this provides a simple means of returning responsibility to the individual hunter or the ammunition industry, both with regard to safety and animal welfare regulations that in any case can be found in Swedish legislation.

Considering how quickly the wild boar population is expanding in Europe, it is a moot point to consider how much worse the already severe levels of damage to the agricultural sector might become should the hunting fraternity choose to hang up their rifles due to the imposition of prohibition and regulations by public authorities. In all likelihood, it would lead to total catastrophe. It is strange that in population groups that are generally and vocally critical of hunting, it is assumed that amateur hunters should shoulder the responsibility for solving the issue of damage by wildlife that society resoundingly lacks the ability to administer in practice or economically.

When it comes to alternative shot of steel or other materials harder than lead, there are mandatory regulations issued by the CIP stating that packaging must, among other things, contain a warning that hard shot is ricochet-prone and may damage weapons in various ways.
As long as this is done, manufacturers are indemnified in the event of injury.
The question is, why has the industry not chosen to use the same method with regard to the use of monometallic bullets? There have been deaths associated with ricocheting copper bullets in a German state a few years ago; a state in which the use of lead bullets was banned.
Svenskt Forum has no satisfactory answer to this question, although one assumption may be that it is a matter of competitive conditions.

Technical aspects and the lethality of monometallic bullets

The common claim that monometallic bullets are fully comparable with lead bullets is pure nonsense. That this type of alternative bullet can be fired from any weapon is only a limited part of a complex issue. In only a few calibres is the rifling in existing weapons adapted to grains that can be considered suitable for all European game, with reasonable precision and shot effect at limited distance.

Like Sweden, for animal ethical reasons various countries have regulations on minimum calibre, grain and impact energy for various species of prey. Copper alloys have a considerably lower specific weight than lead, meaning that copper bullets must be made longer than lead bullets of the same weight. In relatively small-calibre weapons, from 7 mm and under, in most cases it is impossible to dynamically stabilise copper bullets at a weight permitted for hunting elk, deer and wild boar. In the case of Sweden, this means that hundreds of thousands of weapons will be rendered useless for their intended purpose.

A poorly stabilised copper bullet obviously leads to precision issues; however, worse than that, the bullet may tip on impact and impair an already dubious shot effect.

In Sweden, regulations are in place stating that bullets used for game from roe-deer upwards must be constructed to expand on impact so that energy is rapidly transferred and major damage caused to vital organs. Copper alloy bullets do not and never will have the same plasticity as lead. The only possibility for any form of expansion is to make an axial cavity in the nose of the bullet; a hollow tip that causes the bullet's front end to open up when filled with bodily fluid and tissue. This requires

such a high impact velocity that, using a normal calibre weapon, an acceptable expansion is impossible unless the shot is fired from close range. At an impact velocity of 600-700 m/s, expansion will generally be less that the bullets external diameter. It will largely retain its length, causing it to tip during its passage through the animal and exit diagonally, increasing the shot effect somewhat but, for obvious reasons, a solid bullet rotating uncontrollably, like a boomerang, is definitely more likely to ricochet comparing lead bullets when striking a hard surface such as rock or frozen ground. Animals shot through the lungs will of course die, even if the bullet is fully jacketed. It is simply a matter of time. The central issue, however, is whether this type of ethics is to dominate hunting in future?

Lead bullets expand satisfactorily even at low impact velocities and irrespective of calibre. It is also very easy to adapt expansion in the manufacturing process by exposing the lead core in the desired manner. In practice, this is impossible with a monometallic bullet.

Evidence of the relative properties of copper and lead bullets can be obtained through simple comparisons obtained by carrying out a few practical tests using ballistic gel, something that proponents of copper bullets would do well to try. Otherwise, the difference is readily apparent during a practical hunt. A survey by the German association of professional hunters was terminated early when it was realised that it was unethical to shoot animals with bullets that significantly extended flight distances.

Given that throughout the twentieth century our modern society has produced a wide range of substances with such a negative impact on animals, the environment and humans that they have been banned after a few decades, reflection would certainly be in order. A general transition to copper bullets will increase emissions of easily dispersed and highly aquatically toxic copper salts from ammunition by at least 60% with unforeseeable long-term environmental consequences. In years to come. Who and what groups in society will be prepared to shoulder this responsibility?

Its estimated that we have around 500 metals that are classified as carcinogens that is not legally allowed to reach consumers. Most people have no idea which they are or how to avoid them.[17]

This fact besides thousands of chemicals, old and new that soon or later will reach us from diffuse sources is a realty we have to face. Most interesting is that substances who today is stated as serious threat for environment, humans and animals, only have been in practical use for a very limited time less then 30-50 years. Without denying lead in different chemical forms could be toxic for humanity, has compared with a lot of other phased out substances, humans manage to use lead relatively safely for 6000 years.

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