



Blue Etching 2014 di Fabiola Mercandetti

A Brief History of the Non-Toxic Movement and Saline Mordants by Fabiola Mercandetti 2014

Pag. 6- 21

The art of Printmaking, like any artistic form, is founded on the use of methods, tools, and materials necessary for the development of its language. In his "Elogio della mano" (In Praise of Hands, ed1939), H. Focillon highlights that "art begins with transformation and continues with metamorphosis"; it is therefore both technical knowledge and the infinite metamorphosis of a visual and graphic code, capturing the essence of human expression. In the Focillonian, the artist is first a craftsman and then an alchemist, as they embody the secular memories of the past and the experiences of the present to turn toward the new. The concept of the "new" in the non-toxic movement and in the history of printmaking must be considered in relation to pre-existing techniques and to artisanal or industrial practices, according to a continuous exchange. For Focillon, *"every technique presents a development and a continuity; there is no law of randomness."* The burin derives from the goldsmith's art, just as etching was born from the practice of armorers, and J. Callot was inspired by Florentine luthiers for his varnish—this is just to give a few examples and to underline the infinite richness of this art's expressive means. In the nineteenth century, lithography emerged, which, in addition to giving us examples of extraordinary artistic mastery, allowed the researcher J.N. Niépce to create the first photographic image using bitumen of Judea—a discovery that brought about a profound change and definitively freed engraving from its role as a reproduction technique. While printmaking has always been, since its origins, the visual and historical memory and the greatest tool for political, social, and religious information, it must also be remembered that it was the only democratic medium capable of reaching every social class. Engraving has always brought together a dual soul: on one hand, it has been the witness of its time through reproduction or translation prints; on the other, it has increasingly established as an original art form. The reproduction function was later absorbed by photography and, subsequently, by industrial image processes, thus defining the face of printmaking as we know it today: an art form.

This premise is necessary to reiterate how art, and printmaking in particular, is always an evolving reality, characterized above all by continuous experimentation. Non-toxic movement, whose multiple characterizing factors we will analyze here, includes different phases and aspects. Priority will be given to

the artistic dimension, with a few brief mentions of scientific and ecological references. I would define this research of mine as a sort of map. This will be presented in a highly simplified form and should be considered as the itinerary of an adventurous journey, to demonstrate the complexity and wonders of the art of printmaking, there are links with science and with history. I have highlighted unpublished information and points for reflection to emphasize a deep conviction : that behind every technical-artistic achievement and a long path of research. Furthermore, I believe it is important to always give credit to the masters who preceded us, to their research, and not to live in an arid self-referentialism. On this journey, I had an exceptional reference, Prof. Nik Semenoff, one of the fathers of non-toxic printmaking for his numerous researches, inventions, and methods have changed the world of printmaking. Semenoff is a master who transformed my way of seeing printmaking and not only printmaking; he also taught me how important chemistry, knowledge of materials, and the research behind every discovery are. To this master, I dedicate this article and all my work.

In the first instance, the non-toxic movement is a necessary update, as it has involved and is involving every sector of the arts and sciences worldwide. Non-toxic is not an ideology that tends to exclude traditional techniques; but it is the contrary, this research will prove exactly the opposite. For this reason, we will speak both of a rebirth of printmaking, understood as a return to origins, and of innovation, often defined as a “revolution”, as E. Pogue writes in his eloquent text “Printmaking Revolution”, published in 2012.

Non-toxic movement is therefore based on three main aspects:

- rediscovery of ancient materials (from saline mordants to vegetable oils, including other methods and materials);
- reintroduction of these traditional materials through new chemical combinations, which have led to a simplification of procedures and made preparations and use safer;
- development of new materials and methods.

There is an initial theoretical phase of this movement and it must be distinguished from a subsequent phase of practical application. The theoretical phase takes place in the 1960s and 1970s, although, as we will see later, it should be backdated. This theoretical phase draws on studies by chemists and researchers in the science of toxicology, as well as publications by artists in close connection with occupational medicine. Furthermore, the links with ecology must be considered, with the birth of Green Chemistry and industrial ecology. In the 1970s, ecology, which finds its origins in the eighteenth and nineteenth centuries, developed into various branches. In 1974, the English anthropologist Gregory Bateson wrote “Steps to an Ecology of Mind”, a study that brings together different epistemologies and draws inspiration from the poetics of William Blake. In this book, Bateson focuses on two main aspects: one related to the inner reunification of the individual, the other to the relationship between man and the environment. Man lives in a system of relationships, where every unit is a part of a whole and of an ecosystem. He should rediscover this unity of his and empathy with the surrounding world to regain respect for himself, for nature, and for the environment in which he lives. He should rediscover his cultural roots, awareness in a new vision and ecology of ideas. These definitions could be interpreted as pure philosophy, yet Bateson is at the foundation of today's ecological perspectives and their pragmatic application (see in this regard the publications of *physicist Fritjof Capra*, director of the Center for Ecoliteracy in California, a center dedicated to ecological education). A simpler reflection is the one proposed by D. Goleman, who in his “Ecological Intelligence” (2009) tries in an almost journalistic manner to make us reflect on our every action in relation to the environment. The triad proposed by Goleman to activate an ecological intelligence is based on the knowledge of ecological issues, the improvement of such knowledge, and its realization through sharing. Since the printmaker is a human being and part of an ecosystem, they should not apply a method solely for artistic purposes but should consider broader ecological goals. Such changes should involve the ethical

dimension, as the philosopher P.W. Taylor writes, and we should begin to consider the concept of "environmental ethics." A new ethics based on nature, to be placed before the anthropocentric one limited to respect for people (Ethics and nature: the highest moral challenge of our century? The theoretical proposal of Paul W. Taylor by M. Andreozzi 2014).

Until some time ago, as I have already written, I would have placed the birth of the non-toxic movement in the 1960s, with the first research into safety issues in art, followed by a subsequent phase in the 1970s, a moment when the first specific publications on the risks and dangers of materials used in printmaking began to flourish. In recent months, after examining and reading numerous researches, articles, and books, I have changed my mind, as in December 2013, I rediscovered an important figure. In a 1994 article on occupational health by H. Abrams, I came across Henry Ernst Sigerist, a physician and medical historian. Sigerist masterfully brought back to light ancient sources regarding occupational health and safety issues. In a 1996 article of his, later included in the book "History on Medicine" (dated 1960), he cites an important text dating back as far as 1473. This text was written by the German physician Ulrich Ellenbog. I have viewed a PDF copy of the original incunabulum, thanks to the scholar A. Stijnman, and a 1927 biographical study on Von Ellenbog, preserved at the Vatican Library, thanks to the Director of the Cabinet of Prints, Dr. Barbara Jatta. *This short treatise, entitled "Von den gifftigen besen Tempffen und Reuchen", is the first guide on the dangers of toxic nitric acid vapors and the risks derived from charcoal, lead, mercury, and other metals.* This German physician likely wrote the short text for his goldsmith patients, having observed the problems caused by their working conditions. This text was widely distributed through typography and can be considered *the first safety guide in metalworking*. Sigerist also analyzes observations derived from ancient sources such as Hippocrates, Pliny, Juvenal, Paracelsus, Agricola, and many other physicians or physicists, as well as B. Ramazzini, to highlight the important relationship between the causes of diseases and work. This is a crucial aspect about the foundation of the non-toxic movement. The problem of toxicity has always been present for printmakers, as written by E. Figueras and A. Stijnman, who highlight the earliest attempts adopted to avoid toxic acid fumes or other precautions. E. Figueras Ferrer, in "El Grabado no tóxico: Nuevos procedimientos y materiales" (2004), analyzes saline mordants and the recipes of ancient mordants. Her research emphasizes that the first mentions of risks in printmaking were made by C.N. Cochin in the second edition of Bosse's treatise in 1745, where Cochin reiterates how the "pouring biting" (morsura a colata) system was safer and less dangerous for the eyes and respiratory tract compared to the immersion method. Stijnman describes various machines designed during the eighteenth century to agitate acids during biting, covered trays to prevent spillage, or different solutions to avoid acid inhalation. Furthermore, he describes other examples of less toxic procedures, such as a mechanical graining system developed by K.U. Keller in 1815–17 to avoid the use of rosin. These are just a few examples found in the history of printmaking.

Printmaking, like any art form, is based on the use of materials such as inks, colors, papers, fabrics, solvents, varnishes, metals, woods, and many other products. During the creation of the matrix and in the subsequent printing phase, it becomes necessary to process and transform these materials. Often, the products employed and their manipulation and interaction determine chemical reactions. In the etching technique, acids are used, and the corrosion of the metal causes a chemical change at the molecular level; in simple terms, the reaction between the metal and the acid causes the formation of new substances. These substances are often toxic, as in the case of nitric acid, which produces many harmful gases, including nitrogen tetroxides, monoxides, and dioxides depending on the reactivity of the metal. Nitrogen dioxide, for example, is highly dangerous to health because it is strongly oxidizing, to the point of causing severe respiratory tract diseases, such as pulmonary edemas. Furthermore, nitric acid is an oxidizer (comburente), carrying the risk of severe skin burns; not only is it harmful to humans, but it also creates photochemical smog, since under solar radiation it triggers secondary photochemical reactions that create

pollutants in the atmosphere. Among dangerous mordants, Dutch mordant must also be included, both in the preparation phase—where it produces chlorine dioxide—and in its storage, which, if incorrect, carries a risk of explosion. Emissions of toxic substances are highly noticeable in the use of solvents or VOCs (volatile organic compounds) or in the interactions between acids and varnishes, which cause severe health risks and dangers. The use of toxic substances not only causes contamination of the workplace, but disposal and the relative environmental impact must also be considered. For this reason, it is necessary to have knowledge of the risks and the precautions to be taken when using these substances, and to solve the problem of toxicity at the source, as Stijnman writes. Proposals for alternative solutions mainly concern acids and solvents, which are undoubtedly the most harmful and dangerous products.

Acrylics are one of the proposed alternatives to bitumen varnish; however, this does not mean that all traditional bases or varnishes must be discarded. Liquid varnishes containing solvents are certainly the most dangerous and should be avoided, but Stijnman writes that bitumen bases can still be used with due care, such as traditional hard grounds without solvents. Asphalt, Stijnman writes, is to be considered carcinogenic in the event of regular skin contact or ingestion. R. Adam emphasizes that if asphalt is subjected to high temperatures, it can change chemically and further increase the risks. For this reason, it is necessary to avoid excessive heating and the smoking phase (*affumicatura*). The important thing is to know the risks and apply safety regulations in the best possible way, just as it is fundamental to remain informed and updated. In many cases, new methods should not exclude traditional products. It should also be noted that it is not only printmakers—often recovering from health issues—who have decided to address these problems, but the industry is also heavily involved in this change. Large companies collaborate with artists to manufacture specific products, equipment, and tools, as evidenced by the partnerships between Howard and the Polymetaal company, and between Adam and Robertson with the Lascaux company.

The term “non-toxic” what exactly does “non-toxic” mean? A distinction must be made between the concept of non-toxic applied to the arts and printmaking, and the scientific definition. The latter indicates a parameter within which the effect of a given chemical substance, to which a living organism is exposed, may not cause harmful or toxic effects. Therefore, it does not mean that the product is completely non-toxic, but rather that there is a classification of toxic substances according to current regulations. This classification is divided into categories (from highly toxic to irritant), just as there are parameters called reference indices, dose limits, and threshold limits, within which the degree of toxicity and danger of a product is defined. Simply put, a product is defined as non-toxic when, in relation to a specific dose and duration of short- or long-term exposure, it will likely not cause harm, acute or chronic injuries, or lethal consequences. Furthermore, there are various personal risk factors, including specific tolerance thresholds; for instance, there are individuals at higher risk (such as the elderly, children, or pregnant women), and probabilistic calculations do not provide absolute guarantees. Nor should substances considered irritants be underestimated; while non-corrosive, their direct, prolonged, or repeated contact with the skin or mucous membranes can cause inflammatory reactions. There are also risk factors due to potential absorption through inhalation, skin contact, and ingestion. For further analysis, one can consult the texts by Moses, Challis, Figueras, and chemists such as McCann and Rossol. A principle to keep firmly in mind is that no chemical product is completely non-toxic and each must be used with care and caution. It is necessary to follow the information provided on labels, Safety Data Sheets (MSDS), and the precise instructions on the proper use of the product described in the technical documentation.

A method is not just the use of a particular product, but is based on chemical knowledge, correct preparation, application, and extends all the way to safe storage, disposal, or removal. Regarding the term “non-toxic” applied to art, and especially to printmaking, it initially took on an ideological value,

representing a willingness to change attitudes and materials. However, this term was not the only one to be adopted, and reflections on the concept of non-toxic have always been debated by various masters. In his article “Safe & Safer”, A. Stijnman reiterates that the term “non-toxic” in printmaking is inappropriate due to the obvious use of chemicals, and that the only truly non-toxic techniques are those of Japanese woodblock printing (mokuhanga) using water-based ink pastes. R. Adam, M. Graver, and other authors include all direct intaglio techniques in their manuals as being inherently the least toxic, even though the chemist McCann identifies some physical risks even in these methods, such as carpal tunnel syndrome or other ailments—though, of course, one should not exaggerate. Many printmakers have used other, less absolutist terms such as “safer,” “less toxic,” “greener,” and others, which are often linked to the ecological movement (see the definition of sustainable art and printmaking, whose origin lies in the concept of ecological sustainability introduced in the 1980s by Lester Brown).

The Texts

The main texts of the non-toxic movement are divided into texts by chemists or toxicology articles dedicated to health and safety in art, and specific texts on printmaking written by printmakers, often in collaboration with chemists. Chemist M. McCann was among the first to address risks in printmaking. McCann is the author of books such as *Artist Beware* (1979) and *Health Hazards Manual for Artists* (2008). Among the earliest research on toxicity, he cites H. Siedlicki's texts on health risks for painters and sculptors (1968) and G. Agoston's work on risks and safety in art materials (1969). I found two other interesting, less well-known research papers from the 1970s: one by R.R. Gadamoski on emissions in metal decorating processes in the industrial graphic arts (1970), and another from a conference edited by F. Fisher on the environmental aspects of chemicals used in industrial printing operations (1975–76). These studies were conducted during the legislative battle for health protection in the workplace, which was initiated in 1968 by American President L. Johnson and finalized in 1970 by R. Nixon with the "*William-Steiger Occupational Safety and Health Act*" (OSHA). A few years later, in 1974, the famous law known as HASAWA (Health and Safety at Work Act) was also enacted in England. From this moment on, numerous texts began to flourish. Among the first dedicated to printmaking, it is worth mentioning the 1978 text *Health and Safety in Printmaking: A Manual for Printmakers* by C. Moses, J. Pordham, D. Bowham, and R. Hosein—a text that G. Peterdi, a student of Hayter, included in the third edition of his manual (1980).

Two other significant texts are "*A Printmaker's Guide to the Safe Use of Materials*" by N. Seeger (1981) and "*Print Safe: A Guide to Safe, Healthy and Green Printmaking*" by T. Challis (1990), which would later inspire C. Green. The research of chemist and industrial hygienist Monona Rossol with her "*The Artist's Complete Health and Safety Guide*" (1990) is also noteworthy. Subsequently, the publication of manuals, articles, and dissemination on the web by printmakers continued at an unstoppable pace. These texts do not only address risks and health protection in printmaking, but also begin to propose alternative methods and a different approach to this artistic practice.

The historical premises of the non-toxic movement include different aspects: the first is based on a return to the origins of printmaking, with the reintroduction of salt-based mordants and ancient cleaning systems; the other aspect is represented by the influence of photo-etching, electro-etching, and the invention of new solutions. Tradition is absorbed, reworked, and transformed into new expressive possibilities in intaglio and all other techniques. This relationship between printmaking and science is becoming increasingly close: while on one hand photography was born from the laboratories of lithographers, subsequently photographers themselves invented mordants for development, which were then used by printmakers. Ferric chloride, for example, discovered by W.F.H. Talbot in the mid-nineteenth century, was adopted by etchers (P.G. Hamerton, *Etching and Etchers*, 1876 – note “The Chemistry of Etching”). Later on, industrial processes, such as the etching of Printed Circuit Boards (PCBs), constituted an important source

for the reintroduction of saline mordants. Before outlining the landscape of the numerous techniques within non-toxic printmaking, it is necessary to emphasize that this movement emerged in the twentieth century, a historical period of intense experimentation. Indeed, twentieth-century printmakers inherited the great artistic fervor of the previous century, which had seen the birth of printmakers' associations aimed at promoting major initiatives through exhibitions and publications. The nineteenth century was also the century of the rediscovery of Rembrandt and the revival of all printmaking techniques, which allowed the full establishment of original printmaking. The scientific discoveries of the nineteenth century influenced the artists of the Era, as is evident in *E. Degas* and his numerous experiments in printmaking. He etched with the electric or electro-voltaic pencil, kept himself updated on various photographic techniques, and experimented with celluloid as a material to transfer drawings into lithography, combining it with monotype methods. *Degas wrote to F. Bracquemond* that he had even used copper sulfate to fix the drawing onto the zinc plate, perhaps mindful of Vial's method, which we will see later. Similarly, C. Corot, along with the Barbizon School and other artists, realized the technique of "cliché verre," while the sculptor P. Roche, a student of A. Rodin, reintroduced embossing (gaufage) to arrive at "gypsographies" and "gypsotypes." Roche was certainly aware of the inventions of "cerography" by R.C. Morse in 1839 and "glyphography" by E. Palmer, patented between 1840 and 1842, both of which utilized electro-etching. Electro-etching, invented by several researchers, was immediately applied to the reproduction of plates. Numerous other methods were invented, such as A. Griffiths' "chemitype" or F. Gillot's "gillotage."

In 1829, Niépce developed his research on the photosensitive properties of bitumen, and Daguerre invented the "daguerreotype," a photograph on a thin, silvered copper plate. His invention was presented in January 1839, almost simultaneously with the discovery of the "calotype" by the Englishman Talbot.

In the twentieth century, artists continued this previously initiated path, and the use of non-traditional matrices increasingly became a standard practice. Indeed, while *Dox Thrash* was the first to use carborundum for his mezzotint, H. Goetz also developed his famous method using this new material (*Gravure au carborundum*, 1969). The use of plastic materials spread further, such as Rhodoid used in the 1930s by E. Cournault, and celluloid used by P. Picasso—a material already experimented with by Degas and F. Buhot at the end of the nineteenth century. The Ukrainian *Boris Margo*, a pioneer of collagraphy, worked on shaped celluloid in the 1930s, engraving it and dissolving it with acetone, which led to the "cellocut" technique in 1932. Margo was also, as we shall see, one of the first printmakers to employ cupric chloride on zinc. Another name linked to collagraphy is the Norwegian R. Nesch with his "metal prints," as well as E. Casarella with his "paper cuts," R. Ginzel, M. Lasansky, M. Ponce, and others. The term "collagraph" itself was coined by G. Alps in 1956, leading to the experiences of C. Romano and J. Ross, who experimented with cardboard sealed with shellac and began using acrylic gesso. Such premises are necessary to outline the atmosphere in which prominent workshops, such as S.W. Hayter and J. Hecht's Atelier 17, as well as those of H. Goetz and J. Friedlaender, became places of immense experimentation.

Furthermore, mentions of electro-etching can be found in two of Hayter's texts (*New Ways of Gravure*, 1949, and *About Prints*, 1962). Although the development of photography and commercial printing techniques had initially created a rift with art, these separate paths later converged in the twentieth century. From the 1970s onward, photographic techniques were increasingly used by printmakers. An interesting perspective on this can be found in T.R. Newman's text, which analyzes the new directions of printmaking influenced by offset, collotype, photo-offset, electrostatic screen printing, dry offset, photo-etching, rotogravure, and many other processes that were adopted, updated, and translated into new methods. Photo-etching and the manufacture of Printed Circuit Boards had developed in the mid-nineteenth century and toward the final decades of that century. These processes and the photoresist films used for industrial electronics offered many insights to twentieth-century artists and to the new generation of the non-toxic movement. The theoretical and experimental phase was followed by an operational phase of grand development starting in the 1980s, even though Dan Welden had already begun working on his

"solarplate" method back in the 1970s. Many artists began working in different parts of the world, resulting in numerous methods and significant innovations within every field of printmaking.

For this reason, we will initially consider the different activities and techniques, starting with the historical masters, and then move on to look at more recent research. In intaglio printmaking, alternative solutions to traditional varnishes follow a long development consisting of transition phases, leading up to the formulation of specific products. Printmakers began by adopting varnishes already present in tradition, such as spray aquatint using shellac diluted in alcohol to replace rosin and bitumen resin. C. Green adopted the traditional system for the "re-biting" of plates, using oily ink as an acid-resistant base, while among the first less toxic soft grounds proposed was that of J.C.R. Guadix, made with lithographic ink. For etching, products from other techniques or different fields are also utilized—for instance, acrylic waxes for cars or floors, as well as water-based bitumen without solvents, a material derived from the construction industry, which was used initially. Adam, Robertson, Howard, and other printmakers, on the other hand, experimented with mixtures based on screen-printing mediums or acrylic mediums borrowed from painting. For etching and soft ground, mixtures of water-based woodcut inks also prove particularly suitable. This mix was proposed by Prof. G. Ferstman and later taken up by other artists with the addition of different mediums, as seen in the variations by Semenoff, Bøegh, Howard, and Kiekeben. From time to time materials change, and often certain products are discontinued or their formulation is modified; for this reason, printmakers are always ready to challenge themselves again to find further solutions and combinations. In the 1980s, the experiments of Prof. Nik Semenoff also began. A Canadian goldsmith, lithographer, and printmaker, he is one of the fathers of non-toxic printmaking. As a professor at the University of Saskatchewan, he addressed the problem of using safer materials within the context of teaching. Versatile and brilliant, he discovered "dry copier toner" for lithography in 1984–85, on which he held lectures at the Tamarind Institute (New Mexico), which specializes in lithography, and published an article in the scientific journal *Leonardo* in 1987. He applied the "toner wash" method to intaglio plates and interested himself in electro-etching; both researches were published together with C. Christos in an article that appeared in *Leonardo* in 1991. In 1990, he developed waterless lithography using silicone for casting (articles in 1993 and 1995). Between 1990 and 1992, he was the first to discover the "Safer Mordant" for zinc and aluminum: a saline mordant made of copper sulfate, sodium bisulfate, and sodium chloride. The article, written in collaboration with chemist Dr. L.W. Bader, was submitted to *Leonardo* magazine in 1994 but published only in 1998. The article outlines two phases: the first describes a simple solution of copper sulfate and sodium chloride, which etches both zinc and aluminum; subsequently, the addition of sodium bisulfate to the initial formulation is suggested to improve the etching on aluminum, thereby preventing the formation of hydroxide. Semenoff dealt with all aspects of this mordant, from chemical analysis to the preparation of the mordant and its application. This long work of refinement led him to solve the problems of disposal and the neutralization of exhausted salts to prevent any environmental pollution.

In 1991, he focused on particular mixtures of pigment and screen-printing pastes to obtain water-based inks for screen printing and intaglio; he also proposed numerous varnish solutions for etching, such as shellac or positive and negative toner wash. In lithography, he invented recycling systems for aluminum plates and, in 1999, developed the "palm press" (a manual press) drawing inspiration from the Japanese *baren*. In 2007, after years of study, he finalized his research on cupric chloride for copper etching, which was published in *Printmaking Today* in 2009. These are just a few of his inventions, and his research has been disseminated for many years through lectures, demonstrations, articles in journals, in the DVD *New Directions in Printmaking* (2007), and on the web.

After studying architecture, sculpture, and painting, Cedric Green began to interest himself in printmaking and later in electro-etching in Sheffield, United Kingdom, in 1989. In the 1990s, he started dedicating himself to the study of the harmful effects of printmaking, and, starting from T. Challis's text, he attempted

to replace toxic materials. Having moved to France, and following an extensive study of the history of electro-etching, he found a simple and economical electrolytic system and proposed the Bordeaux Etch, a simplified formula based solely on copper sulfate for etching zinc and steel. Green published a text on less toxic printmaking online in 1998, entitled *Green Print*. The name of his mordant, Bordeaux Etch, was inspired—as Green himself writes—by the mixture used by French winemakers in vineyards as a fungicide (*Bouillie Bordelaise*). *Green Print* is an important text that presents alternative solutions for etching, soft ground, and other techniques. For grounds, Green utilized oily inks with a few drops of cobalt according to the techniques adopted. He reintroduced the use of vegetable oil for cleaning plates. This use is an ancient practice that can be found in B. Cellini and was present among seventeenth-century printmakers, who used oil and breadcrumbs, as highlighted by Stijnman. Green analyzed the chemistry of Bordeaux Etch and its safe disposal, proposed “fractint” techniques and other methods by reintroducing electro-etching (“galv-etching”), and published articles on this research in *Printmaking Today* in 1999. He also suggested the use of VCA (Vegetal Cleaning Agent), which had been proposed by Stijnman in *Printmaking Today* in 1996. *Green Print* is also a careful comparative study between traditional and alternative materials. In 1997, *Friedhard Kiekeben*, who worked at the Edinburgh Printmakers Workshop (E.P.W.) and currently teaches at Columbia College Chicago, perfected ferric chloride by adding citric acid to it. He named this mordant for etching copper and brass “Edinburgh Etch”. For etching steel, on the other hand, he proposed the Saline Ferric Etch. In 2002, Kiekeben also reintroduced one of the formulations previously developed by Semenoff, based on copper sulfate and salt, to etch zinc, steel, and aluminum. This mordant was named “Saline Sulfate Etch” and was published in several articles and in Howard’s text (“The Contemporary Printmaker”, 2003). In this text, the mordant reintroduced by Kiekeben is also defined as “Metal Salt Etching” and is recommended by chemists Dr. P. Craig and Dr. P. Rosenberg. The printmaker V. Der Wielen presented his own variation of this mordant: “Daylight Mordant”, based on copper sulfate and citric acid. Ferric Chloride In the United Kingdom, R. Adam and C. Robertson began working on non-toxic printmaking as early as 1987, engaging with all techniques, such as photo-etching, intaglio, screen printing, lithography, and collagraphy. In 1990, they experimented with a mixture of water-based acrylics to be used as alternative grounds to traditional ones.

These new solutions were utilized at the EPW (Edinburgh Printmakers Workshop), where Adam became director in 1994, subsequently forming a staff with C. Robertson, A. Bytautas, R. Mayo, and others, with the precise common goal of adopting non-toxic systems. Adam and Robertson used the term “ARE” (*Acrylic Resist Etching*) to define their acrylic grounds in place of traditional solvent-based varnishes, a shift profile highlighted in an article published in *Printmaking Today* in 1997. In 2007, in collaboration with the Lascaux company, they developed a series of new ARE products—specific acrylics for intaglio, photo-etching, and other techniques; these products and their methodologies are collected in their books. In 1994, the Australian K. Howard also arrived at the EPW, having already worked in Canada on photosensitive films and founded the “Canadian School” for non-toxic printmaking. Howard also focused on intaglio techniques, applying certain screen-printing products as described in his books. The American Mark Zaffron worked on non-toxic techniques as well and was the first to launch, in 1994, a line of specific acrylic products for printmaking under the name “Z-Acryl,” later founding the “Crate” studio in 1997 in California. He developed many tools and materials for non-toxic printmaking. Unfortunately, he passed away in 2013 at the young age of 53. Many printmakers began to work with polymer and photopolymer, which are materials derived from photo-etching or the etching of printed circuit boards (PCBs). Initially, these films were not totally non-toxic; they were later improved and considered safer, although D. Welden himself still emphasizes that doubts remain regarding their absolute non-toxicity. Polymers and photopolymers are of different types. Dan Welden, an American, began working on plates made of non-reactive monomers. These plates are processed in various ways and then exposed to a solar source or to UV-A rays. In this manner, the marks are exposed in positive or negative. In the final processing stage, the plates are developed in water and printed. Welden named this technique “solarplate” and published the book *Printmaking In the Sun* in 2001.

In Denmark, a similar research was carried out by the Danish artist Eli Ponsaig who, in 1989, worked with another type of photopolymer and published his text *Photopolymer Printing Plates* in 1995. In America, since 1993, M. Zaffron was the first to experiment with the photopolymer films used in computer chip manufacturing. Zaffron published the article "Photopolymer Films" in *California Printmaker* in 1995 and suggested this use of photosensitive polymer film to Howard. Howard developed the "Image On" method—which was still toxic, as Stijnman notes—and later improved it in subsequent versions. Howard had been interested in the toxic aspects of etching since 1986 and had published the book *"Safe Photoetching"* in 1991, spreading these methods through lectures worldwide. From 1994 onward, he held lectures at the EPW in Edinburgh, where many printmakers gathered, as previously noted. In 1998, he published *"Non-Toxic Intaglio Printmaking"*, followed by *"The Contemporary Printmaker"* in 2003 to outline a new philosophical approach and the need for a new glossary to define non-toxic research. At the EPW, Howard was followed by the Dane H. Bøegh, who founded the *Grafisk Eksperimentarium* in Copenhagen. Bøegh has been invited by Figueras since 2005 to spread non-toxic printmaking in Spain, where he conducted demonstrations alongside Kiekeben. Bøegh set up his own workshop in Spain, where he teaches non-toxic methods. He published the book *"Håndbog i Non-Toxic Dybtryk"* in 1998, which has been translated into many languages. In 2009, E. Figueras organized the congress *"No Tóxico: Encuentro Internacional de Grabado 09"* in Mexico, with the participation of S. de Osio, A. Crujera, G. Buratti, K. Howard, P. Mora, and many others.

Paco Mora is the director of the *"Pmp Grafix Centro Castellano Manchego del Papel y las Artes del Libro"*; he began his journey into non-toxic printmaking in 1991 with Prof. N. Echeverría de Miguel, working on flexographic photopolymers. Subsequently, he attended courses held by Bytautas, H. Bøegh, and G. Buratti. Mora works with saline mordants, acrylic varnishes, and many non-toxic techniques, and has published numerous articles on the non-toxic movement. In England, following his experiences at the EPW, A. Bytautas continued to disseminate his non-toxic methods based on acrylic mixtures and photopolymers. The English printmaker A. Baldwin also proposed an oleoresinous base (BIG) probably draws inspiration from tradition with excellent results; it is a malleable ground with which many intaglio techniques can be executed. Of particular interest is the research of the American printmaker Richard Stauffacher, collected in the book *"Etching With Permeable Grounds"*, published in 2012. Starting from F. Cassara's *"White Ground,"* Stauffacher creates mixtures of pigments, oil, and soap for less toxic bases as well as other more traditional grounds to achieve unique painterly effects. In France, Jean Aubert proposed a non-toxic technique called "calcium carbonate engraving on cardboard," in which he combines calcium carbonate derived from eggshells with acrylic and rapeseed oil. Also promoting non-toxic printmaking in France is the Belgian Filip Le Roy, a professor at the Anderlecht Academy, who met H. Bøegh in 2004 and translated the Danish master's book into French. In Italy, Pro.ssa F. Genna organized non-toxic workshops conducted by Figueras at the Academy of Fine Arts in Palermo. Genna has held non-toxic workshops and published a book, *"Incisione sostenibile"* (Sustainable Printmaking, 2009), featuring essays by international printmakers. There is *"Opificio della Rosa"* (Montefiore Conca, Rimini), directed by woodcutter artist and historian Umberto Giovannini, is a non-profit association that since 2009 has been spreading low-environmental-impact engraving techniques through summer workshops and artist residencies.

In electro-etching, in addition to the research by Semenoff and Green, the contributions of Marion and Omri Behr on *"Microtint"* and *"Electroetch"* are noteworthy, alongside Ole Larsen's work on *"Polytype,"* A. Crujera, and many others. In lithography, following Semenoff's innovations, research has developed in several directions. Semenoff presented his lectures at the Tamarind Institute, where Ross Zirkle adopted and disseminated these methods. Since the mid-1990s, G. Roberts worked on polyester plate lithography (*Polyester Plate Lithography*, 2001), as did Zaffron. D. Pogue, on the other hand, developed safer solvents and biodegradable products, and F.H. Chavarría, leveraging his experience as a microbiologist, proposed alternative solutions based on honey, lemon, and other natural products. In France, in 2011, Émilie Aizier invented her brilliant *"Kitchen Litho"*. Driven by a major chemical intuition, Aizier succeeded in performing

lithography using simple materials such as aluminum foil, vegetable oil, and the phosphoric acid found in Coca-Cola. She published the manual *Kitchen Litho* in 2011. Paco Mora also worked with a unique method involving lithography on clay, relying on the principle of repulsion between water and natural acidic substances. In silk screen printing, C. Robertson, R. Henning, and M. Kahn contributed to perfecting water-based systems. New developments also occurred in monotype printmaking, with the utilization of Akua Kolor (water-based inks invented by S. Rostow), Henning's screen monotype, and the "clay monoprint" (monotype on clay) by Mitch Lyons, which was brought to my attention by N. Semenoff.

Collagraphy, whose origins we examined previously, is an experimental technique that has replaced traditional materials with simpler ones since its inception. Initially, artists used more toxic materials, such as solvent-based glues, which were later replaced with less toxic substances like shellac, gesso, or vinyl glues, eventually leading to acrylics. Robertson herself proposed the use of Lascaux acrylics. Regarding inks, water-based or water-soluble inks are being introduced across all techniques. In intaglio printmaking, in particular, there are different types of inks: hand-ground inks, made with pigment and oil without using solvents, following ancient tradition; or there are new products, such as water-soluble inks or water-based ones. Regarding the latter, Semenoff's research is worth mentioning, which is based on mixing a water-based screen-printing medium with a coloring paste. The printmakers and printmaking studios working within the non-toxic movement are numerous, and it is impossible to list them all. Among them, we should mention the historic Edinburgh Printmakers in the United Kingdom; Zea Mays Printmaking, founded by Liz Chalfin in the United States; the Rochester Institute of Technology, where K. Howard teaches, in the United States; the AS220 Printshop in the United States; the Warringah Printmakers Studio in Australia; Mark Graver's Wharepuke Print Studio and Gallery in New Zealand; the Edinburgh College, where Brian Park teaches, in the United Kingdom; the Sidney Nolan Trust in Australia; Taller Intaglio in Argentina; Making Art Safely (MAS) in New Mexico; Watermark Press Hartford in the United States; Regina Held's New Grounds Print Workshop in New Mexico; Taller de Grabado y Experimentación by Liliana Aleman and Nubia Ozzi in Argentina; Lezle Williams' Laughing Crow Studio; Eva Pietzcker and Miriam Zegrer's Druckstelle in Germany; Electroetch Enterprises in the United States; North Notts Non-Toxic Printmaking in the United Kingdom; Fernando Santiago Camacho in Puerto Rico (an artist pointed out to me by Veronica Longo of the Atelier Controsegno in Pozzuoli, Italy), and many others.