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PALAEONTOLOGY APPLIED TO CRIMINAL INVESTIGATION

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ABSTRACT. Forensic palaeontology may be applied to the scientific investigation of outdoor crime scenes because of the potential presence of geological trace evidence on victims and perpetrators due to the trace transfer from the crime scene, as a consequence of the Locard principle. Experts in palaeontology can effectively contribute to criminal investigation: i) determining the age and provenance of microfossils for comparative purposes of geological evidence, ii) characterizing the fossils suspected to be object of illegal activities and frauds, iii) characterizing the taphonomy of the evidence especially in the clandestine graves. In this last case, the contribute is more effective if investigation carried out by palaeontologists and geologists is provided by a team of experts that in cases of corpse concealment may be composed of forensic taphonomists, archaeologists, physical anthropologists, and entomologists. The present paper illustrates the main applications of palaeontology in forensics, and reports and discusses some case studies.

1. Introduction

Geosciences may be involved in criminalistic investigation, especially when serious crimes (such as murders, kidnappings, sexual assaults) are accomplished outdoors in the countryside. These may provide precious signs helpful in reconstructing past events. In serious crime investigation, results of geological analyses of inorganic traces, made up of minerals and microfossils, found on victims and perpetrators and soils/sediments at crime scenes, when compared, may indicate the provenance of such traces from a specific source or site or a common origin. Consequently, comparison of geological traces with soils/sediments collected at crime scene may allow to associate/exclude a suspect or a victim with/from the crime scene, or reconstruct the path walked by a subject on the countryside linking him/her to a specific location (Ruffell 2010; Donnelly *et al.* 2021; Fitzpatrick and Donnelly 2021). Forensic geology (or geoforensics, or forensic geosciences) is a discipline that applies the scientific principles of geosciences for solving criminal cases (Murray and Tedrow 1975; Tindall 1994; Murray 2004a,b; Ruffell and McKinley 2008; Di Maggio *et al.* 2014; Donnelly *et al.* 2021; Ruffell and Barry 2021; Spoto, Barone, and Somma 2023). It was initially applied to forensics over 150 years ago, but at the time, it was included in microscopy's analyses, while the denomination of forensic geology was introduced only in the 70s (Murray and Tedrow 1975). Forensic geology may obtain

a wide range of information from materials of geological origin (soils/sediments/rocks) allowing to reconstruct "historical facts" related to criminal investigation. Soils/sediments may constitute robust evidence since contact between two items can determine the transfer (according to the exchange principle of Locard) from the crime scene to the suspect and victim and, therefore, can provide crucial forensic evidence for linking/excluding a suspect to/from a victim, crime scene or site of investigative interest, respectively. Soils and rocks with their fossiliferous and mineral contents (including man-made mineral particles, such as bricks, concrete, and mortars) may offer excellent physical evidence for creating a link between a suspect and the crime scene (Bourguignon *et al.* 2019). The main aim of the geological analyses is to associate traces of soil, rock, fossils, or minerals collected on an item (such as shoes, clothing, footwear, shovel, motor vehicles, *etc.*), related to a victim or suspect with soils, rocks, fossils, or minerals collected on a particular site or crime scene. Such comparative analyses may provide helpful info-investigative information (Ruffell and McKinley 2008). Forensic geosciences are mostly applied to outdoor crime scenes, using multidisciplinary approaches, particularly in cases of homicides and searching activities for clandestine graves (France *et al.* 1997; Ruffell 2002; Pye 2005; Ruffell 2005; Pye 2007; Pringle and Jervis 2010; Harrison 2011; Larson, Vass, and Wise 2011; Pringle *et al.* 2012; Donnelly and Harrison 2013; Ruffell and McAllister 2015; Ruffell *et al.* 2017; Somma *et al.* 2018; Rocke, Ruffell, and Donnelly 2021; Rocke and Ruffell 2022; Somma 2022a; Byrd and Sutton 2023; Somma 2023a,b,c; Somma *et al.* 2023a,b,c; Somma, Sutton, and Byrd 2023; Tagliabue *et al.* 2023). Besides corpses, hiding weapons, narcotics, money in a pit is a common criminal practice (Donnelly and Harrison 2020). Earth and natural sciences surveys may be also devoted to several activities concerning the territorial study (Davenport 2001; Elmes, Roedl, and Conley 2014; Bunch, Kim, and Brunelli 2017) for crimes occurred outdoor in the countryside as in cases of corpse concealments and environmental crimes, bellic activities (Doyle and Bennett 1997), or the characterization of fossils and gemstones in cases of frauds, illicit trading and trafficking (Spoto 2023), among many other illegal actions (Donnelly *et al.* 2021; Spoto, Somma, and Crea 2021; Spoto 2023). In very complex cases, geologists in collaboration with botanists may be also able to collect evidence for assisting coroners in elaborating possible hypotheses related to the modality of death (Donnelly *et al.* 2021; Somma 2023b; Somma *et al.* 2023c). In serious crimes, the comparative analyses of geological and soil evidence (Murray and Tedrow 1975; Murray 2004a,b; Bull and Morgan 2006; Ruffell and McKinley 2008; Di Maggio *et al.* 2014; Donnelly *et al.* 2021) may help to establish the *pre-mortem* presence of the victim/suspect on the crime scene, the walking made by the victim/suspect on a site, or a possible corpse's transfer to a secondary crime scene (Somma *et al.* 2023c). The main analytical techniques used for comparing geological and palaeontological evidence are synthesized in Figure 1 (Murray and Tedrow 1975; Murray 2004a,b).

General Features	Stereomicroscopic characterization, color determination (spectrophotometer, Munsell color charts), pH, organic matter content, particle size distribution
Inorganic component	OM, XRD, XRF, ICP-MS, ICP-OES, SEM-EDS
Organic component	OM, Gas chromatography
Recent organic component	Non-human DNA, OM

FIGURE 1. Analytical techniques and tools for the comparison of geological evidence. Acronyms - OM: Optical Microscopy, XRD: X-Ray Diffractometry, XRF: X-Ray Fluorescence, ICP-MS: Inductively Coupled Plasma Mass Spectrometry, ICP-OES: Inductively Coupled Plasma – Optical Emission Spectroscopy, SEM-EDS: Scanning Electron Microscope - Energy Dispersive Spectroscopy.

Among the earth and natural sciences disciplines, palaeontology may provide very useful information to criminal investigation. Main forensic palaeontological applications regarding fossils may be synthesized as follows:

(1) Determination and provenance studies of microfossil and nannofossil contents in soils/sediments for comparative purposes.
(2) Taphonomical analyses of illegal graves and skeletonized human remains.
(3) Determination of fossils in cases of crimes against the Cultural Heritage.
(4) Determination of fossils in cases of frauds (fake fossils).

The present paper deals with the main fields of application of this discipline to criminal investigation, reporting and discussing a few of case works.

2. Palaeontology in forensic sciences

Palaeontology is a discipline studying the fossilized remains of animal and plant organisms in order to identify and classify them. Other important aspects dealt by palaeontologists are devoted to reconstruct fossil evolution, taxonomy, ecology, geographical distribution, and preservation in the stratigraphic record. Palaeontology can support geoforensics with biostratigraphy, palaeoecology, and palaeoichnology applications (Sacchi and Nicosia 2013). Micropalaeontology, taphonomy (Marra 2023), and taxonomy may be crucial disciplines to

be applied for forensic purposes. Considering that the denomination of "forensic palaeontology" among the disciplines of forensic sciences was not formalized, probably for the broad fields included in this discipline (Sacchi and Nicosia 2013), the authors simply define forensic palaeontology as the application of scientific principles of palaeontology for solving criminal cases.

2.1. Comparative analyses of soil/sediments. The study of micro- and nannofossils for ascertaining sediment's age and provenance can highly support the characterization of soils/sediments for comparative purposes. Micro- and nannofossils can be present in soils/sediments collected at a crime scene or in geological traces sampled on the victim/suspect. Fossils, evaluated together other inorganic and organic particles, and physical-chemical parameters may help to ascertain a common provenance from a similar source. One of the first case works involving the use of microfossils in forensic investigation regarded the case of the homicide of Aldo Moro at Rome. The multidisciplinary approach used for this case, published by Lombardi (1999) over twenty years later the death of the politician, represents a landmark of forensic geology worldwide. In 1978, the Italian Prime Minister was kidnapped and later killed by terrorists. Marine sand traces, sampled on the victim's shoes, clothing, and the car trunk, where the corpse was found, released one gram of sands with microfossils helpful to ascribe them to coastal depositional environments from a restricted area of the *Latium* coast, with relevant consequences for investigation (Lombardi 1999). Another case work, reported in Murray (2004a), was related to fish fossil illegal trading occurred in 2000. FBI accused a subject to have illegally taken several specimens of fossilized fishes from the Green River formation exposed in federal lands. The suspect defended himself by declaring that the fossils were sampled in a private property located in another site of the valley. Investigation carried out demonstrated that the sedimentary layer with fossilized fishes did not outcrop in the *alibi* site indicated. Ten years ago, tens of foraminifers were found by one of the authors (R.S.) on the soles of footwear of the victim of gun shooting. These fossils allowed to link the passage of the victim in certain areas of the Calabria-Peloritani Arc (Somma and Maniscalco 2023). Another more recent case work involving the use of microfossils regarded a case of kidnapping occurred a few years ago. The victim, suspected to be kidnapped, was found in the countryside. The shoes were found dirty and scratched. Geological evidence collected on the victim and soils/sediments sampled at the crime scene were examined by means of OM (stereomicroscope) and SEM-EDS, by one of the Authors (R.S.). Color (Somma *et al.* 2023d), grain size, texture, and mineralogy of thousands of grains were analysed revealing peculiar particle grains and about 1% of microfossils (foraminifers) (Figure 2; Somma *et al.* 2023a). These latter consisted mostly of entire individuals of Miocene benthic and planktonic foraminifers. This finding, together with the peculiar mineral grain assemblages associated with, allowed to ascertain a common origin of traces and soils/sediments from outcrops of flysch deposits deriving from deep sea environments with siliciclastic supply. These results helped to demonstrate as the victim walked on a territory with geological features similar to those typical of Miocene flysch, as in the site of the finding of the corpse.

2.2. Analyses of illegal graves and skeletonized human remains. The methodologies proper of taphonomy can be useful in forensics. Taphonomy (*sensu* Efremov 1940) studies processes occurring from the pre-agonic stages of an organism to the recovery as fossil. The

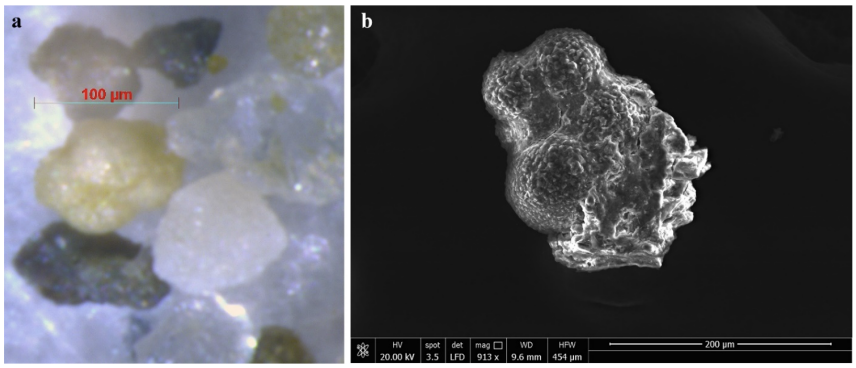

FIGURE 2. Case work - Planktonic foraminifer specimen (globigerinoids), observed under stereomicroscope (a) and SEM (b), collected in the geological trace present on the sole of the footwear. This finding allowed to link the victim to the finding site of the corpse.

discipline has also been applied to archaeological contexts. The application of taphonomy in forensic sciences is defined "Forensic Taphonomy" (Noe-Nygaard 1987; Bristow, Simms, and Randolph-Quinney 2010; Symes *et al.* 2013; Nawrocki 2016; Pokines, L'Abbe, and Symes 2021) and is strictly connected with principles and methods of Forensic Archaeology (Salsarola, Cattaneo, *et al.* 2009) and Anthropology. After a clandestine grave is discovered for a casualty or by means of complex ground searches (Manhein, Listi, and Leitner 2006; Herrmann and Devlin 2008; Harrison 2011; Sagripanti *et al.* 2017; M. Batista, López, and A. Batista 2018; Donnelly *et al.* 2021), taphonomy may be very useful if applied in the study of the graves and in the subsequent excavation activities to accomplish in team with forensic archaeologists and anthropologists. Excavations must be carried out, when possible, with a stratigraphical and archaeological approach for a careful preservation of evidence (Salsarola, Cattaneo, *et al.* 2009; Marra 2023; Somma, Sutton, and Byrd 2023). In addition to GIS applications for facilitating the representation of the excavations (Valenti and Nardini 2004), the laser scanning technology and 3D virtual models may be also used to crystallize crime scenes (Wolff and Asche 2009; Somma *et al.* 2023b) and burials (Baldino *et al.* 2023; Somma *et al.* 2023a). Both the study of clandestine graves, their excavations, and related skeletal contents can be greatly improved by finds of botanical and entomological elements (A. Brown 2006; Salsarola, Cattaneo, *et al.* 2009; Pokines 2018; Byrd and Tomberlin 2019; Caccianiga *et al.* 2021; Byrd and Sutton 2023; Morabito, Mondello, and Somma 2023; Morabito and Somma 2023). The taphonomical approach applied for the excavation of clandestine graves may give information on times and modalities of the concealments, and in certain favourable circumstances also on the decomposition rate of corpses (Carter and Tibbett 2008; Janaway, Percival, and Wilson 2009; Emmons *et al.* 2020; Alfsdotter and Petaros 2021). The accuracy of excavation and the study of collected evidence may provide useful data for evaluating the premeditation of the corpse concealment and defining the criminal and geographical profiling (K. Brown and Keppel 2007; Kamaluddin *et al.* 2021; Somma and Costa 2022; Somma 2023b; Somma and

Costa 2023). Taphonomy on skeletonized human remains may suggest times of exposure to weathering (A. Behrensmeyer 1978; Shipman 1981; Brain 1983; A. K. Behrensmeyer and Hill 1988; R. Lyman and C. Lyman 1994). Furthermore, relative position of the human remains and the geographical orientation of the grave may be indicative of some rituals (Fineschi *et al.* 1998) and religion of the concealer, respectively. Recent cases of investigation on missing persons, found concealed in the underground (as at Novellara[1][2][3] and Mascalucia, Somma and Costa 2022), enhanced the importance of the use of a multi-disciplinary approach where coroners are supported by a team of experts in Forensic Taphonomy, Geology, Archaeology, Anthropology, and Entomology (Byrd and Tomberlin 2019; Byrd and Sutton 2023; Marra 2023).

2.3. Determination of fossils in cases of crimes against the Cultural Heritage. One application of palaeontology in forensics may be related to crimes against the cultural heritage. In such circumstances, taxonomy and palaeobiogeography of fossils may be effective ly used. The Italian law n. 1089 (*GU* n. 184, 1936) reports that fossils are protected as national properties belonging to the cultural heritage. In Italy, the activities of collection and trade of fossils are illegal, whereas the commerce of foreign fossils with legal certifications is admitted. The Code Law for the Cultural Heritage and Landscape (*D. L.* 22/01/2004, *GU ser. Gen.* n. 45 24/02/2004 – *Suppl. Ordinario* n. 28) regulated some practical practice, such as the procedure for communicating a palaeontological discovery. Excavation, study, and promotion of fossils must be carried out under the control of the Superintendence. In the last years, the Italian Palaeontological Society (SPI) transmitted a list of expert palaeontologists active all over Italy to the Ministry of Cultural Heritage to support the local superintendencies in recovering and protecting fossils. In this regulatory framework, a special unit of Carabinieri ("Nucleo Tutela Beni Culturali") investigates illegal collection and trading of fossils. Palaeontologists are often uncharged to determine the provenance of confiscated specimens of fossils during trials or the authenticity of fossils in cases of suspect frauds. Taxonomic determination (Marra 2021) and geographical provenance are crucial in investigation, because define the statement and seriousness of crimes against the cultural heritage. In this evaluation, the identification of a common fossil *versus* a rare one may help judges to determine the weight of the penalty, as well as the provenance from a protected area or from a Nation with specific laws. In some cases, fake fossils are fraudulently sold. Fossil collections hosted in museums and universities can be used as reference (control samples) for sworn appraisals in cases of judicial procedures. In the last years, the restrictive laws of Italy have been widely discussed during the SPI meetings, with constructive workshops involving Ministry officials, Superintendents, *Carabinieri*, and

[1]Ponzi L. 2022. Ritrovato il corpo di Saman Abbas. Il cadavere era nei pressi di un casolare in rovina, a poche centinaia di metri dalla casa della famiglia a Novellara (RE). Ora gli uomini del RIS analizzeranno i resti, https://www.rainews.it/tgr/emiliaromagna/articoli/2022/11/ritrovato-il-corpo-di-saman-abbas-38f22a51-8676-4376-9616-2fb21f72517b.html (accessed online 14 June 2022).

[2]Greco, F. 2022 La madre della piccola Elena ha tentato di nascondere il corpo in una buca. Agi.it. https://www.agi.it/cronaca/video/2022-06-14/madre-piccola-elena-tentato-nascondere-corpo-buca-17094683/ (accessed online 14 June 2022).

[3]Ansa 2022. Saman: al via le operazioni di recupero del corpo. Quesito ai periti, accertare cause della morte e identità. (accessed online the 10 December 2022), https://www.ansa.it

magistrates. Most of discussions were focused on the ways and modes for distinguishing common fossils from rare ones, and how to adapt the legal system to the great variability and diversity of the fossil record. As a matter of facts, the large extension of fossiliferous sedimentary outcrops on the national territory makes it arduous to protect this heritage. Moreover, many sedimentary formations released great amounts of fossils and choosing what must be protected would be a vantage for a correct and sustainable use of territory. The institution of Geosites and Geoparks can be useful to protect and promote Italian fossils in situ (Marra, Sudano, and Guido 2022; Somma 2022b). A direct and continuous interaction among Italian Palaeontological Society, Superintendence, and Universities, coordinated by the Ministry of Culture, actually occurs in order to solve operative problems in studying and protecting the Palaeontological Heritage.

2.4. Determination of fossils in cases of frauds (fake fossils). Marine and continental fossils may have great monetary value and be commercialized worldwide as decorative or collectable items. In certain circumstances, as in the cases of fossils provided of high scientific value (as dinosaurs) or fossils whose trading is prohibited, authorized casts can be commercialized. In many cases, museums produce casts of their most valuable fossils. Casts can also be used for museum exhibitions and for didactic purposes, preventing possible damages of original fossils. Fossil casts are also used for educational purposes and toys, sometimes in reduced or magnified scale. Notwithstanding, a great production of fake fossils is unfortunately addressed to fraudulent trading (Ruffell, Majury, and Brooks 2012; Di Maggio *et al.* 2014; Donnelly *et al.* 2021). The most common fraud is the sale of fake fossils as original ones. Obviously, the prize of an authentic fossil is sensitively higher than a copy. The first advice in buying fossils is to pretend a certification provided of all needed requirements. In some cases, when the fossil derives from protected areas, the prize may be very high, and in such cases, this should make buyers suspect on the illegal origin of the fossil. The materials used for the realization of copies of fake fossils span from gypsum to resins. Modern technologies, such as laser scanner and structured light scanning, may assist the counterfeiters in allowing them to create 3D virtual models of original fossils from which it is possible to reproduce highly detailed casts by means of 3D prints with the Fused Deposition Modeling FDM technology (Somma *et al.* 2023c). These casts may be after furtherly worked to obtain elaborated copies made by sculpturing and painting the material, joining original or reproduced parts[4]. The method for testing the authenticity of a fossil is to verify its anatomy, preservation state, relative position of anatomical parts, and concordance with the matrix and lamination/bedding of the rock. Some details are difficult to be reproduced. A stereomicroscope or a magnifying lens may be effective tools for checking the anatomic details. In complex cases the involvement of portable spectroscopic instrumentations might be crucial. Some advice in recognizing fake vertebrate fossils is at first the relative position of skeletal elements. As a matter of facts, many fakes show spectacular position, that are hardly found in nature. X-rays and Computer Axial Tomography technologies (Somma 2023b) may assist investigators in order to reveal frauds. Trilobites, ammonites, fishes, dinosaurs, teeth of mammoth and shark are the most common fossils to be falsified and manipulated in order to improve their appearance for

[4]Di Silvestro G. (2019) A quick guide to identifying fake trilobites. (Accessed online the 10 December 2022). https://www.trilobiti.com/post/a-quick-guide-to-identifying-fake-trilobites

facilitating the sale (Ruffell, Majury, and Brooks 2012; Di Maggio *et al.* 2014). Trilobites are very commonly subject matter of falsification processes. The finding of anatomical details in a very well-preserved specimen of trilobite (Figure 3a) must arouse suspicion on the high probability that the trilobite may be a fake specimen. As a matter of facts, original trilobites often did not have the exquisite preservation of *pleurae* (Figure 3b), *ommatids* (Figure 3c), terrace lines (Figure 3d), sculptures (Figure 3e), and spines.

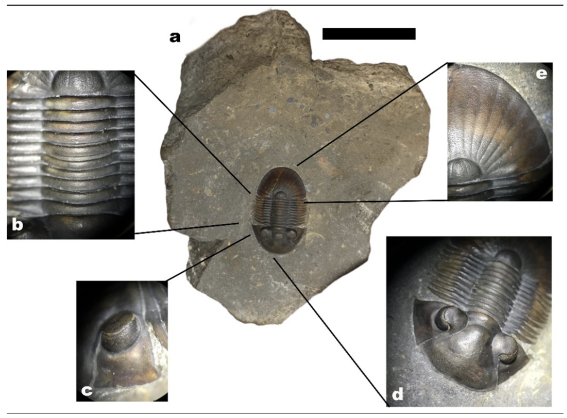

FIGURE 3. a) Well-preserved specimen of Paralejurus sp. (scale bar: 2 cm). b) Magnified details of *pleurae* (scale bar: 5 cm). c) Magnified details of *ommatids* (scale bar: 5 cm). d) Magnified details of frontal view with terrace lines (scale bar: 4 cm). e) Magnified details of sculptures (scale bar: 5 cm). Photographs courtesy of G.D.S. Graphics by A.C.M.

Also, the aspect of the matrix may help to ascertain the falsehood of a fossil. Some forgers engrave the matrix for hiding falsification. Most invertebrates are falsified by placing the fossil resin casts in matrix, later scratched and engraved or modified for acquiring a bad preservation state (Figure 4) in order to hide the mystification. Moreover, the relationships among the fossil and the bedding may suggest the falsity of the fossil. A fossil, such a fish, found preserved in a sedimentary rock, must lie parallel to the depositional surface on the bottom of the sea. Consequently, a fossil arranged transversally to the *laminae*/beds represents surely a fake.

The technique of sculpturing, painting, and combining real skeletal elements is widely used for falsifying vertebrate fossils. Most of Chinese reptiles and basal birds are fake fossils, often obtained by reliable combinations of authentic skeletal elements, but of different species. Sloan (1999) published a newly recovered missing link between dinosaurs and birds: an exquisite specimen with feathers, flight adaptations, and a tail similar to a *Velociraptor* (Figure 5). What seemed to be the real missing link, named *Archaeoraptor liaoningensis* and investigated by different experts, was lastly identified as a fake obtained by specimens of different species glued together (Zhou, Clarke, and Zhang 2002). For these reasons *Archaeoraptor* is considered a "fossil chimera".

Other examples of semi-fake specimens may concern dragonflies. In Figure 6 a semi-fake specimen of the Upper Jurassic dragonfly *Sinaeschnidia* sp., from the Yixian Beipiao

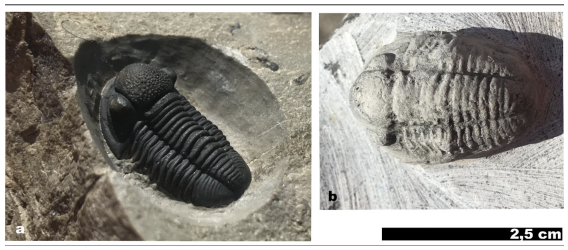

FIGURE 4. Trilobite of the genus Gerastos. A) Authentic specimen. B) Fake specimen whose aspect was modified for appearing in a bad state of preservation. Photographs courtesy of G.D.S. Graphics by A.C.M.

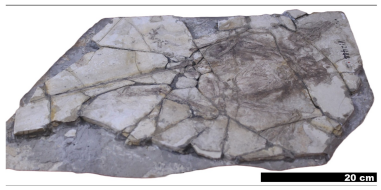

FIGURE 5. *Archaeoraptor liaoningensis* from the paleozoological museum of China (licence Creative Commons. Graphics A.C.M.).

Liaoning Formation (China) is reported. The fossil appeared as a well-preserved specimen (Figure 6 a) but a simple water washing with soap (Figure 6 b) and brushing (Figure 6 c) revealed that only two wing tips were original (signalled by red arrows in Figure 6 d), being the rest slightly sculptured in the matrix and painted with acrylic paintings.

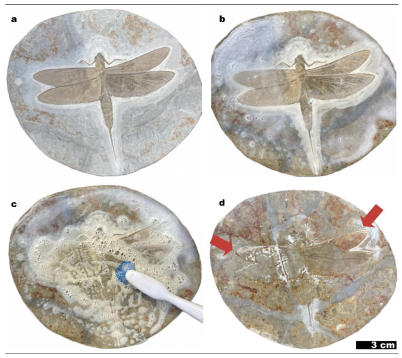

FIGURE 6. Semi-fake fossil of Sinaeschnidia sp. (Upper Jurassic, Yixian Beipiao Liaoning Formation, China): a) The commercialized fossil. b) Treatment with water and soap. c) Brushing. d) After the treatment, it was possible to ascertain that only two wing tips, signalled by red arrows, were original. Photographs courtesy of G.D.S. www.trilobiti.com; Graphic by A.C.M.

3. Discussion and conclusions

Outdoor crime scenes of serious crimes represent the prominent criminal cases for which geoforensics may be very useful in assisting the judicial system for the solution of crimes. In particular, experts in palaeontology can effectively contribute to criminal investigation: i) determining the age and provenance of microfossils for comparative purposes of geological evidence, ii) characterizing the taphonomy of the evidence especially in the clandestine graves, iii) characterizing the fossils suspected to be object of illegal activities and frauds. This contribute is more effective if investigation carried out by palaeontologists and geologists is provided by a team of experts that in cases of corpse concealment may be composed of forensic taphonomists, archaeologists, anthropologists, and entomologists. Finally, some considerations are due to the role and applications of geoforensics in crime investigations in Italy. Notwithstanding the crucial contribute of experts in geosciences for the solution of serious crimes, as demonstrated for the case of the homicide of Aldo Moro, the involvement of experts in geosciences among the Italian specialists of the scientific police is unusual and this important expertise is not requested as a qualification in applications for being recruited by the police forces. Opposite policy is assumed by the FBI in USA or other European police forces, where such experts are involved in their laboratories covering sometimes hundreds of skills as in central-eastern European nations police laboratories. A major involvement of the earth sciences disciplines in the Italian context of criminal investigation should be desirable, widening the expertise of police forces, beyond classical disciplines such as physics, biology, or chemists. Moreover, the judicial authority could benefit of such public resources, also in economic and time terms, in place of to be obliged to search for such experts, furthermore, in some cases, not sufficiently prepared and trained in forensics. Education, training, and courses devoted to these sciences ("minor" in Italy) might help to improve the expertise of geologists, naturalists, and forensic experts and their involvement in the scientific police. With this respect, an important initiative has been promoted since a decade by the University of Messina which is committed in organizing educational activities on geoforensics (palaeontology included), botany, and criminalistics.

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