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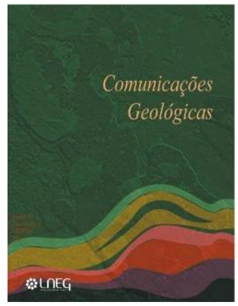
The use of latex moulds as a complement for studying paleobotanical specimens

O uso de moldes de latex como complemento ao estudo de espécimes paleobotânicos



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Abstract: In this paper, we present the history of latex in Paleontology and its role in the field today. We discuss the methodology and advantages of latex fossil moulds, while also presenting examples of moulds of compressions/impressions of plant fossils. Latex rubber has been used to create moulds of fossils since the first half of the 20th century and it is still used in various branches of Paleontology. While the methods have stayed largely unchanged, some innovations have been introduced. We also discuss the virtues of large-scale adoption of latex in the study of paleobotanical compressions/impressions, a technique not widely used in that branch, but in which latex can provide better visualization of certain key diagnostic characters for identification. Furthermore, widespread use of latex would increase the amount of viable fossils for study.

Keywords: Preparation techniques, Latex method, Paleobotany, fossil compressions/impressions, MHNC-UP

Resumo: Neste trabalho, apresentamos a história dos moldes de latex em Paleontologia e o seu uso no ramo. Também discutimos a metodologia e as vantagens de moldes de fósseis em latex. Os moldes de látex em fósseis são usados desde a primeira metade do século XIX e continuam a ser usados até hoje. A metodologia sofreu poucas alterações mas algumas inovações foram introduzidas. Também discutimos as vantagens do uso generalizado desta técnica no estudo de compressões paleobotânicas. Este método é útil no estudo de espécimes mal preservados em Paleobotânica e Paleontologia, dado que o látex permite uma melhor visualização ou destaque de certos caracteres diagnósticos importantes para identificação. O uso generalizado desta técnica aumentaria a quantidade de fósseis viáveis para estudo.

Palavras-chave: Preparação, Método de Látex, Paleobotânica, compressões/impressões, MHNC-UP

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1. Introduction

The use of latex in Paleontology began in the first half of the 20th century. Ever since its introduction in 1938 (von Fuehrer, 1938), this replication method has seen many applications in various areas of the field and is still in use (Baird, 1955; Goodwin and Chaney, 1994; Davis *et al.*, 1998; Green, 2001). However, as Green (2001) points out, the technique has barely changed over the years, evidenced when comparing the methodologies from Fischer (1939) and Parsley (1989).

Latex casting and moulding can serve three main purposes: curating original material, research and/or teaching. Moulds or casts help in curation in museums, since holotypes and additional type material can be replicated in high detail so other researchers can study the material from replicas, preventing deteriorating the original specimens; furthermore, it can be used as a way of safekeeping in the event of the destruction of the original material. Moulds produced for research require very fine detail; meanwhile replicas produced for teaching purposes, whether in a classroom environment or an exhibit can be less detailed. Another distinction that should be made is between moulds (negatives) made with the intention of casting a positive replica of a fossil and moulds where the mould itself is the final product. This paper focuses heavily on the latter, as it is the most pertinent to the study of paleobotanical compressions/impressions. While casts and replicas are copies of the fossil itself, the latex moulds used here are just a copy of the internal or external relief of the specimen.

Resins like latex and other materials like silicone, which is an artificial inorganic polymer, have been widely used in the creating moulds of type specimens. Even though, in a research environment, latex rubber is most commonly used to create casts/moulds of smaller invertebrate fossils, i.e. trilobites, brachiopods, crinoids, insects, etc. (Angiolini *et al.*, 2003; Ausich *et al.*, 2007; Pereira, 2017; Domingos *et al.*, 2020; Correia *et al.*, 2019, as exemplified in Figure 1c–f, it can also be applied to other groups such as vertebrates (Garner, 1953; Swanson and Carlson, 2002; Leite *et al.*, 2007) or even plants (Boersma, 1985; Taylor *et* *al*., 2009), see Figure 1 a–b. The use of this technique in the study of plant fossils is the primary focus of this work.

According to Green (2001), there are some drawbacks to the use of latex, such as the shrinkage the moulds are bound to suffer over time. This can lead to distortion of the specimen if the changes are not equal in all dimensions (Monge and Mann, 2005). According to Heaton (1980), the constitution of the latex affects the "shelf life" of the mould. Latex with a high ammonia content leads to moulds that are more prone to lose their elasticity and become brittle, and finer details will degrade over time; higher quality latex is much more stable and can last up to 15 years without degrading (Heaton, 1980). Ideally the cast is photographed (or 3d modelled, using photogrammetric techniques), and so, if and when the latex cast degrades, there is already a photographic record to be analysed without having the need to make another mould, which might, in time and if done too often, damage the fossil.

One of the advantages of this material is the absence of emission of toxic fumes. It is also easily cleaned from tools (Green, 2001). Another advantage of the technique is that after the removal of a latex cast, any impurities that might be present on the surface of the fossil are peeled away with the latex leaving the specimen completely clean. Latex is also cheaper than silicone, has exceptional tensile strength and, if stored in an airtight container, has a fairly long shelf life (Stanley, 1975).

In this paper, we discuss latex moulding methodology as well as the history of its use in the field of Paleontology and its many branches, with a focus on the application of this technique in the study of paleobotanical impressions/compressions (sensu Shute and Cleal, 1996). It sometimes can be difficult to find bibliographic support for paleontological techniques and methodologies, due to the organic way these tend to pass from colleague to colleague. This may lead to some difficulties for students or researchers looking to learn more techniques. With this paper, our aim was to offer an overview of one of those techniques and a jumping off point for further research.

1.1. Latex in Paleobotany

Even though latex moulds have been used in Paleontology for about 80 years, they continue to provide additional insights to researchers everywhere. Next, two different applications of this material in the field of Paleobotany are discussed.

The first, most common use of the technique, already widespread in other fields, is the use of casts to highlight anatomical characters of specimens. The use of latex moulds in Paleobotany has been reported before – such as Boersma (1985) – and especially in the study of cuticles, but its use in Portuguese Paleobotany was pioneered by Correia *et al.* (2016) (see Fig. 1a).In this particular case, the method was chosen due to poor preservation of the holotype (see Correia *et al.*, 2016, fig. 5). The whitened latex mould allowed for a high degree of contrast, which emphasized anatomical features. As such, the use of latex moulding to analyse plant impressions can be useful for reproducing the original morphology of an external mould and/or for studying internal "hidden" structures. Using latex can also, in some cases, help clean the specimen of some extra sediment.

The second is a preparation method that the authors have dubbed latex peeling. While working on another specimen, a plant adpression from the Douro Carboniferous Basin preserved in compressed grey shales and part of the botanical collection of the Museu de História Natural e da Ciência da Universidade do Porto (MHNC–UP), the authors intended to use latex moulding to produce images for taxonomic studies. When the moulds were removed from the fossil, a lot of oxides and matrix particles were removed alongside them. This had two consequences: the moulds were not usable but the fossil was exceptionally clean.

However, the usage of latex is not recommended as the moulding might compromise the fossil and future cuticular analysis (Stankiewicz *et al.*, 1998; Zodrow *et al.*, 2000); nonetheless, since our studies focus primarily on the general morphology of the leaf, the latex casts highlight characters that would otherwise be very hard to perceive, such as venation and leaf margins (Correia *et al.*, 2016).

2. Creating latex moulds

When choosing to produce a mould of a specimen there are many important factors to consider. The first is whether the specimen in question can be cast without suffering irreparable damage, as this is obviously counterproductive. The methodology discussed here will focus on latex moulds made for the purpose of taxonomic studies, in other words, the moulds need to be highly detailed and well photographed but do not need to be especially durable.

It should be taken into consideration that, when the fossil is delicate or the matrix it is in is not consolidated there are several consolidating techniques (such as using diluted resins) that have to be made before attempting a latex cast, since they penetrate the fossil and matrix pores creating a surface coating and protecting the fossil (Goodwin and Chaney, 1994).

2.1. Methodology

The first step is making sure the fossil is clean (see Fig. 2a). As mentioned before, a preliminary cast – a latex peel – can be made to clean the fossil. However, we should stress that specimen cleaning can be accomplished simply by washing the specimen, or by using mechanical or chemical techniques, before considering latex as a viable option.

The next step is to prepare the latex mixture (see Fig. 2b). The liquid rubber is poured into a container and mixed with drops of Chinese ink, which serves the purpose of dyeing the transparent rubber in order to enhance contrast (Green, 2001). The raw latex is slightly translucent and white/yellowish in colour, which does not photograph well: the translucency hides details and surface topography of the mould, and the colour of raw latex reflects too much light, which reduces contrast and obscures details (Heaton, 1980). The optimal tone should be dark and even (Parsley *et al.*, 2018).

After the mixture is prepared, it is very carefully applied in a thin layer to the surface of the fossil, making sure no air bubbles are formed, since these would diminish the quality of the final mould. It is common practice to humidify the surface of the specimen with soapy water for optimum surface contact, which prevents the formation of air bubbles (Baird, 1955). In this case, the latex was applied with a standard glass rod (see Fig. 2c). An alternative method of spreading is with a compressed air hose (Heaton, 1980). The specimen is then placed in a dehydrator or oven, at a temperature between 70–80ºC, until the latex has dried (see Fig. 2d). It is possible for the mould to air dry, however this may take longer.

The process of spreading a layer of latex and curing it (in an oven or at room temperature) is repeated until the mould is sufficiently thick (see Fig. 2e).

The proper removal of the latex cast is very important, as demonstrated by Saleh *et al.* (2020): the authors identify a specimen in which the incorrect/incomplete removal of the latex after numerous moulds led to the remnants of the mould

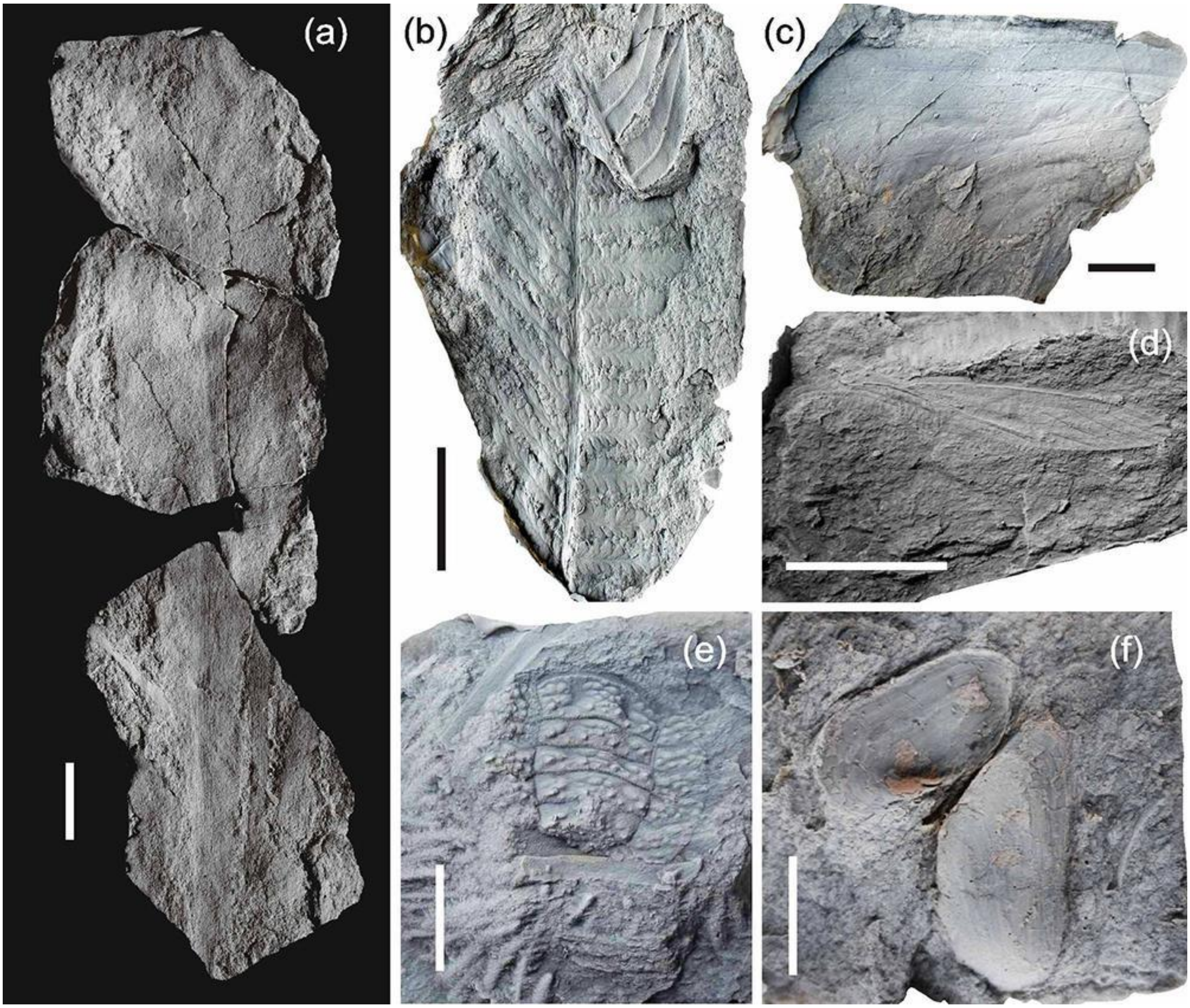

Figure 1. Examples of latex casts of plant, arthropod and bivalve fossils from S. Pedro da Cova, Douro Carboniferous Basin (lower Gzhelian, Upper Pennsylvanian; NW Portugal). (a) *Lesleya iberiensis* (cycad–like gymnosperm); (b) *Sphenopteris* sp. (pteridosperm); (c) *Stenodyctia lusitanica* (insect); (d) *Lusitaneura covensis* (insect); (e) *Aphantomartus pustulatus* (spider–like arthropod); (f) *Anthraconaia*–like non marine bivalves. Scale bars: 5 mm (e); 10 mm (c, d and f); 20 mm (a and b). Figure by P. Correia.

Figura 1. Exemplos de moldes de latex de fósseis de plantas, artrópodes e bivalves de São Pedro da Cova, Bacia Carbonífera do Douro (Gzeliano inferior, Pensilvaniano Superior; noroeste de Portgual). (a) *Lesleya iberiensis* (Gymnospermophyta); (b) *Sphenopteris* sp. (Pteridospermophyta); (c) *Stenodyctia lusitanica* (Insecta); (d) *Lusitaneura covensis* (Insecta); (e) *Aphantomartus pustulatus* (Arthropoda); (f) *Anthraconaia* sp. (Bivalvia). Escalas: 5 mm (e); 10 mm (c, d, f); 20 mm (a, b). Figura por P. Correia.

mimicking morphological structures, which were mistakenly identified as soft tissue.

This example highlights the need to be aware of any given specimen's previous history as well as the danger of submitting a fossil to too many interventions, so recording the history of a specimen within an institution is vital (Saleh *et al.*, 2020).

After the removal, it is customary to glue – using latex or diluted resins like Paraloid B-72 – the mould to a piece of cardboard to give it more structural stability and make it easier to handle (see Fig. 2f).

The next step is whitening the mould, which increases contrast and emphasizes details (Parsley *et al.*, 2018), making the specimen easier to photograph. There are many ways to do this, here we approach two. Virtual whitening is also possible and shows great promise for bigger specimens (Hammer and Spocova, 2013; Parsley *et al.*, 2018).Dry application of ammonium chloride (NH_4Cl) is by far the most common way to whiten fossils (Parsley *et al.*, 2018). There are a few different configurations (Branson and Mehl, 1933 in Parsley *et al.*, 2018, p239; Cooper, 1935; Teichert, 1948; Sakamoto, 1970; Feldmann, 1989; Green, 2001) but they all converge on the basic concept: ammonium chloride is heated inside a glass tube over a flame and the vapour is blown (with a squeeze bulb, compressed air or even by breath) into the fossil. Whitening with ammonium chloride is fairly safe and controllable and allows for more consistent results (Parsley *et al.*, 2018).

One other method is to burn a strip of magnesium ribbon and hold the mould above it, in the direction of the billowing smoke (see Fig. 2g). This should be done carefully since the magnesium oxide burns very hot and can completely cover the mould, leaving it completely white and rendering it useless. Luckily, the magnesium oxide is easy to remove from the mould so another

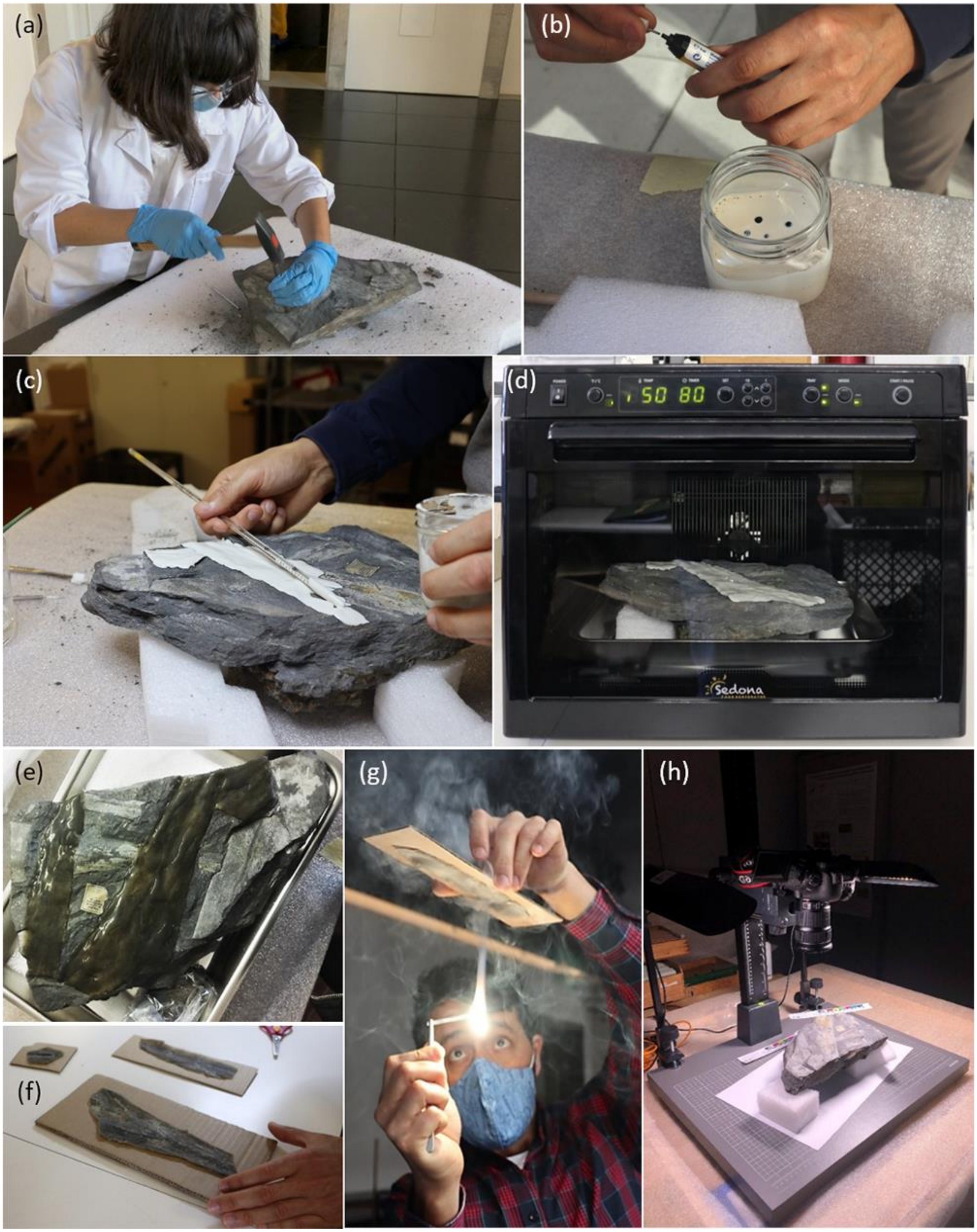

Figure 2. Steps of the latex moulding process, photographs by J. Muchagata. (a) Make sure the fossil is clean, fossil being prepared by one of the authors (C. Barbosa); (b) mix latex with a dye; (c) apply thin layer of latex on the fossil, careful not to create air bubbles; (d) allow to cure either at room temperature or in an oven; (e) Apply the next layers and allow to cool, carefully peel the mould from the fossil, starting from the edges and progressing inward; (f) glue the mould to a piece of cardboard; (g) whitening (latex mould being whitened by P. Correia); (h) photographing the mould: example of copy stand setup from the PO Herbarium, at the MHNC–UP.

Figure 2. Passos do processo de moldagem em látex, fotografias por J. Muchagata. (a) limpar o fóssil (fóssil a ser preparado por C. Barbosa); (b) misturar látex com um corante (p.e. tinta da china ou grafite); (c) aplicar camada fina de látex, com cuidado para evitar formação de bolhas de ar; (d) deixar o látex curar à temperatura ambiente ou numa estufa; (e) repetir o processo para as camadas seguintes, descolar o látex do fóssil cuidadosamente; (f) colar o molde a um cartão; (g) branqueamento (látex a ser branqueado por P. Correia); (h) fotografar o molde (exemplo de copy stand do Herbário PO, no MHNC–UP.

attempt can be made. Even though it can be used successfully (Correia *et al*., 2016), the highly reflective nature of magnesium oxide and the difficulty in obtaining an even coat are clear disadvantages of this method.

The final step, and ultimate goal of the technique, is photography. Traditional specimen lighting techniques dictate that the primary light come from the upper left corner and secondary light come from the lower right to act as a bounce light (see Fig. 2h).

After the photographs are taken, it is important to rinse the ammonium chloride or magnesium oxide off the mould to prevent it from being damaged or corroded: clear running water will do.

3. Closing remarks

Latex moulding in Paleontology can take many forms, depending on the purpose of the mould. While not a necessary process for the study of plant fossils, it can be especially useful for reproducing the original morphology of an external mould and/or for observing/studying internal structures hidden in pits. These are especially important when taxonomic descriptions, especially in potential type specimens, are being made.

However, it is critical to consider the impact latex moulds can have on a fossil: from the mould peeling process taking away part of the cuticle, to poor removal of the mould leaving behind traces of latex, there are many ways in which a latex mould can negatively impact a specimen. When deciding whether or not to employ this technique (or any other) the conservation of the fossil should be foremost. While it is common practice to whiten fossil specimens directly, the use of latex moulds for photography those reduces the interventions done on the specimen.

Further studies on the subject would include systematizing the density of the latex rubber in relation to the quality of preservation and type of matrix of a fossil specimen. Although, like any method, they have their drawbacks, latex moulds are a valuable asset to any palaeobotanist's arsenal of techniques.

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References

Angiolini, L., Racheboeuf, P. R., Villarroel, C. A., Concha, A. E., 2003. Stratigraphy and brachiopod fauna of the Carboniferous El Imán Formation, Colombia. *Spanish Journal of Palaeontology*, **18**: 151-158. https://doi.org/10.7203/sjp.18.2.21641.

Ausich, W. I., Sá, A. A., Gutiérrez–Marco, J. C., 2007. New and Revised Occurrences of Ordovician Crinoids from Southwestern Europe. *Journal of Paleontology*, **81**: 1374-1383. https://doi.org/10.1666/05–038.1.

Baird, D., 1955. Latex Micro–Molding and Latex–Plaster Molding Mixture. *Science*, **122**: 202-202. https://doi.org/10.1126/science.122.3161.202.

Boersma, M., 1985. *Aphlebia lauteria* nov. sp. from the Rhaeto-Liassic of Franken (G.F.R.). *Review of Palaeobotany and Palynology*, **44**: 27-36. https://doi.org/10.1016/0034-6667(85)90027-2.

Branson, E. B., Mehl, M. G., 1933. *Conodonts*. The University of Missouri Studies, **8**: 39-52.

Cooper, C., 1935. Ammonium chloride sublimate apparatus. *Journal of Paleontology*, **9**: 357-359.

Correia, P., Sá, A. A., Murphy, J. B., Šimůnek, Z., Flores, D., 2016. Lesleya Lesquereux from the Pennsylvanian of the Iberian Massif: Part of a dryland megaflora from the Variscan Orogen, northwestern Portugal. *Canadian Journal of Earth Sciences*, **53**(9): 883-895. https://doi.org/10.1139/cjes-2015-0213.

Correia, P., Schubnel, T., Nel, A., 2019. What is the roachoid genus Eneriblatta (Dictyoptera: Phyloblattidae) from the Carboniferous of Portugal. *Historical Biology*, **33**: 777-782. https://doi.org/10.1080/08912963.2019.1661407.

Davis, L. E., Kolb, R. L., Derewetzky, A., 1998. Molding and Casting Fossils for Geology Laboratories. *Journal of Geoscience Education*, **46**: 233-237. https://doi.org/10.5408/1089–9995–46.3.233.

Domingos, R., Correia, P., Pinto de Jesus, A., Legoinha, P., Callapez, P. M., 2020. First occurrence of Tiaracrinus (Crinoidea, Zophocrinidae) in the Devonian of Iberia: Biostratigraphical, palaeoecological, and palaeogeographical implications. *Geological Journal*, **55**: 6029-6037. https://doi.org/10.1002/gj.3760.

Feldmann, R. M., 1989. Whitening fossils for photographic purposes. *The Paleontological Society Special Publications*, **4**: 342-346. https://doi.org/10.1017/S2475262200005323.

Fischer, A., 1939. Rubber casts and molds of fossils. *Journal of Paleontology*, **13**: 621-621.

Garner, M. R., 1953. The Preparation of Latex Casts of Soil Cavities for the Study of Tunneling Activities of Animals. *American Association for the Advancement of Science*, **118**: 380-381. https://doi.org/10.1126/science.118.3066.380.

Goodwin, M. B., Chaney, D. S., 1994. Molding and casting: Techniques and materials. *In*: Leiggi, P., May, P. (Eds). *Vertebrate Paleontological Techniques Vol. 1*. Cambridge University Press, 235-270.

Green, O. R., 2001. *A Manual of Practical Laboratory and Field Techniques in Palaeobiology*. Springer, Dordrecht, 43–54, 400-418. https://doi.org/10.1007/978-94-017-0581-3.

Hammer, Ø., Spocova, J., 2013. Virtual whitening of fossils using polynomial texture mapping. *Palaeontologia Electronica*, **16**: 1-10. https://doi.org/10.26879/384.

Heaton, M. J., 1980. New Advances in Latex Casting Techniques. Curator: The Museum Journal, **23**: 95-100. https://doi.org/10.1111/j.2151–6952.1980.tb00556.x.

Leite, M. B., LaGarry, H., Breithaupt, B., Matthews, N. A., 2007. Direct and photogrammetric replication of latex–molded trackways from Toadstool Geologic Park, northwestern Nebraska, U.S.A. *Geological Society of America Abstracts with Programs*, **39**: 557. https://doi.org/10.13140/RG.2.36792.70408.

Monge, J., Mann, A., 2005. Ethical issues in the molding and casting of fossil specimens. *In*: Turner, T. R. (Ed). *Biological anthropology and ethics: From repatriation to genetic identity*. State University of New York Press, Albany, 91-110.

Parsley, R. L., 1989. Latex casting of macroinvertebrate fossils. *The Paleontological Society Special Publications*, **4**: 275-281. https://doi.org/10.1017/S2475262200005244.

Parsley, R. L., Lawson, M. H., Pojeta Jr., J., 2018. A practical and historical perspective of the how and why of whitening fossil specimens and casts as a precurser to their photography. *Fossil Imprint*, **74**: 237-244. https://doi.org/10.2478/if-2018-0016.

Pereira, S., 2017. *Trilobites do Ordovício Superior da Zona Centro–Ibérico Portuguesa*. Unpublished PhD thesis, Universidade Nova de Lisboa – Faculdade de Ciências e Tecnologia – Departamento de Ciências da Terra, Lisboa, 714 p.

Sakamoto, K., 1970. Some techniques for whitening fossils. *Geological Survey Professional Paper*, **700–D**: D230-D232.

Saleh, F., Lefebvre, B., Hunter, A.W., Nohejlová, M., 2020. Fossil Weathering and Preparation Mimic Soft Tissues in Eocrinoid and

Somasteroid Echinoderms from the Lower Ordovician of Morocco. *Microscopy Today*, **28**: 24-28. https://doi.org/10.1017/S1551929519001238.

Shute, C. H., Cleal, C.J., 1996. Palaeobotany in museums. *The Geological Curator*, **4:** 553-559.

Stankiewicz, B. A., Scott, A. C., Collinson, M. E., Finch, P., Mösle, B., Briggs, D. E. G., Evershed, R. P., 1998. Molecular taphonomy of arthropod and plant cuticles from the Carboniferous of North America: implications for the origin of kerogen. *Journal of the Geological Society*, **155:** 453-462. https://doi.org/10.1144/gsjgs.155.3.0453.

Stanley, J. W., 1975. Alginate impression compound: A comparative assessment of a cheap moulding material with potential applications in palaeontology. *Newsletter of the Geological Curators Group*, **14**: 191-193.

Swanson, B. A., Carlson, K. J., 2002. Walk, Wade, or Swim? Vertebrate Traces on an Early Permian Lakeshore. *Palaios*, **17**: 123-133. https://doi.org/10.1669/0883-1351(2002)017<0123:WWOSVT>2.0.CO;2.

Taylor, T. N., Taylor, E. L., Krings, M., 2009. Introduction to Paleobotany, How Fossil Plants are Formed. *In*: Taylor, T. N., Taylor, E. L., Krings, M. (Eds). *Paleobotany*. (second edition). Academic Press, 1-42. https://doi.org/10.1016/B978-0-12-373972-8.00050-4.

Teichert, C., 1948. A simple device for coating fossils with Ammonium Chloride. *Journal of Paleontology*, **22**: 102-104.

von Fuehrer, O. F., 1938. Liquid rubber, a new casting medium. *Museum News of Washington*, **15**: 7.

Zodrow, E. L., Mastalerz, M., Orem, W. H., Šimůnek, Z., Bashforth, A. R., 2000. Functional groups and elemental analyses of cuticular morphotypes of Cordaites principalis (Germar) Geinitz, Carboniferous Maritimes Basin, Canada. *International Journal of Coal Geology*, **451**: 1-19. https://doi.org/10.1016/S0166-5162(00)00018-5.