Archaeologia Historica Polona
vol. 29, 2021, pp. 253–264, ISSN 1425–3534, DOI: 10.12775/AHP.2021.013

[1] *Laboratory of Dating and Conservation of Artifacts*
Institute of Archaeology
University of Lodz
e-mail: magdalena.majorek@uni.lodz.pl
ORCID: 0000-0003-1254-9917

[2] *Laboratory of Dating and Conservation of Artifacts*
Institute of Archaeology
University of Lodz
e-mail: artur.ginter@uni.lodz.pl
ORCID: 0000-0002-3455-949X

MAGDALENA MAJOREK[1], ARTUR GINTER[2]

A jewel on a man's head – a felt hat from an archaeological excavation at 1 Sadowa Street in Gdańsk

Abstract. In 2009–2010, an archaeological excavation was carried out at 1 Sadowa Street in the so-called Lower City of Gdańsk/Poland (former Danzig), during which a considerable number of artefacts of organic materials were discovered, including a well-preserved felt hat from a 17th/18th century layer of a building. The aim of the activities undertaken by the Authors of this paper was to establish the chronology of the hat, determine how it was made, identify the material, and perform an in-depth analysis of its form compared with other finds of this kind using basic research methods. The employed methods included the typological method, a case study as well as organoleptic and microscopic methods for identifying the item and determining the degree of material biodegradation. The following research techniques were adopted: technological textile, felt, etc. analysis including observation of the surface with a stereoscopic microscope, material analysis with an optical microscope, and XRF spectrometry.

Keywords: hat, archaeology, XRF spectrometry, fibre analysis, Gdańsk (Danzig).

Introduction

During archaeological excavations at urban sites, we learn and reconstruct the history of people and places through the lens of the things found, the arrangement of sediments, and their accompanying architectural relics. Gdańsk (former Danzig) was one of the largest and wealthiest cities in Poland, with a long trade and port tradition, which used to be a member of the Hanseatic League. Modern dynamic development of the metropolis resulted in an increased number of pre-investment

rescue excavations, the scope of which is limited to the investment area, usually with a short deadline. In many cases, such surveys are carried out with less care of organic artefacts which are not only difficult to find in dark, organic city layers, but also require considerable financial outlays on preservation. Textiles from city accumulations in Poland are still very rare. In 2009–2010, at 1 Sadowa Street in the Lower City of Gdańsk[1], a rescue survey connected with a construction of a residential building with the surface area of more than 2000 m^2 was carried out under the management of Artur Ginter and Aleksander Andrzejewski from the Institute of Archaeology at the University of Lodz. Open-area excavations allowed to draw broad conclusions concerning the development of settlement in this area.

According to historical data, the settlement in the area dates back to the 14th century, when a contagious hospital with St. Barbara's Chapel were built in Długie Ogrody Street (Biskup 1978, p. 498; Stankiewicz 1982, pp. 10, 411). In the 1420s, English settlers came to the Lower City and settled north of Długie Ogrody Street, while Scots settled to the south. Members of these two settler groups lent their names to two dikes surrounding the district and meeting near the Elbląg Gate built in the 15th century, enclosing the street from the east (Stankiewicz 1960, pp. 186–190). This period can also be associated with the beginnings of an organised settlement operation in the area in question, however, these processes only intensified at the beginning of the 17th century, when city parcels were marked out and large-scale levelling work started to prepare the ground for gardening purposes. In the orchards and gardens, utility buildings (both wooden and masonry) of different nature were erected. Within them, during archaeological excavations, a number of everyday items (pottery, tools, pieces of cutlery), toys, coins, and fragments of fabrics, knitted materials, and felt products were found (Antosik *et al*. 2015). What deserves particular attention among these artefacts is a well-preserved, modern, man's felt hat. The hat was excavated from a layer of matted straw full of movable artefacts, with thickness up to 150 cm (marked with no. 130) – the level of a utility building (marked with no. 4) dated to the period between the second half of the 17th century and the end of the 18th century (Fig. 1) (Andrzejewski, Ginter 2010, pp. 29, 95). That artefact should be treated as unique on account of the fact that such artefacts are rare not only in Poland, but in the whole of Europe.

[1] Pre-emptive archaeological excavations were carried out in Gdańsk at 1 Sadowa Street between October 9, 2009, and July 22, 2010 (with a winter break between December 15, 2009, and April 14, 2010). The excavations covered plots no. 157/10, 158/2, 159, section 100 (based on the decision of the Provincial Office for the Protektion of Monuments in Gdańsk no. 89/2009 of October 9, 2009, and decision no. 49/2010 of May 5, 2010). The investor and the owner of the land was Przedsiębiorstwo Budowlane 'Kokoszki' S.A., 31 Budowlanych Street, 80–298 Gdańsk (Andrzejewski, Ginter 2010, p. 4).

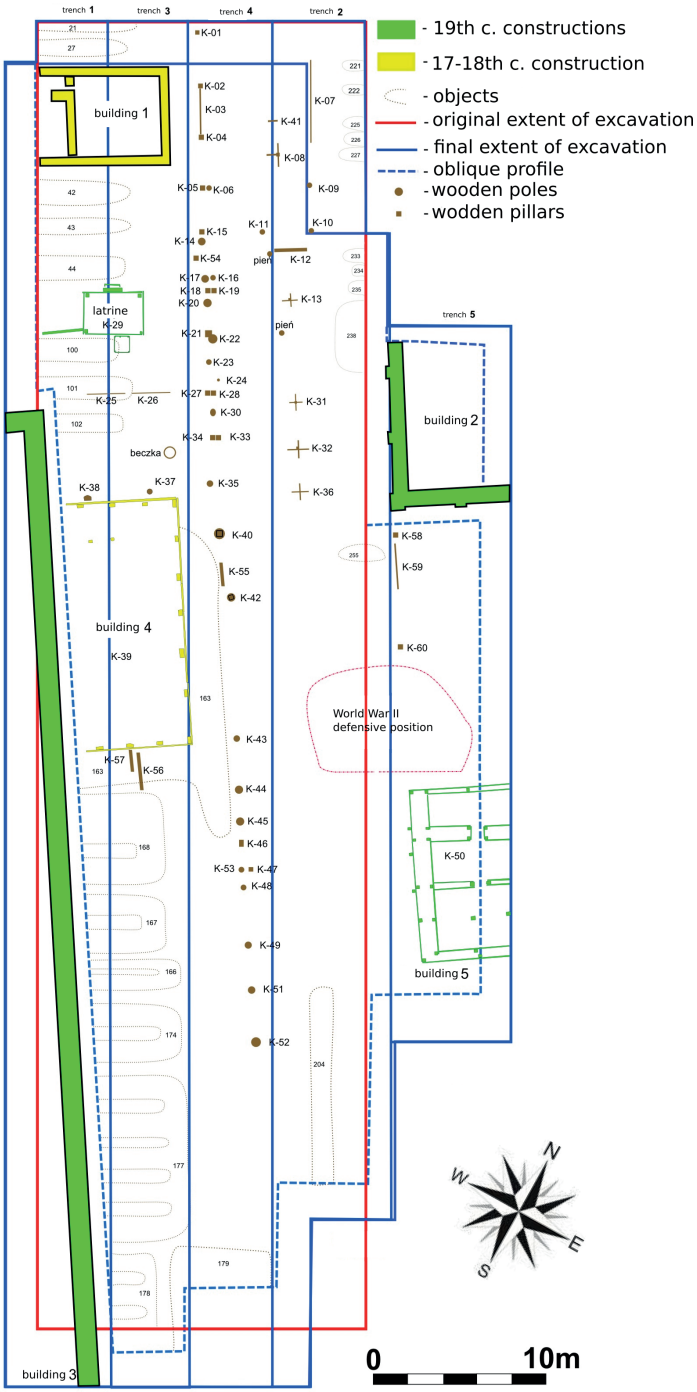

Fig. 1. Gdańsk, 1 Sadowa Street. An excavation plan with uncovered buildings (development by A. Ginter)

Research aims

Studies on organic artefacts such as textiles, felt, basketry etc. are extremely time-consuming and sometimes even difficult. It requires researchers to conduct broad comparative studies and analyses requiring specialist interdisciplinary knowledge (Žemaitytė *et al*. 2006, pp. 258–261; Baldia, Jakes 2007, pp. 519–525; O'Connor, Brooks 2007), embracing both the humanities (studies on typology, written and pictorial evidence etc.) and natural sciences such as fibre analysis, ^{14}C dating, isotopic tracing, dyestuff analysis and others. The aim of the activities we undertook was to establish the chronology of the hat, determine how it was made, identify the material, and perform an in-depth analysis of its form compared with other finds of this kind using basic research methods.

Methods

In order to achieve the aims, the typological method, a case study, and methods for identifying the item/material and determining the degree of material biodegradation were used (Goodway 1987, pp. 38–44; Wang 2009, pp. 97–99; Rast-Eicher 2016; Skals *et al*. 2018, pp. 161–179). Out of the last ones, organoleptic and microscopic methods were employed due to their non- or micro-invasive character and the fact that they did not require any specialist preparation of the research material (e.g. grinding) or using control samples (unlike in the case of other methods, see: Salerno-Kochan, Wąs-Gubała 2000, pp. 63–65; Tridico *et al*. 2014, pp. 101–107). The following research techniques were adopted: technological textile analysis including observation of the surface with a stereoscopic microscope[2] (maximum magnification of 80x), material analysis allowing to identify individual fibres using an optical microscope[3] (maximum magnification of 400x), and XRF spectrometry[4].

[2] The Delta Optical stereoscopic microscope, model SZ-630T, owned by the Laboratory of Luminescence Dating and Conservation of Artifacts of the Institute of Archaeology at the University of Lodz.

[3] The biological digital microscope XJS–900B with a Siedentopf binocular head, 30° inclined, 360° swivelling, owned by the Laboratory of Luminescence Dating and Conservation of Artifacts of the Institute of Archaeology at the University of Lodz.

[4] Measurements were made using POLON-IZOT XRF PI-MKON 0.1.XRF 01 spectrometer owned by the Laboratory of Luminescence Dating and Conservation of Artifacts of the Institute of Archaeology at the University of Lodz, using dedicated Spc and SpcArcheo software. The device was equipped with an X-ray lamp (4W, 50kV, 132 μA) and a tungsten anode. The measurements were performed with the following lamp parameters: 40 kV and 5 μA, with 300s of accumulation time (the software mentioned normalises all results to 100s regardless of the accumulation duration). Tungsten and tantalum peaks visible on the spectra are Rayleigh scattering peaks connected with the tungsten anode used, and so they are not elements of the artefact studied. Argon is the basic component of the air present between the lamp and the artefact during the measurement. The spectrogram created as described above was processed using a Savitzky-Golay smoothing filter and background subtraction

For microscopic analysis samples were taken from three places – from the surface of the hat, from the edge of the brim and from the needle hole.

A biography of hats: history, shapes, functions

Hats were made – among others – with one of the oldest textile techniques which consisted in manufacturing pieces of different sizes by felting different kinds of animal hair. The aim of felting was to condense fibres together, using moisture and heat, by crumpling or compressing them (Bogucka 1956, pp. 106–107; *Zarys historii włókiennictwa* 1966, p. 280; Turnau 1987, p. 246; 1999, p. 55; Michałowska 1995, p. 241; Grupa 2012, pp. 158–161). According to written evidence beaver hair felted the best; also sheep and lamb wool as well as camel, rabbit, and hare hair had good properties. The felting process was most difficult in the case of goat, roe deer, dog, cow, and ox hair. The most valued material came from living animals (Turnau 1987, p. 246; Drążkowka 2012, pp. 197–198). In the Modern Era, 'felt mass' was felted in both manual and mechanical ways. The former method yielded better results as the semi-finished product was of higher quality thanks to, among others, its thickness, so it was easier to form it on hat blocks usually created by turners (Turnau 1987, pp. 248–250). The final stages of finishing hats used to be called in Poland *sztafirowanie*. They consisted in ironing the product, covering its surface with appropriate adhesive, rubber, and fat to ensure water-resistance, and combing it to make it fleecy. Then such headgear was decorated with leather straps, trimmings, feathers, artificial flowers, and even gems (Bogucka 1956, pp. 107–108; Bartkiewicz 1974, pp. 204, 206).

Countries where large numbers of felt hats were produced, probably also for export, included France (from the 13th century onwards), Italy (particularly until the 16th century), and Spain (from the 16th to the 18th century). Even though we have only fragmentary historical data on felting in other countries, considering modern period fashion, this branch of production must have been highly developed on the British Isles, in the Netherlands, and in Germanic and Scandinavian countries (Turnau 1987, pp. 254–265; 1997, pp. 21–51, 89–113). In the Polish territory, felters mostly satisfied the demand of the regional market, and for a long time the most important production centres of the early modern period included Gdańsk, Poznań, Łomża, and Kraków (*Zarys historii włókiennictwa* 1966, pp. 280–281). In

using the Peak Stripping method. The use of XRF spectrometry in analysis of archaeological textiles is a novelty in Polish research, particularly in the case of items without marks of metal braid and without corrosion products. According to the foreign literature, this tool should be used to better understand textile technologies and dyeing techniques (e.g. Katayama *et al.* 2007, p. 1047; Luxford *et al.* 2011, pp. 1–9; Wilson *et al.* 2012, pp. 1–13).

the 18th century, felt was mass produced in Pomerania, Silesia, and near Warsaw. In the already mentioned Gdańsk, manufacturers of felt hats lived and offered their services as early as in the 14th century. The first guild of these craftsmen was established already in 1458. However, 16th-century sources indicate that there were only seven masters in the city, while a considerable increase in the volume of production only took place in late 16th century and early 17th century (Bogucka 1956, pp. 34, 266). In mid-17th century, there were a few dozen felt shops in Gdańsk, mostly located in Nowe Ogrody and Siedlce districts, run by felters (*Filtzmacher*) and numerous hatters (*Hutmacher*). The development of broadly understood woolen textile production (including felting, hat-making) was undoubtedly influenced by the easy availability of relatively high-quality sheep wool from Pomerania and Poland (Kuyavia and Masovia), lamb wool, also the fine underwool of beaver and cow hair were used (Bogucka1956, pp. 80, 106; *Zarys historii włókiennictwa* 1966, p. 585; Grupa 2012, p. 62). The craft crisis arose in the second half of the 17th century. It is believed that it was caused by the liquidation of early craft production and restoration of the guild system, impoverishment of the bourgeoisie and the Polish gentry, and the deteriorating situation in the country, which was a ready market and a source of workforce (Bogucka 1956, p. 278; *Zarys historii włókiennictwa* 1966, p. 581). Work in the textile industry, particularly connected with felting and dyeing, was dangerous to health. Wearing a dark apron protected clothing from soiling, but the substances used – predominantly mercury – were inhaled, causing respiratory diseases and, in many cases, diseases of other systems, mostly endocrine and nervous systems (Turnau 1994, p. 74). Mercurialism could cause irreversible changes in behaviour – tremor of extremities, emotional lability, and slurred speech, which was why the modern period saw a new disease entity called mad hatter disease (Kłys 2010, pp. 303–306).

The significance for various aspects of live in early modern societies of such professions as dyer, tailor, weaver, hosier, shoemaker, cloth maker, glove maker, button maker, wool comber, and hatter is for example proved by the fact that as much as thirteen percent of the crew of HMS *Caledonia* in 1810 was connected with the textile and clothing industry (Babits, Brenckle 2008, p. 169). They made and repaired sailors' clothes directly on the see, which ensured uniform clothing of nearly the whole crew. Not infrequently, however, clothing was purchased in clothes shops typical of the wharves of the main ports, which definitely included Gdańsk, or it was received from the Maritime Association (Laffin 1969, pp. 34–35).

Different styles and fashions mixed freely in ports. Clothing, and particularly accessories, constituted an important element of the social life, indicating one's social class (Żukowski 2010, pp. 367–385; Majorek 2013, pp. 199–210; Majorek, Grupa 2014, pp. 335–348). In the modern period, various forms of hats existed at the same time in the territory of modern Poland (Drążkowska 2012, pp. 197–201, 261–263). A very popular hat was a bicorne that came in different forms: of the

chapeau bras type – flattened, carried under the arm; of the *tricorne* type, which was a hat with three corners, usually black and decorated with a ribbon (in the winter worn on the head, and in the summer – under the arm), and of the *bicorne* type – with two brims turned up. All these types were used with both civilian clothes and uniforms (Turnau 1999, p. 81; Drążkowska 2012, pp. 204, 262, 291). Such headgear was worn with the 18th-century men's justacorps decorated with wide pocket lapels and cuffs, which towards the end of the century was transformed into a frock coat and a double-breasted coat, the so-called redingote coat (Turnau 1967, pp. 173–174, 205, 208–211; Gutkowska-Rychlewska 1968, pp. 580, 605; Możdzyńska-Nawotka 2002, p. 117; Nalewajska 2010, p. 14; Drążkowska 2012, pp. 202–203). Each year, there were more and more followers of the foreign fashion, as the above elements of the French dress were considered in the Polish territory, also called *German fashion*. Thus, it is no surprise that archaeological finds include such hats. In the streets of the 18th-century Gdańsk, one could see colourful clothes with lace, embroidery, bows, and ribbons: women in dresses decorated with flowers and draped skirts, and men in long-tail jackets, waistcoats, fitted short trousers, and tights accentuating calves, but mostly with elegant accessories: shirt ruffles and three-cornered hats on their wigged heads (Bogucka 1997, p. 168). Hats also accompanied sailors, mostly serving protective purposes, shielding them from sun and rain. At the end of the eighteenth century, tricornes were replaced by slightly higher, stiff felt hats with a turned-up front and a characteristic fold, worn pressed down on the front of the head, i.e. bicornes, and hats with a higher crown, decorated with ribbons in national colours, constituting elements of uniforms (Gutkowska-Rychlewska 1968, pp. 610, 615; Turnau 1999, p. 23; Drążkowska 2012, pp. 263–264).

The hat from Gdańsk

The subject of in-depth analysis is a felt hat, which is now dark brown (Fig. 2). The diameter of the crown is approx. 58 cm, while its height does not exceed 8cm (after restoration and conservation). The crown is surrounded by a relatively wide brim, with the outer diameter of just over 112 cm. Based on the examination of the artefact carried out before it underwent a conservation processes (Antosik *et al*. 2015, p. 437), inside the hat there were two small fragments of woollen threads, which could be used to fasten (sew on) the lining or the brim.

Along with other textile artefacts from the second half of the 17th/end of the 18th century layers of the utility building, it underwent conservation treatment involving soaking in an extract of common soapwort root, and then repeatedly rinsing under running water and drying in the Institute of Archaeology and Ethnology Polish Academy of Science in Lodz, under the supervision of Łukasz Antosik (Andrzejewski, Ginter 2010, pp. 108, 130).

Fig. 2. The felt hat from 1 Sadowa Street in Gdańsk a view from the top and from the side (photo by M. Majorek)

Results

In the macroscopic view, the state of preservation of the hat was assessed as good. The surface of the felt is relatively smooth, without any visible holes, chafing, or swelling. On the surface of the brim there are two diagonal creases indicating its original form. Analysis under an optical microscope revealed that the hat had been made of quite well-selected wool (Fig. 3), mostly sheep wool (Bovidae), with a very small addition of fibres from the lagomorphs, the Leporidae family (rabbits or hares) (Fig. 4). The image obtained with a stereoscopic microscope revealed small isolated needle holes on the brim indicating delicate stitching the aim of which was to maintain the brim edge turned up (Fig. 5). Observation also allowed to find broken fibres. Analysis with an XRF spectrometer yielded a spectrogram that shows that the dominant elements are: iron (Fe), calcium (Ca), and sulphur (S) (Fig. 6). Iron and sulphur identified may come from the matted straw in which the hat was found or be remains of iron tannate or iron sulphate – dye in the form of ink giving items a dark colour. The presence of calcium proves that the fibres are of animal origin.

Despite the small number of hats found during archaeological excavations in Poland, the form of the headgear described is similar to a fragmentary item from Gdańsk broadly dated to the 17th century (Drążkowska 2012, p. 201). Closer analogies are the 18th-century hats found on the wreck of the English ship *General Carleton* (1785) (Babits, Brencle 2008, pp. 174–177, 328). There are also some similarities (the brim size, the shape and the size of the crown) with the 18th-century

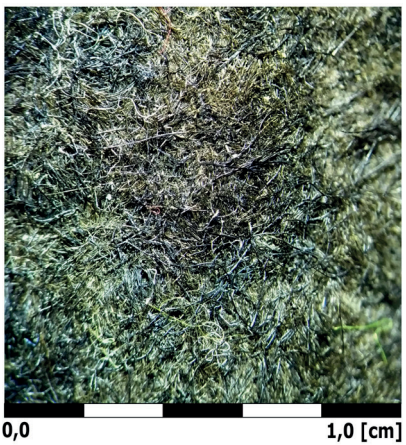

Fig. 3. The felt hat from 1 Sadowa Street in Gdańsk: a close-up of fibres (photo by M. Majorek)

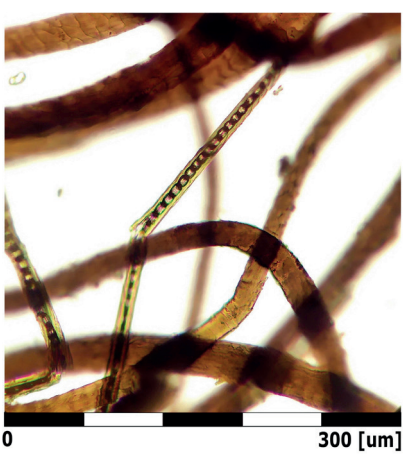

Fig. 4. The felt hat from 1 Sadowa Street in Gdańsk: woollen fibres, mostly from sheep, with small addition of fibres from the lagomorphs, the Leporidae family – rabbits or hares (photo by M. Majorek)

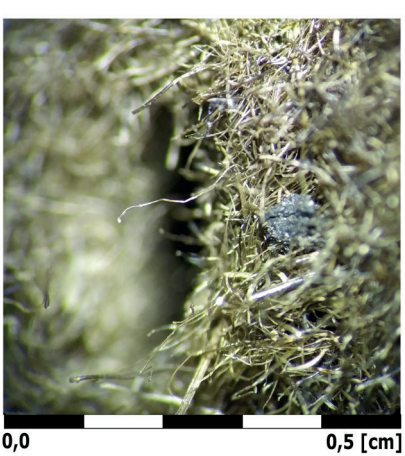

Fig. 5. The felt hat from 1 Sadowa Street in Gdańsk: a close-up of stitching holes (photo by M. Majorek)

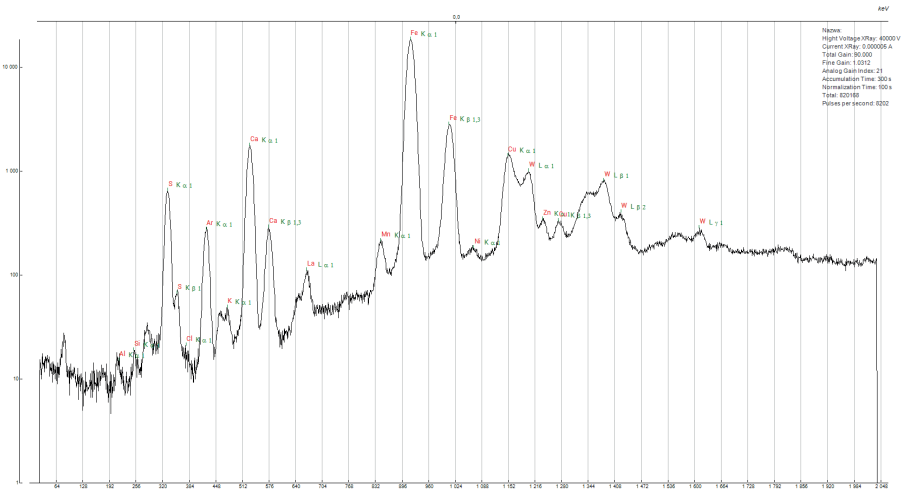

Fig. 6. The felt hat, XRF energy spectrum (development by A. Ginter)

three-cornered felt hat of a royal *hajduk* Szymon Mikulski from the collection of The Princes Czartoryski Museum, a branch of the National Museum in Kraków (Poland) (Drążkowska 2012, p. 261). It seems that hats with round-up brims, such as the analysed hat, were most popular from the end of the 17th century to the 1780s. Specifying the chronology of the hat described is difficult for a number of reasons. First of all, the item underwent a conservation process, which could have influenced the shape of the brim. As it was already mentioned, even though the brim is now horizontal, analysis revealed two diagonal creases and isolated stitching holes. Second of all, it should be emphasised that the artefact was found in urban accumulations, which means that over many years of post-depositional processes affecting items of organic materials it might have been considerably deformed.

Conclusions

The hat found at 1 Sadowa Street in Gdańsk was made of one piece of dark brown felted sheep wool with addition of hare or rabbit hair. It can be assumed that uniform hat mass of good quality was prepared manually. Apart from the brim arrangement characteristic of the hat, no traces of other ornaments were identified. As Polish felters satisfied the demand of the internal market and Gdańsk was one of the largest centres of felt production, the hat described could be a local product. However, its foreign origin cannot be excluded considering the fact that Gdańsk was an important international trade centre.

References

Andrzejewski A., Ginter A., 2010, Sprawozdanie z badań archeologicznych przeprowadzonych w okresie od października 2009 roku do lipca 2010 roku na działce przy ulicy Sadowej 1 w Gdańsku, pow. Gdańsk, woj. pomorskie, typescript in the archive of Pracownia Dokumentacji Archeologiczno-Konserwatorskiej, Łódź.

Antosik Ł., Ginter A., Rybarczyk A., 2015, *Tekstylia z badań archeologicznych prowadzonych przy ul. Sadowej 1 w Gdańsku. Wstępne rozpoznanie*, [in:] *XIX Sesja Pomorzoznawcza, Szczecin, 21–22 listopada 2013 r.*, eds. A. Janowski et al., Acta Archaeologica Pomoranica, 5, Szczecin, pp. 435–444.

Babits L., Brenckle M., 2008, *Sailor clothing (Ubrania marynarskie)*, [in:] *The General Carleton shipwreck, 1785 (Wrak statku General Carleton, 1785)*, ed. W. Ossowski, Gdańsk, p. 167.

Baldia Ch., Jakes K., 2007, *Photographic methods to detect colourants in archaeological textiles*, Journal of Archaeological Science, no. 34, pp. 519–525.

Bartkiewicz M., 1974, *Odzież i wnętrza domów mieszczańskich w Polsce w drugiej połowie XVI i w XVII wieku*, Wrocław.

Biskup M., 1978, *Przemiany przestrzenne i demograficzne*, [in:] *Historia Gdańska 1*, ed. E. Cieślak, Gdańsk, pp. 364–378.

Bogucka M., 1956, *Gdańskie rzemiosło tekstylne od XVI do połowy XVII wieku*, Wrocław.

Bogucka M., 1997, *Żyć w dawnym Gdańsku*, Warszawa.

Drążkowska A., 2012, *Ozdoby i nakrycia głowy na ziemiach polskich od X do końca XVIII wieku*, Toruń.

Goodway M., 1987, *Fiber identification in practice*, Journal of the American Institute for Conservation, vol. 26, no. 1(198701), pp. 27–44.

Grupa M., 2012, *Wełniane tekstylia pospólstwa i plebsu gdańskiego (XIV–XVII w.) i ich konserwacja*, Toruń.

Gutkowska-Rychlewska M., 1968, *Historia ubiorów*, Wrocław.

Katayama T., Ide-Ektessabi A., Funahashi K., Nishimura R., 2007, A*pplication of XRF and AMS techniques to textiles in the Mongol Empire*, MRS Proceedings, 1047, 1047-Y01-04, doi:10.1557/PROC-1047-Y01-04.

Kłys M., 2010, *Z rtęcią (i…) przez stulecia*, Archiwum Medycyny Sądowej i Kryminologii, vol. 60, pp. 298–307.

Laffin J., 1969, *Jack Tar – the story of the British sailor*, London.

Luxford N., Thickett D., Wyet P., 2011, *Non-destructive testing of silk: problems and possibilities*, 'Textiles', https://www.english-heritage.org.uk/siteassets/home/learn/ conservation/ collections-advice-guidance/ndt-silk-1810-47-luxford-paper-en.pdf.

Majorek M., 2013, *Pasy kontuszowe z wstępnych badań archeologiczno-inwentaryzacyjnych krypt kościoła pw. the Church of the Blessed Lady Mary in Szczuczyn*, Studia Łomżyńskie, vol. 24, pp. 199–210.

Majorek M., Grupa, D., 2014, *Wybrane nowożytne pasamony z krypty południowej kościoła pw. św. Mikołaja w Gniewie*, [in:] *Rzeczy i ludzie. Kultura materialna w późnym średniowieczu i w okresie nowożytnym. Studia dedykowane Marii Dąbrowskiej*, eds. M. Bis, W. Bis, Warszawa, pp. 335–348.

Michałowska M., 1995, *Słownik terminologiczny włókiennictwa*, Warszawa.

Możdżyńska-Nawotka M., 2002, *O modach i strojach*, Wrocław.

Nalewajska L., 2010, *Moda męska w XIX i na początku XX wieku. Fashionable, dandys, elegant*, Warszawa.

O'Connor S., Brooks M., 2007, *X-radiography of textiles, dress and related objects*, Amsterdam, Boston, Heidelberg, London, New York, Oxford, Paris, San Diego, San Francisco, Singapore, Sydney, Tokyo.

Rast-Eicher A., 2016, *Fibres. Microscopy of archaeological textiles and furs*, Budapest.

Salerno-Kochan R., Wąs-Gubała J., 2000, *Analiza mikroskopowa zmian strukturalnych tkanin i włókien wełnianych spowodowanych działaniem mikroorganizmów*, Zeszyty Naukowe Akademii Ekonomicznej w Krakowie, no. 546, pp. 63–75.

Skals I., Gleba M., Taube M., Mannering U., 2018, *Wool textiles and archaeometry: testing reliability of archaeological wool fibre diameter measurements*, Danish Journal of Archaeology, vol. 7, no. 2, pp. 161–179.

Stankiewicz J., 1960, *Rozwój fortyfikacji miasta Gdańska w XVI i XVII wieku na tle współczesnych osiągnięć sztuki fortyfikacyjnej w Europie*, [in:] *VIII Powszechny Zjazd Historyków Polskich, VIII: Historia wojskowości*, Warszawa, pp. 186–190.

Stankiewicz J., 1982, *Przemiany przestrzenne i demograficzne Gdańska*, [in:] *Historia Gdańska 2*, ed. E. Cieślak, Gdańsk, pp. 7–34.

Tridico S. R., Houck M. M., Kirkbride K. P., Smith M. E., Yates B. C., 2014, *Morphological identification of animal hairs: myths and misconceptions, possibilities and pitfalls*, Forensic Science International, no. 238, pp. 101–107.

Turnau I., 1967, *Odzież mieszczaństwa warszawskiego w XVIII w.*, Wrocław.

Turnau I., 1987, *Historia europejskiego włókiennictwa odzieżowego od XIII do XVIII w.*, Wrocław.

Turnau I., 1994, *European occupational dress from the fourteenth to the eighteenth century*, Warsaw.

Turnau I., 1997, *Hand-felting in Europe and Asia from the Middle Ages to the 20th century*, Warsaw.

Turnau I., 1999, *Słownik ubiorów. Tkaniny, wyroby pozatkackie, skóry, broń i klejnoty oraz barwy znane w Polsce od średniowiecza do początku XIX w.*, Warszawa.

Wang J., 2009, *Effect of structure-property relationships on fatique failure in natural fibres*, [in:] *Fatique failure of textile fibres*, ed. M. Miraftab, Boca Raton–Boston–New York––Washingtown, DC, pp. 95–132.

Wilson H., Carr Ch., Hacke M., 2012, *Production and validation of model iron-tannate dyed textiles for use as historic textile substitutes in stabilisation treatment studies*, Chemistry Central Journal 6, 44 (2012), https://doi.org/10.1186/1752-153X-6-44.

Zarys historii włókiennictwa, 1966, *Zarys historii włókiennictwa na ziemiach polskich do końca XVIII wieku*, eds. J. Kamińska, I. Turnau, Wrocław.

Žemaitytė R., Jonaitienė V., Milašius R., Stanys S., Ulozaitė R., 2006, *Analysis and identification of fibre constitution of archaeological textiles*, Materials Science (Medžiagotyra), vol. 12, no. 3, pp. 258–261.

Żukowski J., 2010, *Chapeau bas. O nowożytnych przodkach trikorna*, Kwartalnik Historii Kultury Materialnej, 58, no. 3–4, pp. 367–385.