Central European ethnomedical and official uses of peat, with special emphasis on the Tołpa peat preparation (TPP): An historical review

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ABSTRACT

Ethnopharmacological relevance: Medical or hygienic uses of peat mosses dates back to the 18th century. Peat was used externally (as poultices) in the early 19th century. The peat preparation invented by Stanisław Tołpa (Tołpa peat preparation, TPP) was patented in Poland in 1991; its concept had emerged in the 1980s. It raised high therapeutic expectations still being researched in the early 1990s. Profound expectations for peat, a natural product well known in Central European (and Polish) spas (for medicated baths and poultices), earned Tołpa's preparation great renown before any actual benefits (internal actions) were scientifically confirmed.

Aim of the review: We study the origins of medical interest in peat in Polish science against the background of the historical ethnopharmacy of peat and Sphagnum moss in Central Europe. It is aimed at shedding a new light on the history of TPP, its connections with local ethnopharmacological traditions and inspirations for local medical studies on peat products and peat-derived drugs of the 1980s and early 1990s.

Materials and methods: The literature on peat baths was found and reviewed including the information and data about the studies of TPP from published though unknown sources as well as from Polish patents, unpublished typescripts, press interviews and reports.

Results: Tołpa's research team missed the historical data about external and topical actions of Sphagnum peat or its preparations which were published in the 19th- and early 20th-century. This is strange because folk medicine based on peat emanated eastwards from ethnic Austria along the Vistula river and the Carpathians. Tołpa ignored balneotherapeutic (external) applications as well as the action of sphagnum from Sphagnum herb, and rejected this kind of peat as scientifically not promising, based on a single biological test on plants. The concept of an active principle in peat or its preparations evolved, and speculation concerning its nature was not followed by adequate basic research. The active principle was not found. Results concerning plant meristem growth were too readily applied in animal production and finally human medicine. The natural ingredient in TPP production was never defined botanically. Anti-cancer properties ascribed to the TPP on the basis of bio-stimulation tests stirred powerful social emotions.

Conclusions: Topical peat cure originated in Austria in about 1820. It evolved as a whole branch of Central European balneotherapy which had been completely scientifically described by the 1950s. At that time an undefined peat extract was once successfully used in ear infections in paediatrics. Stanisław Tołpa's research project to find any internal application of peat ignored the achievements of ethnobiology, balneotherapy, surgery and otorhinolaryngology known at that time. His strenuous and insistent efforts, carried out in isolation, crucially failed pre-clinical and clinical tests in any branch of his therapy. Three commercial drugs were allowed for 3 years before substantial clinical proofs of peat efficacy were achieved. Social impact was high and resulted in the birth of the Polish legend of Tołpa's marvellous drug.

1. Introduction

According to the map published in Hildebrandt (1985), peat bog areas are widely distributed in Central Europe including Germany, Austria, Poland, the Czech Republic, Slovakia, Hungary and western Belarus. Living near bogs and struggling with bogs must have given birth to the idea of using peat for health. Studying the earliest scientific contributions on the medical application of bogs, peat itself or peat
products, we were surprised to see that it was conceived by doctors of medicine rather than by folklore. So, could the path from the oldest medical ideas to Stanisław Tolpa’s efforts in making his drug from peat, be straightforward, or was it ever inspired by any folklore, if not ethnobotanical then at least ethnobiological? Peat baths and poultices are still administered in Poland in many spas, but Poles have failed to produce any more advanced drug. The history of the Tolpa Peat Preparation (TPP) is unknown outside Poland, and the whole story of how and where peat baths were invented and propagated, and how they inspired medical sciences, has never been told in full.

2. Aims of the work

There is much confusion about the peat preparation invented by Prof. Tolpa in the 1980s in Poland. We decided to present this historical preparation and drug tests against the backdrop of rich Central European traditions connected with the medical uses of peat in any form for therapeutic purposes. We intend to show why the invention betrayed all hopes and whether its ethnopharmacological heritage was properly used by inventors and clinicians.

Even in Polish literature, the information is very scattered and fragmented. Additional information, however, is in our view, important for shedding a new light on the history of TPP. It has been obtained from unpublished typescripts as well as press interviews and reports.

3. Definitions

According to Flores (2014):
Rheotrophic bog — a peatland type which occupies the depressions of the area, especially river valleys, and is fed with surface and ground water, usually rich in biogens. Source of rheotrophic (Carex, Cladium) peat.

Ombrotrophic bog — a peatland type which is dependent entirely on precipitation for water and nutrient supply, a nutrient-poor ecosystem. Source of ombrotrophic (Sphagnum) peat.

Transitional bog — a type of peatland with the features of both reotrophic and ombrotrophic bogs.

4. History of the knowledge of medicinal uses of peat

4.1. Geology

Peat was scientifically described in the 18th century and named in Latin humus vegetabilis lutosa, turfa dicta (‘vegetable muddy soil called turf’). Da Costa (1752) summarized all early geological contributions on peat: “This mould is of a brownish-black colour, not so soft or fine as common vegetable mould, but of a more loose and harsh texture, and is always full of fibres, roots and other putrefied remains of vegetables.” He distinguished varieties of this fossil: Swedish, Dutch and Danish, but for all of them he mentioned only one use, as a fuel. The Latin name humus vegetabilis shows that da Costa understood properly the origin of peat. It started to be classified as vegetable soil, e.g. by Cronstedt and Brännich (1770).

The first two dissertations on peat were: Dissertatio physico-medica de cespite ustili vulgo turfa … Sectio I Chemica (Hofmann, 1794) and the Sectio II Physica (Fiebiger, 1794). Hofmann (1794) recorded German vernacular names for peat: Torf, Turv and Turf. Fiebiger (1794) studied the physical composition of peat (plant remnants) and the reason for its calorific value as a fuel. Although these studies were dissertations for medical degrees, they described only the physical and chemical properties of peat. These both authors noticed and named 3–4 varieties of peat.

4.2. Peat as a medicinal material

4.2.1. Invention of peat baths

Medicated baths in peat or peat products were invented near Salzburg (Austria). In 1813, local peat bogs were utilized only for fertilizing fields (Spaur, 1813). The origins of the concept for medicinal use are uncertain, and historians investigating this have provided contradictory information. According to Zieleniewski (1866, pp. 40–41), the first peat baths were prescribed by Dr Nehr in 1817 in Marienbad (Austria), and by Dr Heidler in 1821, and a simple peat bath spa was opened there in 1822. A second was launched in Franzensbad (Czech: Františkovo Lázně) in 1838. Heidler (1822) wrote that peat had already been used topically before him, by Dr Nehr and other physicians. The natural product being used was named by Heidler (1822) in German as Moorerde (‘bog soil’) and was saturated with water until it attained the consistence of a slurry (ibid. p. 55) or heated with steam (ibid. p. 63).

An Austrian physician Oberlechner (1826) told a different story: “Thousand-year-old bogs spread from 4 h away from Salzburg up to Untersburg, but no physician came up with the idea of seeking a remedy against crucial diseases just in mud, in peat.” (pp. 5–6). He was inspired by the smell of bogs. Then he also recalled the example of the Biblical Bethesda pool near Jerusalem, a place of miraculous healings by baths (Joh. 5, 2–5). He analysed the Greek text of the gospel in which the words xéros – ‘dry’ and tarasso – ‘to disturb, to make muddy’ are used, and concluded that gases were released from in Bethesda. Hence, he claimed that mud or bubbling water could have medical powers. Thermal and mud baths had already been known in Europe (e.g. in the Netherlands, France) but Oberlechner noticed that in fact the term bog (Germ. Schlamm) not peat (Germ. Moor) was used. Although sometime recommended, baths were prescribed as a cure extremely rarely. Thus he wrote: “Although, according to Heidler (1822), there are few chronic diseases for which the topical or general application of mud baths would not be advisable, they are still rare in Germany, and furnished only in Eilsen, Nendorf, Marienbad, and, to a lesser extent, in Meinberg and Nordheim. Diseases for which mud baths have so far been considered as remedies are: paralysis from gout causes; contractures and immobility; ulcers of the lower extremities; lichen planus and chronic skin defects; chronic pain in general and inability to walk.” He described and classified peat (p. 22) and named it in Latin turfa and cespes bituminosus (p. 26). For medicinal purposes he chose bog-peat (Latin: turfa paludosa) as the best “among many of its kinds”.

Making an analogy to bog baths, Oberlechner (1826) proposed peat baths. For chronic skin lesions (lichen planus, skin ulcers, scabies), rheumatism, stiffness of the limbs (after wounds and fractures, in podagra and gout more generally), and paralysis. To cure paralysis and skin lesions, he devised a warm cataplasm of peat (p. 42), and suggested rubbing the lesions with pieces of cooked peat (p. 43).

Oberlechner designed baths in tubs containing peat diluted with water. He also discussed the impact of the internal use of peat water, and he drew on local ethnobiological knowledge that cattle and horses drink it willingly and without damaging their health. Moreover, some curative effects were observed (no lung diseases among cattle herded on ombrotrophic bogs).

He also claimed: “First of all, the [ombrotrophic] bog seems to me to be a true refuge for patients […] with lung diseases.”, as he expected a curative effect of bog vapours on the lungs.

Kryniwa, situated by the southern border of today’s Poland, was the first Polish spa to offer peat baths as a result of Dr Zieleniewski’s efforts in 1858: “A wet meadow behind the old bathhouse, which had been receiving the wholly unutilised mineral water of Kryniwa for the last 50 years, was the place of abstraction of peat matter [for the baths]. Apart from general baths, peat poultices were introduced” (Zieleniewski, 1866, p. 41). Truskawiec (in Lviv region) was the second spa in which, since 1863, peat has been offered (Zieleniewski, 1866, p. 42).

In Kryniwa, medicated baths were administered similarly to those
above, except that the peat was dug in autumn and seasoned throughout the winter for better decay. Fragmented, dried peat was saturated with steam in vats, and thus warmed, was loaded into bath-tubs (Zieleniewski, 1866). Linen sachets were filled for topical applications.

Since the early 19th century, an extensive literature on spas, peat baths and bathing peats, including symptoms, posology and contradictions, both in German and Polish have been published (the Polish language was still used in northern parts of the Austrian Empire after the annexation of southern Poland in 1772). A copious German and Polish bibliography of early references in this literature was provided by Melion (1847) and Zieleniewski (1866), respectively.

The first medical description of peat in German medicine and pharmacy was compiled by Dierbach (1837, pp. 329–330). He provided a physical description and classification and then wrote: “Medicinal usage of peat seems uncommon”.

Then Dierbach abstracted a naive case report from Austrian medical writings by Hornung (1835) who described a successful cure of a patient with a stroke: “Peat has been used recently in baths for paralysis, something at least deserving a mention. A 60-year old housemaid […] was found with all the symptoms of cerebral haemorrhage. […] her right limbs remained totally paralyzed. […] Peat baths were adminis-tered which cured this condition within 4 weeks.” The case was re-corded in 1833 in Salzburg (Hornung, 1835).

Hahn (1842) still remembered this case report in his monograph of external remedies (pp. 450–451) and added the dose: 4–10 lb per single bath in paralysis.

4.2.2. Development of peat baths

Within 36 years of the publication by Oberlechner (1826), peat therapy in Austria had become widespread and highly developed. Even farmers who owned wetlands, established small amateur bath houses in which they offered baths (in peat or peat bog water) to the visitors. Wallmann (1862) devoted a whole chapter of his book to peat spas around Salzburg, and he described also as many as 71 peat bogs of this region (pp. 216–221).

In Marienbad spa (established in 1828 by Oberlechner), the following fluids were used for medicated baths: peat water, peat mud (Germ. Torfmoorschlamm) and peat soil (Germ. Torfmoorerde) (p. 236). Peat water was diluted in various proportions with ordinary water and heated (p. 229). What was named peat mud (Germ. Torfmoorschlamm) was prepared from peat mixed with peat water, up to the consistency of mud. Peat soil (Germ. Torfmoorerde) was a soil-like product cut from peat bogs, and was used both for preparing baths and as a poor fuel. The bathrooms in spas offering peat baths were equipped with wooden bathtubs. Water from peat bogs was supplied there by brass or wooden pipes.

In the higher parts of the Alps similar spas were established such as at St Martin (in 1856) and Neuwitterbad zu Altenmarkt (in 1857). But usually people set out for the mountains to take baths directly in peat bogs. Wallmann (1862) described 3 such places.

The peat baths (Germ. Moorschlammbäder) were applied to the whole body for 30–60 min. The peat water was also administered as a medicated drink. A long list of ailments cured by peat baths (Germ. Moorschlammbad) simply included all major skin afflictions and general illnesses.

Warm peat baths were offered also at other places in the Austrian monarchy, e.g. Töplitz (today Czech. Teplice) and Hofgastein (today: Bad Hofgastein) (Mayer, 1843). This author pointed out that these treatments stimulated blood circulation in the skin and delivered the following advantages in external applications which he had confirmed clinically: in chronic skin conditions of a herpetic nature and scabies, in paralysis of single limbs, in gout (podagra) and rheumatic disorders, in serious wounds, in spasms and neuralgia, in oedema, in aged ulcerating conditions of the feet, in gout and scrofula, in osteopathy and in some (unnamed) internal diseases. Mayer’s (1843) and Oberlechner’s (1826) recommendations are convergent.

During this period, peat baths seem to have been unknown in Germany. For example, a monograph on the history of balneotherapy “… or on the use of waters for religious, dietetic and medicinal pur-pose” by Lersch (1863) makes no mention of peat or peat bog water.

In the 20th century, peat was used in thermotherapy (peat baths at temperatures up to 70 °C) (Gottstein et al., 1932, p. 78). In the 21st century, peat baths are still being widely offered, e.g. in 2011 in Poland it was available at 31 spas (Drobnik and Latour, 2011).

4.2.3. Peat and Sphagnum dressings

We have recently shown that the oldest certain ethnomedical observation on the use of Sphagnum palustre L. as a hygienic material in Lapland comes from the year 1732. Peat is formed not only (or not solely) by more or less decayed Sphagnum plants, and the names peat and Sphagnum were often confused in writings about medicinal peloids and moss dressings (see: Drobnik and Stebel, 2017).

Peat was independently developed as a dressing material in Germany in 1882. The application of a peat poultice on wounds was inspired by folk medicine there (Drobnik and Stebel, 2017). The anti-septic action was overlooked in those times, and the absorbing prop-erties of peat and later of Sphagnum sp. were appreciated. Hagedorn (1883) tested the herb of Sphagnum palustre L. (as S. latifolium Hedw.), and Leirink et al. (1884) mentioned Sphagnum capillifolium (Ehrh.) Hedw. (as S. acutifolium Schrad.) and S. subsecundum Nees as examples of a dressing material named by him Herba Sphagni. Studies by Painter (1983, 1991) finally proved that an oxopoyosaccharide residing in the cell walls of Sphagnum mosses, called sphagnum, is responsible for the topical action: it induces Maillard reaction, lowers the pH and binds nitrogen compounds (including amino-acids and enzymes). In Painter’s opinion (Painter, 1998, 2003), sphagnum is active in unprocessed peat sediment too (Drobnik and Stebel, 2017). The chemistry of living Sphagnum and the method of isolation of sphagnum were summarized by Taskila et al. (2016). Czapek (1899) isolated a crystalline compound named sphagnol from Sphagnum herb. It was expected to possess any medicinal properties, only Molisch (1923) regarded it toxic. The Cza-pek’s sphagnol was a mixture of 8 phenolic compounds (Rudolph and Engmann, 1967; Engmann, 1972).

4.2.4. Clinical tests on medicinal peat (Polish borowina)

Apart from biological tests of peats, in the first half of the 20th century in Germany and Poland clinical tests were developed. Zachwiej (1949) summarized this knowledge. In Poland, the medical application of peat (as such, called in Polish borowina) was popularized after 1850 and the chemical studies of medical peats were undertaken between 1880 and 1913. The researchers learned that “the older peat deposits are (that is the more decayed they are), […] the more valuable for medical application they become”. The advanced decay process produces brown-coloured hemic bodies of an acidic nature and with the properties of a hydro-gel. “The older peat is, the more hemic acid it contains.” (ibid.:7). “The hemic acid binds […] the water which is es-sential in producing the thermal properties of the peat mud”. […] “A well-decomposed peat produces a uniform bathing medium and the area of contact with [the patient’s] skin is correspondingly large”. He added: “We used to think that the way peat acted to the body was chemical and biological and was based on the irritating role of chemical components dissolved in the water. Yet in modern times we have learned that the physical properties of peat baths are more important than chemical ones….”. The advantages of peat baths are determined by their thermal properties. Borowina is a poor thermal conductor in comparison with water, it is an insulator. Thanks to the physical properties of borowina, the body tolerance of a high temperature of borowina is greater than that of equally warm water. Thus, borowina baths can be hotter than water ones and the heat penetrates to deeper organs (Zachwiej, 1949, pp. 5–11).

Warm borowina baths enhance blood circulation, they have
spasmyotic and analgesic effects in myalgia and chronic inflammation (Zachwiej, 1949, p. 23). Local congestion occurs in skin and in deeper organs. The body is overheated and its general temperature grows, blood pressure is reduced (ibid.: p. 12), the pulse is slowed (noticed already by Zieleniewski (1866, p. 43, 59). Regarding chemical influences, astringent and even tanning effects were observed, which in those times were attributed to humic acids, Al salts and Fe sulphides. In the blood cell count, an increase in the number of leucocytes was observed after a peat bath. Already by 1935, the presence of oestrogenic bodies was found in peat together with their action on the body (Zachwiej, 1949 p. 12, 15, 16). The level of oestrogenic bodies increases with the decay process of the peat (Baszyski et al., 1956).

The truly useful property of peat is its large heat capacity and relatively flat cooling curve in comparison to water. Many publications on peat compounds and on the nature of peat-bath therapy were released in Germany in the interwar period — for a review and resources see: Hildebrandt (1985).

4.2.5. First internal use of a peat preparation

The first researchers to use a peat preparation internally were paediatricians from the Paediatric Clinic in Poznań (Poland) in 1950. In late 1949, a peat preparation was inaugurated there. The authors wrote: “Considerations of the biological properties of peat inspired us to research in vitro and in vivo its bacteriostatic action” (Rafiński and Fojudzki, 1950). This was a period of serious antibiotic shortage in Poland. The action of peat constituents on soil bacteria was already known from pre-World War II publications on soil science (compare: Gumiński, 1971). A young talented chemist, Edmund Fojudzki, created a preparation of peat and tested it in vitro against haemolytic Staphylococcus aureus, Streptococcus pneumoniae, Corynebacterium diphtheriae and Streptococcus pyogenes with good results (Rafiński and Fojudzki, 1950; Rafiński, 1950). Within a half year, the peat preparation was introduced into clinical tests in paediatric patients who had been unsuccessfully treated with penicillin or streptomycin. It was applied in the form of wet poultices on to necrotic wounds. In chronic Sphaerococcus infections of mastoid antrum in infants, the preparation was injected therein. Swabs were applied to an abscess. Swabs were used after otiatric surgery, including antrotomy in chronic otitis, in periosteal abscess of the nose, and in mastoiditis abscesses.

These two preliminary reports contained no characteristics of the peat preparation. Clinical testing was performed on 15 infants or children. 1953 brought another short report on experimental diphtheria treatment in 131 children with combined use of peat extract and aureomycin (Rafiński, 1953), then all was forgotten.

5. Studies on peat by Tolpa and his scientific team

5.1. Scientific biography of Stanisław Tolpa

Professor Stanisław Tolpa (read: tow-pah) was born on 3 Nov. 1901 in Ruda Łańcucka (south-eastern Poland). He studied at the Jan Kazimierz University in Lviv (in those times this city was in Poland) where he specialised in botany. He graduated in 1928, and in 1930 was granted a doctorate degree with a dissertation on peat bogs. He remained faithful to this research discipline until the end of his life.

In 1930–1934, he investigated the vegetation and stratigraphy of peat deposits in Polesia (eastern parts of the then Poland) (Zurek, 2016). Between 1928 and 1934, Tolpa took part in extensive preparatory studies within the artificial drainage project (Figit, 1991 p. 2) planned by the Polish government (Fig. 1). In the meantime, he received his PhD degree based on his studies of the high-mountain peat bogs of Chornohora (Ilńicki, 1997). He put on paper his fascination with the nature and folk of Polesia in a popular book about his 4-year long research journey in Polesia. For his and other pre-WWII Polish bibliography on peat bogs and peat consult Zurek (2016).

Then, until the outbreak of WWII he was employed as a biology teacher in Kalisz […] One of the results of this period was an investigation of the peat bog flora of the present “Lis” nature reserve upon Prosna River near Kalisz (Ilńicki, 1997). In 1939, Tolpa also launched his research of the flora and vegetation of the Bagna Jelnińska peat bog upon Dysna (the border river between the then Poland and Latvia), published in 1947 (Jasnowska, 1998).

After WWII, Tolpa started his work in the destroyed Wroclaw, which was incorporated into Poland. He took part in establishing and launching Polish universities, including the University of Agriculture (now the Wroclaw University of Environmental and Life Sciences), where he spent his whole later career as Head of the Department of Botany. His research scope included the biology and classification of peat bogs.

Tolpa became interested in biologically active substances in peat in the mid-1950s (see Chapter 4.2.4). His aims were crop plant production, animal production, veterinary medicine and finally human medicine. These investigations were intensified after Tolpa retired in 1972. In the same year, he became Head of the Laboratory of Peat Biology and Biochemistry established for him at the Wroclaw University of Agriculture. Its output was a patented method of obtaining a peat extract, to which some medicinal effects were attributed (or at least, suggested). A series of patents described the technology of producing the extract. The product is currently known as the “Tolpa Peat Preparation” (TPP); other variants: TTP (“Tolpa torf preparation”) or PTT (from Polish: Preparat torfowy Tolpy).


5.2. Biological studies of peat by the Tolpa research team

The origins of Polish research on peat compounds date back to 1954. In those times, a research team headed by Prof. Tolpa launched botanical field research aimed at developing a botanical classification of peat bogs and peat deposits in Poland. Then only 3 types of peat bogs were known: ombrotrophic, rheotrophic and of transitional type. But within one type, further differences in the peat flora were visible. The team considered that the chemical composition of the peat itself must be consequently different in such cases. For that purpose, in 1958 or 1959, peat samples were collected in 13 localities near Wroclaw and other regions of Poland. A series of extracts were obtained, and one of them was chosen for further tests, it was a concentrated, neutralized extract obtained with 0.1 n solution of NaOH. It was separated by paper chromatography (elucent: 1-butanol, Fig. 2). Parts of the chromatograms with a single fraction were cut off from the chromatogram strips. These cutouts directly became a growth medium for a test plant which was a seedling of Sinapis alba L. with a 2-mm long radicle. After 10 days of growth, the root system was measured. All peat samples produced repeatedly 7 fractions (named A through to G) on the chromatograms. Substance A was the fastest. It inhibited the growth of the root, while fraction E promoted it. The same reactions were observed in the pH range 5–8. The authors noticed that extracts from ombrotrophic peats contained little of substance A (Tolpa and Czyżewski, 1960).

Research on the stimulating properties of fraction E was postponed, and the inhibiting substance A was studied further. It inhibited roots of seedlings of Sinapis alba and Solanum lycopersicum L. and it caused necrosis of apiol shoot meristems of Syringa vulgaris L. and S. lycopersicum (Tolpa and Czyżewski, 1962). The still unidentified substance A created suspicion of antibiotic properties. Then the authors tested in vitro its action on the growth of Proteus vulgaris, Salmonella typhi, Escherichia coli, Staphylococcus aureus, Sarcina lutea, Bacillus subtilis as well as Saccharomyces sp., Penicillium sp. and a macrofungus Merulius larcyns (Wullen) Schumach. The substance A did not inhibit bacterial growth. Saccharomyces was inhibited remarkably and Penicillium moderately. No influence on M. larcyns was observed (Tolpa and Czyżewski, 1962).

They found later that grasses, sedges and bryophytes which are natural components of the peat bog flora are insensible to fraction A.
Especially, the extract did not inhibit the growth of _Sphagnum recurvum_ P. Beauv., _S. magellanicum_ Brid., _Eriophorum vaginatum_ L. or _Vaccinium oxyccocos_ L. The reaction of _Sinapis alba_ roots to extracts from peat bog plants was tested too. Extracts from ombrotrophic bog plants did not (or slightly) inhibit root growth in _Sinapis alba_ which was consistent with the low level of inhibiting principle _A_ in the extract from ombrotrophic bog peat. In turn, an extract from rheotrophic bog plants considerably inhibited the test plant and it corresponded with the high content of principle _A_ in the peat extract. It remains unclear what the bog plant extract was: was it composed of decayed peat-forming plants or a constituent of living plants? No methods of preparing such extracts were provided either. It was concluded that substance _A_ was produced in some peat-forming plants and is accumulated in peat; it was to be identified chemically. Lastly, it was concluded that substance _A_ inhibited mitosis in the apical meristem of _Sinapis alba_ and _Solanum lycopersicum_ roots and _Syringa vulgaris_ shoots (Tołpa and Czyżewski, 1962).

This ended the basic research on peat extract at that time. But it inspired further research questions which we reconstruct here:

- The pure substance _A_ should be isolated and chemically identified and a peat extract showing the properties of substance _A_ should be obtained.

- The substance _A_ hinders the growth of yeast. Does it stunt the growth of any pathogenic microorganisms? Can it be a medicine?
- How to process the rheotrophic peat (which contains the substance _A_) into a drug?
- Mitosis of root tips was inhibited by _A_. If it is a mitotic poison, can it be tested on cancer tissues?

The above research questions were never set forth in print but must have been rooted in the deep memory of Tołpa’s research team. They became evident in the whole scientific output, as we are going to show, regarding both the research material and the purposes of their research.

Tołpa resumed medical topics after he retired in 1972.

In the 1970s biostimulation experiments were launched. They included the influence of a peat preparation admixture on crop and livestock production (Tołpa et al., 1972). An idea of medical application of peat was communicated in this publication too. Tołpa (1982) concluded:

- an increase in the biomass of _Saccharomyces cerevisiae_ (Desm.) Meyen, _S. ellipsoideus_ Reess, _S. fragilis_ A. Jörg. and _Torulopsis inconspicua_ Lodder & Kreger-van Rij was observed after the extract had been added to the culture medium.
- an increase in crop yield of _Allium cepa_ L. and medicinal plants and an increase in alkaloid content after spraying the preparation on to plants,
- increases in body mass and haemoglobin level in calves,
- an increase in milk yield in cows,
- an increase in body mass in piglets,
- an increase in bee brood yield.

But how the increase in the yeast growth was reconciled with the previously observed inhibition of growth caused by substance _A_? Tołpa (1982, pp. 93–94) became inconsistent in his interpretation of these results: he suddenly stopped relating the biostimulation results to the effect of the substances _A_ or _E_. Instead, he began to relate these results to the concentration of the peat extract in which he assumed (but never tested) the presence of both _A_ and _E_. Low concentrations of this extract promoted, and high ones inhibited the growth of yeast. In other words, the same experimental extract was a biostimulator at low concentrations and a bioinhibitor at high ones. Since the chemical identity of _A_ and _E_ was still unknown, Tołpa started to use the concentration as a parameter which differentiated stimulation and inhibition.

However, the above observations had already been recorded in ethnobiological studies. Namely Tołpa (1949) wrote: “Peat converted into so-called peat-molasses was added to feed materials for pigs. Peat...
molasses with wheat bran and potato flakes is a perfect fattening feed. Peat molasses promotes the health of these animals” (Tołpa, 1949, p. 70). No sources of these observations were provided but they seem to have an ethnobiological and ethnopharmaceutical origin.

“Encouraging results of zootechnical experiments held by Tołpa over the course of the 1960s, were capped by Polish patent P.204.466 entitled: Method of obtaining a biostimulator from peat for feeding to breeding animals (1984)” but production was not launched (Ilnicki, 1997).

An introduction to Tołpa’s (1982) work entitled ‘Peat-derived substances shows how this idea was germinating: “This year marks 25 years since I started my detailed research on peat material, assuming that peat, as a complex product of microbiogenic processes, can contain still unidentified chemical compounds with interesting biological properties. My considerations originated from the use of some kinds of peat (Polish: borowina) as a balnotherapeutical remedy. I started to strongly suspect that chemicals contained in the peat are responsible for medicinal effects and that these are enhanced by warm water. During the [external] use of borowina, these chemicals penetrate the patient’s skin and produce beneficial changes [...]” (Tołpa, 1982). These hypotheses of Tołpa were to be proved experimentally by isolation of the alleged chemical compounds (Tołpa, 1982 p. 87). Tołpa the supposed action of borowina was connected with the potential content of any active substances (Szmytówna and Górecki, 1970).

In those times (the 1970s till the beginning of the 1980s), the idea of introducing a peat preparation into therapy appeared, but we have not found any published materials. The name abbreviated TPP (or its variants, see chapter 5.1) was used for the first time in a 1991 Polish patent No. 169544 (Tołpa et al., 1991b). The Tołpa Peat Preparation was the crowning achievement of Tołpa’s research efforts. Its alleged healing properties, including anti-cancer, aroused controversy. This information is contained in chapter 5.3.

The genesis of clinical experiments was thus related by Tołpa: “After 6 months of adding various fractions to animal feeds, physiological changes in all organs of the test animals were noticed. We observed increased vitality, similar to that in the plants which had grown faster after fertilising them with peat fractions. So, we named those substances biostimulators.” (Figat, 1991 p. 3). “We isolated bio-inhibitors, too, which mitigated inflammations in animals [...] so we could start thinking how to use such a preparation in medicine.” (Figat, 1991).

The first study aimed at assessing the anticipated internal therapeutic properties of peat was carried out by Kukla (1984). S. Kukla was a member of S. Tołpa’s scientific team in the 1970s, 80s and 90s, closely cooperating with him in the field of peat preparation. Kukla’s work is the most comprehensive study, providing the most important information about peat extraction, its chemical composition, fractioning, purification and testing the actions of the peat fractions. Kukla (1984) wrote: “The research, launched in 1954, resulted from the concept, then unconfirmed, that the peat substrate possessed biologically active principles. We believed so with regard to the medical application of the so-called borowina which was a specially prepared peat.” The major findings contained in his work, which are of great importance for further assessment of the peat preparation and its therapeutic properties, together with our comments, are provided in the Supplementary Material (Table 1).

5.3. Tołpa Peat Preparation (TPP)

5.3.1. Technology of TPP production

The technology of the production of the Tołpa Peat Preparation has not been clearly stated anywhere. It was published in a one-page paper by Kukla and Sawicka (1992). Descriptions of raw peat material and its preparation methods were mentioned in Kukla (1984) and scattered in some patents. Below we reconstruct these data.

The origin of peat as a natural material: “The peat material [...] is taken from the peat bog situated in the valley of the Prosná River, because it was found to contain optimal amounts of chemical compounds with a fairly high biological activity” (Kukla and Sawicka, 1992).

Technological process of TPP production. “The peat is dried to adequate humidity, and then it is brought to the Laboratory [...]. Here the preliminary basic tests are done for establishing its botanical composition, the degree of plant decomposition, pH, ash content, humidity degree and other physico-chemical features.” [...] “Peat with the characteristic features described is placed in an extractor and covered with an aqueous solution of sodium hydroxide. After extraction of active substances, the suspension of peat is separated from the solution which is now acidified with hydrochloric acid of about 6 n and left standing for sedimentation of the precipitate. At this stage the precipitate is discarded and the liquid is acidified with 6 n hydrochloric acid and concentrated in a vacuum. The concentrate obtained is neutralized and evaporated to dryness in a vacuum. The dry concentrate is extracted with an aqueous ethanol solution. The alcoholic extract is alkalinized and left standing for sediment precipitation.

After precipitation, the sediment is discarded, and the clear water-alcohol solution is filtered for removal of precipitated salts, and the solution is concentrated in a vacuum with the simultaneous removal of ethanol residues. Then the excess of sodium chloride is removed by alternating crystallization and extraction with water and ethanol. After reduction of the content of NaCl to about 60% of the dry mass the solution is concentrated in a vacuum, sterilized and dried after pulverisation under aseptic conditions. The final preparation is the beige-coloured hygroscopic powder with characteristic features as specified in the standard.”

Technology of the production of medicines: Polish patent No. 169544 (Tołpa et al., 1991b) entitled ‘Pharmaceutical compositions describes the production of medicated ointments and gels which contained the Tołpa® Peat Preparation which it is called here for the first time. The production process is briefly described too; in general, it was similar to the description in Kukla and Sawicka (1992), but it differs in detail. The main discrepancy is that “the excess of sodium chloride is removed by alternating crystallization and extraction with water and ethanol (Kukla and Sawicka, 1992)” but the desalination is achieved by means of reverse osmosis (p. 3).

5.3.2. Compounds of TPP

Information about the chemical composition of TPP is scarce. It was published by Kukla (1984) and Olechnowicz-Stepień et al. (1987), and these analyses were partially repeated by Olechnowicz-Stepień et al. (1991). Two extracts were selected by the authors as promising and were named fractions PF-290/I and PF-290/II — the original code names, never explained, appeared earliest in Karmińska et al. (1983). These fractions were expected to stimulate adherent human cells in vitro. Olechnowicz-Stepień et al. (1987) identified only the following compounds of PF-290/I and PF-290/II: polysaccharides (rhamnose, 6-deoxyglucose, xylose, mannose, galactose and galactosamine, glucose and glucosamine), amino acids (aspartic acid, threonine, serine, glutamic acid, proline, glycine, alanine, valine, isoleucine, leucine, histidine, lysine, arginine). Microelements in TPP were listed only by Olechnowicz-Stepień et al. (1991): PF-290/I and PF-290/II had in common Na, K, Ca and Mg. This constitutes all the published data on the composition of the peat extracts.

Polish patent No. 167664 (Tołpa et al., 1992) entitled ‘Method of peat extraction’ from March 11, 1992 is likewise general. On p. 5 the authors state: “Depending on the origin of the peat, the extract may contain: cellulose, hemicellulose, free amino-acids, resins, plant waxes, humic acids and their salts, sulphoacids, lignin, hynatomelanic acids, other organic acids, enzymes and other substances.” The origin of the substrate (plant material) is not declared (“depending on the origin of the peat …”), the list of substances is very general, too, making the product unstandardizable.

Between 1991 and 1993 when TPP was registered as a drug
ingredient, it was described as “an immuno-active fraction of an extract from a certain type of peat, containing organic compounds, mainly bounded sugars, uronic acids and humine substances as well as mineral salts” (Figit, 1991, p. 22). Drugs containing TPP were described per-factorily (UWSF, 1996):

- "Tolpa – peat preparation (capsules)”: it contained 5 mg of TPP per dose,
- "Tolpa – peat preparation (tablets)”: 5 mg of TPP per dose,
- "Tolpa Chamosaldont Gel”: TPP and Chamonillae extractum (no dose specified),
- "Tolpa Hypocalen Gel": TPP (50 mg), Hippocastani extractum (10 g), Calendulae extractum (5 g), Acidum salicylicum (50 mg).

5.3.3. Biological properties of TPP according to the Tolpa team

Properties of biologically active substances present in TPP and their action. Kukla and Sawicka (1992) wrote briefly on this subject: “In the technological processing of raw peat by means of certain chemicals peat extracts are obtained containing active substances, among them the so-called biostimulators and bioinhibitors. The former substances have the ability of enhancing the growth and development of plants and animals, the latter inhibit their development by exerting immunosuppressive effects on the organisms.” No citations of relevant bibliography to support such results are provided; the statements are general, and facts related to tests on plants (!) and animals are randomly mixed (see previous chapters).

Immunomodulatory and anti-cancer properties are mentioned in Polish patent No. 167664 (Tolpa et al., 1992) in which many oncological diseases are listed but without references to published or unpublished data.

Medicines: In Polish patent No. 169544 (Tolpa et al., 1991b) we find that a gel and an ointment (containing also extracts from Calendula officinalis L. flowers and Aesculus hippocastanum L. bark) were simultaneously applied in the cure of venous ulcers of the crural region (no bibliography provided). The authors also said: “Good results were obtained in patients with chronic ulcers, treated up to then with traditional remedies, within only a few weeks.” (no publication or data source provided).

Between 1991 and 1993, when TPP was an official drug in Poland, the attached reference materials informed: "TPP is an immunomodulatory remedy which promotes the tissue renewal process. In small doses (5 mg daily for 7 days), it intensifies immune responses, and in large doses it inhibits them. It is effective on both antigen-presenting cells, and regulatory cells by correcting their function. The immunomodulatory effect of TPP depends on the functional status of the immune system. In the case of immunosuppression, TPP usually increases it both by an increase in antibody production and by increasing the phagocytosis ratio; it also increases the CD4+ and CD8+ indices of the lymphocyte T population. In topical applications or combined topical and internal ones, it promotes the regeneration and repair processes, and in this way is successful in treating slow-healing wounds and chronic inflammations.” A TPP powder for making a solution, 5 mg tablets, an ointment and a gel were produced (Figit, 1991).

5.3.4. Seeking active principles in TPP

None of the constituents found in TPP (see: chapter 5.3.2) is a natural anti-cancer factor. Discovering such a substance in TPP was still an ongoing problem and a challenge towards finding a remedy for cancer.

Other scientific ideas were born in the meantime but produced no research. According to the Tolpa’s own words, “The peculiarity of peat lies in the fact that many bacterial or fungal metabolites reside in it which conceal a variety of components of important chemical activity. Such compounds are clustered in peat deposits having no access to oxygen, so they are not oxidised and do not undergo any chemical changes.” […] And: “Basic chemical groups present in peat are enzymes (!) and antibiotics (!)” (Figit, 1991, p. 5).

The study by Rzadkowska-Bodalska et al. (1988) was designed to identify the active compound of TPP. The authors found that both PF-290/I and PF-290/II were active in immunological tests but this kind of activity was not reproduced by their sub-fractions. The authors were resigned to the conclusion that the chemical character of biologically active principles was unknown. They cited Kukla (1984) and Karnańska et al. (1983) as sources which had provided results on stimulation of human granulocytes but in fact those both papers lack such results, showing only an increase in the number of macrophages.

5.3.5. Clinical tests on TPP or its fractions

After Tolpa and Czyżewski (1962) published their results, no more publications about the medical properties of peat or its preparations have been issued. Such data were only shortly reported in Tolpa (1982). From a memoir by Tolpa (1992) we learn that by the end of the 1970s it was decided “to conduct follow-up observations of patients using the peat preparations” but they were not launched before 1986, that is when the funds were granted by the government. Prior to 1986 some minor tests on animals were conducted, e.g. the effect of TPP on trichinosis induced in mice (Karnańska et al., 1983). But most of the results of such experiments were only communicated orally in scientific assessments (compare the Chapter Discussion). Pre-clinical tests were accomplished in 1990 (Tolpa, 1992).

Funds awarded after TPP was conditionally registered at the beginning of the 1990s allowed a programme of full and comprehensive clinical studies to be launched.

Polish researchers carried out in vitro, pre-clinical and clinical studies upon the therapeutic effects of TPP in nearly all branches of medical sciences but published only in Polish journals. Most of the tests were carried out and results released in the early 1990s. TPP was tested on: venous ulcers (Witkiewicz, 1992), cancer (Koziorowska and Anuszewska, 1994), as an antioxidant (Piotrowska et al., 2000), as a hepatoprotective (Maśliński et al., 1993a), as a potential dermal irritant (Czyżewski-Szafran et al., 1993), on sinusitis (Stankiewicz et al., 1997a, b), cervices (Woytań et al., 1993), on Alzheimer’s disease (Leszcz et al., 1991, 1993), against gastric and duodenal ulcers (Brzozowski et al., 1994), against respiratory tract infections (Jankowski et al., 1993; Romański et al., 1997) and on oral inflammations (Jańczuk et al., 1996a, b, c, d). The greatest number of publications concerned immunology and allergology (Baj et al., 1993; Blach-Olszewska et al., 1993; Inglot et al., 1993, 1999; Kowalska et al., 1993; Kowalski et al., 1992; Madej et al., 1993a, b; Maśliński et al., 1993b; Obmińska-Domoradzka, 1993; Obmińska-Domoradzka et al., 1993a, b, c; Wyczółkowska et al., 1993), as well as haematology and angiology (Buczko et al., 1993; Skopieński et al., 1993). The toxicity (Czyżewski-Szafran et al., 1993) and embryo-toxicity (Juszkiewicz et al., 1993) of TPP were also tested, as well as its mutagenic and genotoxic properties (Koziorowska et al., 1993). Bartmańska and Schüetz (1992) tested TPP influence on the seminiferous epithelium in mice.

All these studies enabled the authors to classify TPP as an immunomunotropic drug (Blach-Olszewska et al., 1993). Podeński et al. (2004) also confirmed TPP to be a natural immunoresistance enhancer. According to Bartmańska and Schüetz (1992), a decrease in the spermatogenesis ratio was the first negative effect of TPP in mammals. TPP was used once in the treatment of endometrial cancer-associated retinopathy by Adamus et al. (1998). It was also clinically tested as a non-specific immunostimulant and was found to provide good protection against respiratory infections in sportsmen (Inglot et al., 1999).

The Tolpa peat preparation was mentioned in international literature in a review by Schepetkin et al. (2002) which collated our knowledge of various medicinal products derived from peat, sapropels and the Asiatic natural product mumie (aka shilajit). Schepetkin et al. (2002) pointed out that the only medicinal preparation similar to the Polish TPP was the Soviet Torfat, which was a steam distillate of peat.
Selected information on TPP was also quoted in some reviews e.g. by Peña et al. (2005), Wollina (2009), van Rensburg (2015) and Zykova et al. (2018).

Schepeletkin et al., 2002 also summarized key Polish results: “ TPP contains organic substances, primarily bound sugars, amino acids, uronic and humic acids, and mineral salts. [...] No embroytotic or teratogenic effects were observed in hamsters or rats after the administration of TPP [...] (Juszkiwicz et al., 1993). TPP was found to be neither mutagenic nor genotoxic in selected short-term tests (Koziorowska et al., 1993) and was unable to induce or enhance an allergic sensitization in mice and guinea pigs (Maśliński et al., 1993b). The cytotoxicity (CD50) of TPP on human peripheral blood leukocytes was 1–9 mg/ml (in vitro test) (Inglot et al., 1993). TPP is an interferon-α and -γ and tumour necrosis factor-α (TNF-α) inducer in cultures of human peripheral blood leukocytes. [...] (Inglot et al., 1993). TPP [...] enhanced the interferon-β and TNF-α production by mouse peritoneal macrophages (Blach-Olszewska et al., 1993). The promoting effect of TPP [...] on mouse humoral response occurred for doses of 0.5–10 mg/kg, whereas doses of 100 and 250 mg/kg had a suppressive effect. The impact of TPP on the percentage of splenocytes forming E-rosettes was also dose-dependent [at other doses] [...] (Obmińska-Domaradzka et al., 1993b). The intravenous administration of TPP to rabbits [...] increased the percentage of phagocytizing cells and phagocytic activity of neutrophils. A single administration of TPP [...] to rabbits with lipopolysaccharide (LPS)-induced fever led to the total inhibition of endotoxic shock syndrome (Obmińska-Domaradzka et al., 1993a). TPP increased the ability of human mononuclear leukocytes in patients with coronary artery disease to induce neovascularization in the local graft-versus-host reaction and decreased the high activity of lymphocytes in rheumatoid arthritis patients (Skopińska-Różewska et al., 1993). The interleukin-1 release in cultures of mononuclear leukocytes from patients with rheumatoid arthritis was inhibited by TPP at a concentration of 100 µg/ml (Skopińska-Różewska et al., 1993). Both TPP and its fractions suppressed lipid peroxidation in the mitochondria from the human placenta (Piotrowska et al., 2000).”

Some clinical tests have been resumed recently in the areas of angiogenesis and cardioprotection (Krzemiński et al., 2005) and angiomodulatory properties (Radomska-Leśniewska et al., 2016). In their assessment of more recent results, authors are sceptical, e.g. Krzemiński et al. (2005) stated cautiously that TPP “might possibly be used as an adjunct to conventional therapy in coronary artery disease”.

6. Inspiration with TPP: the PBP preparation and its properties

Another mutation of TPP existed. Obmińska-Domaradzka and Stańka-Jońc (2001) studied the mitogen-induced proliferation of thymocytes in mice after treatment with peat basic preparation (PBP). It was characterized thus: “PBP is a natural immunomodulator found in [...] some kinds of bog [...] (Tołpa). The studies on isolation of the active substances present in the peat extract showed that the organic fraction associated with the immunotropic activity of PBP contained products of the Maillard reaction, notably Amidori compounds and products of advanced glycation, in literature referred to as advanced glycation end products (AGE) (Horuchi et al., 1991). These compounds were obtained during technological processing from major components of native peat extract, i.e. oligo- and polysaccharides, phenolic glycosides, proteins and proteids. Natural catalysts in this reaction were fulvic acids present in peat extract and salts of multivalent metals.” The researchers obtained their PBP samples by methods described in Polish patent No. 170294 (Mioduszewski et al., 1992). In order to obtain 600 g of pulverised PBP (final product) as much as 2500 kg of peat had to be extracted according to the following procedure: “(i) extraction into 0.35% NaOH; (ii) deballasting in acidic (HCl) [at] pH 1.5 and after that in alkallic (NaOH), [at] pH 9.0; (iii) thermal densification at 60 °C of the clarified extract; (iv) further extraction into 60% ethanol with adjustment of pH to 8.5 (10% NaOH) and next to 7.5 (6N HCl), removal of alcohol by distillation; (v) deballasting of pitchy substances and waxes from the extract by ethyl ether, then removal of ether by distillation; (vi) desalting by a reverse osmosis technique (Dow Denmark – DDS) until the Cl ions attain a level 40%; (vii) filtration through 0.22 µm Millipore filters and final desiccation (< 5% H2O) and pulverisation. The stability of the peat-based preparation is obtained during warm-air drying.” (Obmińska-Domaradzka and Stańka-Jońc, 2001). The research was never continued or implemented. The whole paper seems to be a failed attempt at a continuation of the Tołpa school.

7. Discussion

7.1. Rejecting the old knowledge

Irrefutably, in the interwar period, Tołpa did not learn any ethnomedical applications of peat, although he carried out 4-year long field research of peat bogs in Polesia and published other ethnobiological records from there. In his summary of that expedition (Tołpa, 1936, pp. 175–177), he mentioned peat for use as fuel, animal bedding, thermal insulation in architectural engineering, cardboard and paper production, brewing, manufacture of dark printing ink and textile dye, and lastly food packaging, preserving it from spoilage. Regarding the last, he wrote: “The use of peat for wrapping is scarcely known. Experiments have shown that perishable goods, e.g. fruits, are perfectly preserved in such packaging.” (Tołpa, 1936, p. 177). The same topics were expanded in his post-WWII study (Tołpa, 1949): “Meat wrapped with ombrotrrophic peat is preserved for a relatively long time. Fruit picked early and placed between layers of ombrotrophic peat mature very slowly and can be stored on extended period. The same is true of vegetables.” (Tołpa, 1949, p. 70). Lastly, Tołpa was aware of the peat action on proteins, as he wrote: “The corpses of people drowned in peat bogs, found in undecayed condition after many years should have prompted questions about the properties of peat substances.” (Figat, 1991, p. 3). The same action on skin was already known to Zachwiej (1949) cited above. Indeed, research by Painter (1983, 2003) on Maillard reaction triggered by Sphagnum herb and peat, was based on knowledge of just this action of peat on human skin and other proteinic debris and led him to the discovery of sphagnum (see Drobnik and Stebel, 2017).

Had Tołpa followed up those old ethnobiological contributions on food preservation, he would have had the chance to lay grounds for new discoveries in food science, medical materials or drug stabilization; compare: Bertsheim et al. (2001), Taskila et al. (2016).

Tołpa was competent in the German language (Figat, 1991), so he could have easy access to the rich German library left in Wrocław University after it was abandoned by the Germans in 1945. In his early post-war publications, he cited but few methodical publications. Neither Tołpa nor other Polish peat researchers (and later TPP-researchers) addressed for example any discoveries by Czapek (1899) who isolated a substance named sphagmol from Sphagnum, whose chemical composition was resolved by Engelmann (1972). Polish researchers also did not know the history of the Sphagnum and peat dressings invented in Germany after 1880. The ability of those dressings to heal wounds (see: Drobnik and Stebel, 2017) was cited in medical works until the outbreak of WWI (see: Oks, 1910) and had experienced a real renaisance by the end of 1918 (Drobnik and Stebel, 2017). Further, they were unaware of the product of dry distillation of Sphagnum, nor did they notice the results by Painter (1991, 2003) who proved the anti-bacterial action of sphagnum, an oxopolysaccharide constituent from the cell walls of Sphagnum, isolated by himself (Painter, 1983). They overlooked otolaryngologic tests by Rafiński (1950). Sphagnum is still present in decaying peat. An understanding of these findings could have reoriented Polish researchers. Before the era of Tołpa, only Zachwiej (1949) and Baszynski et al. (1953) knew and cited the output of pre-war balneotherapy, especially the German detailed studies on the action of peat on the human body. Tołpa never mentioned these latter publications either.
Even extracts from documentaries published in the 2000s about the peat preparation research programme of the 1980/90s evoke or suggest external uses. Tolpa said once that “Australians, Canadians, New Zealanders, they know only poultices of peat. When we tried to tell them about internal applications, we suddenly had nobody to talk with” and “poultices directly on wounds [gave] surprising results: wounds healed faster than with any other known healing remedies.” (Augustyn, 2000).

With no knowledge of any 19th or early 20th-century data, the Tolpa research team rejected Sphagnum peat (ombrotrophic peat) as not medicinally promising. Their only scientific background was their own results on root meristem inhibition in a few plant species (Tolpa and Czyżewski, 1960, 1962). However, it is just living Sphagnum herb which is today the most promising source of medicinal and economic substances. In only one publication Taskiła et al. (2016) have compiled referenced data which show different and wide applications of Sphagnum moss and its products, both potential and being implemented. These include food packaging, preservation of archaeological artefacts, surgical dressings, oil absorbents, water purification (cation exchange), functional foods, and as a substrate in bioprocesses, in medicinal materials or cosmetics, adsorption pads (hygiene), and antimicrobial additives in coating materials. Sphagnum itself can be obtained from Sphagnum herb at a yield of as much as 10 g of sphagnum form 33 g of holocellulose (Ballance et al., 2007).

Tolpa (1992) mentioned only that Polish borowina (that is, peat prepared for medical topical applications), widely known and used in Polish spas, inspired him to consider peat as a source of substances of external medicinal potential. He stated clearly: “the borowina when applied as baths, poultices, tampons etc exerts a beneficial effect in certain diseases of joints and muscles.” (Tolpa, 1992). The peat bath exerts effects on skin and wounds, as well as promoting blood circulation. These easily observable effects must have been noticed independently many a time. Tolpa was familiar with the basic chemical constitution of peat and its healing effect. He once explained: “Before application, peat is finely ground because its constituents, humic acids and various salts, are more effective when the contact area is large. A properly fragmented peat absorbs and radiates heat well, which is important in medicine. Some of our spas in Lower Silesia […] utilize ombrotrophic peats for this purpose from the Giant Mts (Karkonosze) and Izerskie Mts” (Tolpa, 1949 p. 70). It is just that he only never considered this in his research.

Uses for hygienic purposes were mentioned by Tolpa too: “slightly decayed high-moor peat is a material used in manufacturing mattresses and bedding for children and patients. Owing to the antibacterial properties of ombrotrophic peat, these products are very suitable for such applications. Ombrotrophic peat was also used for making wound dressing and bandages during wars” (Tolpa, 1949, p.74). This information is inaccurate, because, in fact, living Sphagnum herb was used (compare: Drobnik and Stebel, 2017) but correct with respect to the hygienic application of peat.

Tolpa (1982, p. 103) wrote similarly: “Our research was focused on attempts to isolate biologically active substances from humus. Their existence was supposed on the basis of the positive effects of peat bath-based therapies.” This statement concludes with Tolpa’s (1982) results on crop and livestock production obtained over the course of the 1960s and 1970s, such as increased milk yield, body mass and haemoglobin level. But none of these effects could have been attributed to peat cures which already enjoyed an established reputation in Polish spa therapies. As we learn from the conclusions of Rządkowska-Bodalska et al. (1988), the search for biologically active principles in peat failed (see chap. 6).

7.2. Criticism of the peat research methods

Exploring the beginnings and progress of the Polish research on peat, we attempted to locate as many publications as possible. Sadly, a number of conclusions repeatedly cited, apart from being very general had no bibliography. Research papers were also cited in support of statements which they failed to do or do not contain. Lastly, authors’ hypotheses were distorted or easily misused as facts. Additionally the researchers themselves also committed new mistakes in methods or reasoning.

7.2.1. The 1984 project by Kukla

For our critical comments on the Kukla’s (1984) project and sources cited therein see Supplementary Material (Table 1). Despite these issues, the fractions I and II of the peat extract, studied by Kukla (1984) were used in all further research on the peat preparation.

7.2.2. Active principle and standardization problems

Polish patent No. 168857 (Tolpa et al., 1991a) is the only source to mention that the solid preparation of peat (a final commercial drug) was sterile and stable after the NaCl had been removed by reverse osmosis. In relation to the idea that microbial metabolites determine the medicinal properties of peat and its preparations (Figat, 1991, p. 5) it should be stated that:

- Tolpa’s team had no publications to prove this thesis: microbial peat cultures were never examined, and no microorganisms were ever grown or identified to check the microbiological purity of the peat.
- TPP was not tested for the content of bacterial or fungal metabolites either.
- No comparative research was undertaken on the effect of identified bacterial or fungal substances (especially alleged enzymes and antibiotics) and on TPP as a whole. Nobody tested whether the biosimulation was exerted by microelements present in the peat.

What is more, already by the late 1950s and early 1960s, Polish science had learned a lot about the antibacterial properties of peat. Gocha and Mikołajska (1965) summarized: „Klosowska (1958) proved the antibacterial action of peats, especially those from ombrotrophic bogs, Klosowska and Pawłowska (1960) found that the inhibiting effect on pathogenic bacteria came from a non-bacterial substance and that this activity was not diminished by sterilization.” Tolpa never used these results.

In relation to the technology of TPP production, there are at least the following issues: 1) Only the geographical origin was given, no other parameters were ever specified. No earlier studies in which such parameters could be normalized or at least measured, were referenced. 2) The technology of TPP was described superficially. And, in Polish patent 167664 (Tolpa et al., 1992), the authors described only modifications of the peat extraction process.

Lastly, the methods evolved greatly during the long research programme: Tolpa (1982) admitted himself that the peat preparation obtained over 25 years (until 1982) varied. In particular, differences existed for the measured contents of Na and NaCl between Kukla (1984) and Tolpa (1982): “In our preliminary research, peat fractions used in experiments contained remarkable admixtures of mineral salts, especially NaCl, residues of humic acids, fat acids etc. Improvement in purification of the fractions made the final product more uniform […]. However, it was still an organic-mineral complex. The mineral part contained considerable amounts of Na (350–380 g/kg).”

The methods in Tolpa (1982) were different: “To obtain biologically active substances from peat, it must first be hydrolysed in alkaline and acidic conditions several times. […] After each hydrolysation, the mixture is filtered to remove unnecessary ballast substances. The filtrate is condensed by evaporation. It becomes a starting material for obtaining active fractions by means of […] organic solvents, thus enabling us to obtain peat fractions of higher or weaker biological activity. Best results were obtained with ethanol as an extracting agent.”

In view of these considerations, we should be concerned by the fact that the chemical composition of the substances A and E had never been
discovered nor related to the peat extracts produced later under the names PF 290/1 and PF 290/II. Moreover, nobody checked whether substances A and E (Fig. 1) were still present in the TPP used for clinical tests.

The chemical composition of TPP was still unknown. Apart from the data cited in Chapter 5.3.2, no more complex compounds were isolated in order to be tested in a pure state. On the contrary, Tołpa and Czyżewski (1962) claimed that “the extract was regarded as a whole and was not fractioned into classical fractions such as fulvic acids, humic acids”.

Kukla (1984) added nothing on the composition of active principles despite the title of his work. He seemed to study active substances present in various kinds of peat (but in fact he studied fractions of peat extract of unrecognised and unmeasured composition). However, Kukla (1984) took a critical view of the possibilities of peat substances as candidates for medicinal use. His work, issued in only 382 copies, remained unknown or was ignored by further researchers. Kukla included many cautious conclusions and caveats, but he committed new mistakes both in methods and in discussion of own results.

The final conclusion of pre-clinical tests was that TPP was a non-toxic and well-tolerated immuno-modulator (Mikołajczyk, 1990; Tołpa, 1992). Pre-clinical tests neither confirmed nor undermined the alleged anti-cancer properties (see Chapt. 7.2.3). These became the aim of clinical tests (Mikołajczyk, 1990) as was evident from most of the papers published in 1993.

7.2.3. Dispute of antitumorous properties

Although Tołpa (1992) himself wrote: “In 1981/82 the preparation obtained from peat was admitted for screening tests […] as a part of a government programme […] This study was based on a method used for evaluation of cytostatics, despite my fundamental objections that the peat preparation was not a cytostatic drug”. On the other hand, he repeatedly mentioned that studies on cancer treatment in animals were carried out. Moreover, Ilnicki (1997) cited patent “P.201.762 by Tołpa, Kukla, Rzadkowska-Bodalska, Olechnowicz-Stepień, Czyżewski, Adamek, Dec, Dudek, and Wróbel-Pieciewicz entitled A method of production of an anti-cancer preparation from an acidified alkali hydrolysate of peat. A patent with this number or title is, however, absent from databases.

In another Polish patent, No. 158565 (Dziegielewski et al., 1989), entitled Method of obtaining a biostimulator from peat, there is the statement: “In the literature, there is a method of isolating from peat a mixture of polysaccharides possessing anti-cancer properties. It is based on the extraction of peat material with an aqueous solution of NaOH, removing from the extract some impurities in the acidic environment, and then dialysis and chromatography (Chem. Abstr. 1974; vol. 80, 41027 j).” The referenced source is invalid as a basis for this statement. Anti-cancer action was not proved in it.

Karmańska et al. (1983) referenced the Tołpa et al. (1982) article in claiming that TPP was an anti-cancer drug, but this source was a brief conference abstract from which any data or bibliography were missing!

Moreover, according to Figat (1991, p. 10), Polish researchers commissioned TPP tests in the late 1980s “in some research centres in the USA”, having informed them first, that “in many patients the development of cancer cells had been inhibited by the Tołpa preparation.”

Any Polish or American publications which would precede, announce or conclude such research are missing. Figat (1991) wrote only that: “In Bloomfield in Alta Cell Corp., they tested the action of TPP on 5 human neoplastic cell lines in vitro. […] TPP acted on these cells mainly via the immune system, that is, indirectly. […] At the University of Illinois […] a modulatory and activating influence on the immune system cells was confirmed.” (Figat, 1990 p. 10). This excludes any cytostatic or cytotoxic action.

7.2.4. The 1992 memoir by Tołpa

The 91-year old Tołpa wrote his 1992 article as a history of the research on TPP. We used his ultimate publication as a review source. It was released just before the completion of Polish clinical tests on TPP (see chapt. 5.3.5). In the Supplementary Material (Table 2) we provided comments on the problem of scientifically unreferenced statements about peat which were cumulated in this memoir.

7.3. Social reception: birth of the legend

The influence of the reputation of TPP was strong. It reached the media in the late 1980s, especially the news on it as a possible cancer cure. Despite scientific objections (see Chapter 7.2.3), many statements from that time have been carelessly repeated in interviews and memoirs.

Tołpa was truly possessed with the idea of finding a medicinal substance which would make the peat a remedy (for internal or intravenous use). He admitted: “I often heard: «Dear Professor, how did you happen to seek drugs in all this bog?» [I answered that] one day people will not only take peat baths as I will retrieve fractions of peat which will rapidly cure many of their ailments.” (Figat, 1991).

For source quotations from the popular Polish press see Supplementary Material part 3.

8. Further development

Addressing the information on crural ulcers with patent No. 169544 (Tołpa et al., 1991b) we notice that the commercial TPP gels and ointments mentioned there, were compound preparations which contained other medicinal ingredients: extracts from Aesculus hippocastanum cortex and Calendula officinalis flowers. These are known to improve capillary and skin microcirculation. The patent could not justify the medicinal action of pure TPP.

In our opinion, the public acclamation which accompanied the introduction the Tołpa preparation into medical practice was induced by the expectations of the Polish government. In a near bankrupt country following the 1989 collapse, the state provided a vast subsidy in zlotys and dollars. The authorities demanded success which would make Poland famous and support the state expenses. The mechanism had another consequence too: according to Tołpa (1992) “… the Ministry of National Education, responding to pressure exerted by public opinion and the mass media, especially the Wroclaw TV Centre, provided the researchers with considerable financial support”. The researchers themselves also needed success.

But renown came prior to success. For example, Figat (1991, p. 7) had already called TPP a success of Polish science. Social expectations were also raised in 1989 after an investor was found who was ready to bear the risk of launching production and financing further research.

In conclusion, research on the medicinal properties of peat and seeking biologically active substances in it seem to have been inspired only by the Prof. Tołpa’s personal belief. He expressed it in a short sentence, quoted many times: “I will bring to light peat fractions which will cure the patients faster and will remedy many diseases.” (Figat, 1991).

Today, TPP is not an ingredient of any remedy. But in Poland a variety of cosmetics which contain peat are on offer. They include: stomatology gels, ointments, pastes for poultices, toothpastes, creams, bathing emulsions, shampoos and peat briquettes (Drobnik and Latour, 2011). The medical actions of humic substances (the constituents of peat, including horowina) have been recently reviewed by Klöcking and Helbig (2005). They concluded these materials did possess anti-inflammatory and oestrogenic activity.

9. Final comment

TPP should be classified among scientific hoaxes. Its impact in Poland was large: it embraced hundreds of thousands of people (the exact number today is inestimable) including the higher levels of
government.

The hallmark of the TPP “research” was basically lack of any scientific dispute, and the whole “legend” of old, poor though unremitting Tolpa and his drug was disseminated by word of mouth, in typescripted reports, in unauthorized package leaflets describing the application of TPP-based remedies, and, in some extent, by media. This caused the story of TPP to differ from famous scientific hoaxes of the late 1980s such as the water memory and the cold fusion. The problems of those alleged discoveries were widely debated in the scientific literature (supporters of those hypotheses still exist) but they had no social impact. Conversely, the history of TPP is virtually unknown or forgotten in scientific circles but it had a huge effect on patients.

The Polish career of TPP was facilitated by the social popularity of peat baths. The medicated peat (borowina) is commonly regarded here as a safe and multidirectional remedy, and in addition is commonly linked with folk (or at least natural) medicine which has always been highly esteemed in Poland. This way, both the confidence to TPP and the therapeutic expectations were continuously increasing. The TPP creators and researchers have never denied the alleged link between borowina and TPP. Contrary, in some of their comments they seemed to take advantage of the fame of borowina and the authority of ethnomedicine to better promote the alleged TPP invention as a potential drug.

Our review is the first attempt to shed light on the true story of TPP with a special view to the researchers who study the natural medicines.

The activity of the Tolpa Laboratory of Peat Biology and Biochemistry between the years 1972 and the early 1990s remains a big and still unresolved mystery. This long period saw only a few published papers or brief communications, which missed reliable scientific data.

Even later, no clinical case reports or medical records were ever published. No scientifically valid case of the use of TPP in treatment of any patient was ever released either. This makes our assessment of the whole story of TPP even more negative.

The pressure of publishing in those times was not the same as it is now. The TPP research results were likely to have a form of simple reports and were sent to funding institutions. Would the potential retrieval of them change our today's view of the history of TPP? That hardly seems likely because, as we have shown, the published content, even the patents which undoubtedly capped the substudies, were in many cases superfluous, inconsistent or chaotic, or missed crucial research data.

A separate matter is the moral aspect of the TPP-based therapy. The scientists who had no reliable clinical or preclinical proofs of anticancer remedy arrogated themselves to a discovery of such a drug. They pretended to possess or seek such results and this pose attracted a lot of social attention and high hopes. Tolpa had a good feeling of the public opinion and of the expectation of the market (all this was well reflected in his words which we have quoted) which all is scandalous. A diagnosis of a neoplasm condition has always been causing fear of suffering and discomfort of treatment in patients. How many patients who saw an alternative in the Tolpa’s marvellous drug had neglected the conventional treatments for the TPP? These questions will remain unanswered, but the implications of such dramatic choices seem obvious.

10. Conclusions

1. Treatment using peat as a remedy was launched in the 1820s in Austria, and quickly became popular there and in the then Austro-Hungarian empire. First, Austrian physicians designated a number of external treatments for skin and rheumatic diseases. Then local investors, including physicians and even farmers, organized simple spas in the countryside, where they offered peat baths to the visitors. At least in Austria it gave birth to a new therapeutic method associated this way with a folk medicine. Around 1850 medicinal peat baths became a novelty in spa resorts. Independently, in 1882 Germany, peat and soon Sphagnum herb were applied as a dressing material because of their good absorbent properties. Antiseptic action was confirmed in the 1900s.

2. The external action of peat on the human body had been well described and fully studied by the middle of the 20th century.

3. The idea of using peat or peat-based preparations as internal remedies dates back to the beginning of the 19th century when drinking peat bog water was proposed for some lung conditions. Unlike external applications it never produced visible effects and passed into oblivion.

4. Tolpa and his research team missed the historical ethnobiological data about external and topical actions of Sphagnum peat or its preparations which were published in the 19th- and early 20th-century literature. This is strange because folk medicine based on peat emanated eastwards from ethnic Austria along the Vistula river and the Carpathians. Tolpa ignored balneological (external) applications (though he knew that Sphagnum-peat was used in Polish balneotherapy), and he also rejected this kind of peat, based on a single test of a limited scope on root tip inhibition in Sinapis alba L.

5. The concept of an active principle in peat or its preparations evolved, and speculation concerning the nature of this compound was not followed by adequate basic research. The substance was neither sought nor found.

6. The research projects were chaotic and poorly substantiated, based on poor or erroneous reasoning. Results concerning plant meristem growth were too readily applied as hypotheses in animal production, veterinary and human medicine.

7. The natural ingredient (raw material) in TPP production was never defined botanically (taxonomically); in geological terms the only hint was that it was rhetropeptic peat from specified locations in Poland. Thus nothing more precise than its position in peat classification and the geographical origin of the raw peat material were specified to define and standardise the drug. The places of origin also differed in various studies.

8. Descriptions of peat extracts, chemical instruments and apparatus were poorly designated and published only in patents from the 1980s. Polish publications mentioned only the methods relating to these patents, whereas in fact a whole sequence of methods (or undocumented oral tradition) must have existed because the production centre was just a single laboratory. Besides, the methods used by the Tolpa team evolved over time.

9. Similarly, in the patents of 1980s, preliminary clinical results for various diseases were mentioned, but no references were provided.

10. Outpatient treatment of volunteering patients was held before the TPP became official, and the results were not documented (or at least never published). Such experimental therapy was practised illegally by non-physicians.

11. Tolpa's (1992) paper revealed important gaps in knowledge of chemical, pharmacological and clinical topics, although it was a summary written by the best specialist on peat research in Poland.

12. Citing imprecise or false results from publications was common practice during TPP research.

13. The only international publication on the anti-cancer effect of peat remedies by Tolpa et al. (1982) was in fact an abstract with neither references nor shortened results provided. Later, this source was cited only for its title which was treated as a documented and proven scientific fact.

14. In the 1980/1990s, clinical tests on TPP were performed with the aim of finding its effects in all major branches of therapy, but no breakthrough uses were discovered.

15. Snippets of information, undocumented by publications, could only feed social expectations towards TPP in Poland. A remedy made of peat became official conditionally and for a limited time in the early 1990s, and was then withdrawn from the market owing to either the abandonment of clinical tests or the procurement of unsatisfactory results. But the legend survived in popular memory
even to this day.

16. Proponents of the peat preparations (the patients) referred to the data and facts published in press interviews and reports (this was an example of the so-called viral phenomenon).

17. The failure of Tolpa's whole project was due to the fact that the prolific output on peat properties was either ignored or just rejected by Tolpa. This could have been the result of his uncritical approach and his belief in success, rather than his intention of creating a new path in peat research.

18. Had Prof. Tolpa known the history of peat application in the 19th century, he would have directed his research efforts to other areas, e.g. external remedies.

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Appendix A. Supplementary data

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