

The pomological collection – apple and pear trees at the Arboretum and the Department of Physiography in Bolestraszyce

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Abstract

The pomological collection was established in the late 1980s by Jerzy Piórecki to preserve and protect old varieties of fruit trees. The starting material for setting up the apple tree collection came from old orchards that had survived in south-eastern Poland and from the nearby border regions of Ukraine. The collection also includes varieties from the Botanical Garden of the Polish Academy of Sciences in Warsaw. In 2002, Narcyz Piórecki began working on the pear tree collection and under his leadership, an inventory was carried out in the Podkarpackie Province. At the same time, they gathered a selection of material for grafting old pear varieties. In 2004, the pomological collection was incorporated into the National Centre for Plant Genetic Resources in Radzików. Currently, the Bolestraszyce orchards have a collection of 1,370 apple trees and 632 pear trees over a total area of 8 ha. 400 apple trees are growing on the newly established area at Cisowa. In order to popularize the old varieties of fruit trees, the Arboretum conducts a number of promotional and educational activities. There are open-air events, workshops, lectures, fruit exhibitions combined with tastings, films available on the website, and published information folders. To the same end, traditional and regional products are made according to traditional recipes from fruits of different varieties. In order to evaluate the ecotypes and varieties of the Bolestraszyce collection and the suitability of selected fruits for processing into specific products, laboratory tests were carried out at the Department of Fruit, Vegetable and Nutraceutical Technology of the Wrocław University of Environmental and Life Sciences. The research was conducted in cooperation with Alicja Kucharska. Between 2013–2020,

the laboratory tested 141 ecotypes and varieties of pear and apple fruit, as well as many products produced in the Arboretum, such as juices, vinegars, and pickled apples in cabbage. The content of dry matter, extract, sugars, organic acids, pectin, ash, vitamin C, polyphenols (anthocyanins, phenolic acids, flavanols, procyanidins, dihydrochalcones), carotenoids and triterpenes was determined in the fruits and products, and the anti-oxidation properties were assessed by three tests: DPPH, ABTS and FRAP. The research has shown there is a wide variety of raw materials and high value products made from the most interesting fruits from the Bolestraszyce collection. The research has identified the most interesting forms which make good material for the registration of cultivars and are worth promoting, especially among local recipients.

Key words: pomological collection, apple trees, pear trees, Bolestraszyce Arboretum, genetic resources

The protection of biological diversity in Bolestraszyce Arboretum comes in the form of various productive plant collections; among them the pomological collection. This was established by Jerzy Piórecki in order to protect and preserve historical varieties of fruit trees. The collection mainly consists of apple and pear trees, cornelian and wild cherry and other less known trees and shrubs which have edible fruits. This article presents a part of that collection – the apple and pear trees.

The catalyst to setting up the pomological collection in the Bolestraszyce Arboretum comes from the old orchards that survived in south eastern Poland and the nearby regions of Ukraine. As the discussed location is not a typical orchard region, large-area commercial orchards with low diversity of varieties were not established. The only ones still present to today are the garden and old manor-house orchards that have a wide range of varieties. In terms of these orchards, the ones that deserve attention are the orchard from the 1930s in Bzianka near Brzozowo and the orchard from the same period in Bybło, Ukraine (Piórecki and Żygała 2008a, 2008b, 2008c, 2016, Żygała et al. 2011). Many trees were discovered in towns which no longer exist, having been deserted after World War II.

Unfortunately, in the case of both garden and old manor-house orchards, there have been many examples of their total destruction, with that, the irreversible loss of old varieties (Fig.1).

HISTORY OF THE COLLECTION

Field research began in the Bolestraszyce Arboretum in the 1980s and, from 1986, was conducted as a research topic: *Establishing a national collection of endangered species with particular emphasis on wild and primary forms of fruit trees and shrubs*. This was also the subject of the Central Programme of Fundamental Research of the Polish Academy of Sciences (PAN): *Collecting and preserving species of the domestic collection of endangered plants and the primary forms of commercial plants*, which ran from 1986-1990, coordinated by the PAN Botanical Garden in Warsaw. In this period there was intensive field work in south-east Poland. The results showed that over 80 species of apple trees are present in the Przemyśl region (Piórecki 1992).



Fig. 1. A manor-house orchard in Bzianka established in the 1930s, 2006, photo N. Piórecki

Establishing the first orchard collection on land belonging to Bolestraszyce Arboretum, now known as the “Jerzy Piórecki Orchard”, began in the late 1980s. The propagating material for its foundation was collected by Jerzy Piórecki during many field trips. Complementary plantings took place as late as autumn 1991 and spring 1992; these were trees transferred from the PAN Botanical Garden in Warsaw. In the “Jerzy Piórecki Orchard” the plantation consisted of 554 apple trees, 18 pear trees, 163 wild cherries and 12 hazel on an area covering 1.8 hectares. Apple and pear trees were planted 5m x 5m apart, cornelian

cherries in rows every 3 metres, wild cherries 5m x 3m apart and the hazels in one row, 3m apart. (Fig. 2).

In 1997, another apple orchard was established in Bolestraszyce — the “New Jerzy Piórecki Orchard” — where 395 apple trees were planted on an area of 1.5 hectares 7m x 8m apart. The saplings came from the PAN Botanical Garden in Warsaw and were also acquired during a field trip in Slovakia in 1995, led by Marta Dzubiak; the curator of the PAN Botanical Garden pomological collection in Warsaw at the time. These types of orchards were systematically supplemented by subsequent species, obtained during field surveys and through grafting in nurseries at Bolestraszyce onto the “Antonówka” variety (Fig. 3).

In 2009, 90 apple trees were planted in the “Behind the Fort” orchard from material collected during an inventory of old apple trees in the Podkarpackie voivodeship.

In 2011, the “Kresy” (borderlands) apple orchard was created on area of 1.2 hectares with 381 apple trees (Fig.1). The necessary materials were collected in the western part of Ukraine as part of the project “Survey and preservation of the diversity of old varieties of fruit trees in Eastern Galicia”, implemented in collaboration with the Botanical Garden of Lviv National University. The project was led by Narcyz Piórecki with the support of Ewa Antoniewska, Dagmara Lib, Eligiusz Rybienik and Elżbieta Żygała.



Fig 2. The Jerzy Piórecki Orchard, 2020, photo N. Pióreck



Fig. 3. The New Jerzy Piórecki Orchard, 2018, photo N. Piórecki



Fig. 4. The “Kresy” Orchard just after its establishment in 2011, photo N. Piórecki

Attempts to establish apple tree collections were also made in the Arboretum in Cisowa. The first was founded in 1998, followed by others in 2002 and 2016. Due to the damage caused by wild animals they ended up failing. In 2019 preparatory work began again (fencing, mulching) and, in the autumn of 2020, a two hectare orchard was established with 400 apple trees.

In 2002, Narcyz Piórecki began work on another pear tree collection and, under his management, a survey was conducted across the Podkarpackie voivodeship alongside the collection of grafting material for old varieties of pears. Already by 2004, the first site, called the “Pear Orchard” (0.5 hectares) was established with 186 pear trees. The next pear orchard, the “Orchard below the Fort”, covering 1.8 hectares, was founded in 2007 with 283 trees. In 2009, a third pear orchard, “Behind the Fort”, was established on an area of 1.2 hectares, with 186 pear trees. (Fig. 5).

Currently, the Bolestraszyce orchards have a combined area of eight hectares, with 1370 apple trees and 632 pear trees, with a further 400 apple trees on 2 hectares in Cisowa. Among the varieties found at the Arboretum are those known from, and described in old pomological textbooks; varieties/cultivars formerly cultivated on Polish territory as well as in other European countries. The Bolestraszyce collection also consists of especially valuable local varieties/cultivars which are not widely known or are completely unknown to pomologists and fruit farmers, and yet are very well adapted to the local soil and climate conditions. The permanent identification and verification has succeeded in determining the name of 90 varieties of apple trees and 12 varieties of pear trees.



Fig. 5. The “Pear Orchard below the Fort” shortly after its establishment in 2007 and 2020, photo N. Piórecki

A list of designated apple varieties/cultivars in the Bolestraszyce Arboretum collection:

‘Ananas Berżenicki’, ‘Antonówka’, ‘Antonówka Kamienna’, ‘Bankroft’, ‘Beforest’, ‘Beleur Kitajka’, ‘Bernier Rose’, ‘Boiken’, ‘Bukówka’, ‘Cesarz Aleksander’, ‘Cesarz Wilhelm’, ‘Charłamowskie’, ‘Cukrówka Litewska’, ‘Cytrynówka’, ‘Czeskie Panieńskie’, ‘Doneszta’, ‘Dr Oldenburg’, ‘Fameuse’, ‘Geflamter Cardinal’, ‘Glogierówka’, ‘Gloria Mundi’, ‘Grafsztynek’, ‘Grafsztynek Czerwony’, ‘Grafsztynek Inflancki’, ‘Grochówka’, ‘Gruszówka’, ‘Gustawa Trwałe’, ‘Inflancka’, ‘Jabłko Gruszkokształtne’, ‘Jakub Lebel’, ‘Jonatan’, ‘Kalwilla Badeńska’, ‘Kalwilla Biała Zimowa’, ‘Kalwilla de Saint Sauveur’, ‘Kalwilla Jesienna Czerwona’, ‘Kalwilla Letnia Fraasa’, ‘Kandil Sinap’, ‘Kantówka Gdańska’, ‘Kardynalska’, ‘Kardynalskie Płomieniste’, ‘Kazachstanskoje Jubilienzoje’, ‘Koksa Pomarańczowa’, ‘Koricznoje Połosatoje’, ‘Kosztela’, ‘Kronselska’, ‘Królowa Renet’, ‘Krótkonóżka Królewska’, ‘Księżna Luiza’, ‘Lanes Prince Albert’, ‘Manks Küchenapfel’, ‘Malinowa Oberlandzka’, ‘Mecaun’, ‘McIntosch’, ‘Mohringer Rosenapfel’, ‘Niezrównane Peasgooda’, ‘Ohm Paul’, ‘Oliwka Czerwona’, ‘Ontario’, ‘Pepina Linneusza’, ‘Pepina Szafranowa’, ‘Piękna z Boskoop’, ‘Piękna z Rept’, ‘Pepina Parkera’, ‘Polskie Mnichy’, ‘Queen’, ‘Rajewskie’, ‘Rajok’, ‘Rapa Zielona’, ‘Rarytas Śląski’, ‘Reneta Herberta’, ‘Reneta Kanadyjska’, ‘Reneta Kulona’, ‘Reneta Kurska’, ‘Reneta Landsberska’, ‘Reneta Osnabrück’,

Type of orchard	Apple orchards						Pear orchards			
Fruiting	Fruit bearing		Non-fruit bearing			Total	Fruit bearing	Non-fruit bearing		Total
Date established	1986–1991 "Jerzy Piórecki" (Old orchard)	1997 "New Jerzy Piórecki" (Orchard below the fort)	2009 "Orchard behind the Fort"	2011 "Kresowy" Orchard (the Ukrainian Orchard)	2020 Orchard in Cisowa		2004 "Pear Orchard"	2007–2009 "Orchard in front of the Fort"	2009 "Orchard behind the Fort"	
Number of trees	520	391	78	381	400	1770	169	283	180	632
Number of examples ¹	520	391	35	202	400	1548	80	133	100	313
Number of designated examples ²	233	152	0	56	0	441	20	27	7	54
Number of	287	239	35	146	400	110	60	106	93	259

non-designated examples						7				
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‘Reneta Szara Jesienna’, ‘Reneta Woskowa’, ‘Reneta Złota’, ‘Roter Bellefleur’, ‘Rumianka Ałmatinskaja’, ‘Ryszard Żółty’, ‘Sałtanat’, ‘Signe Tillisch’, ‘Spartan’, ‘Starking’, ‘Sinap z Ałma Aty’, ‘Szara Reneta Francuska’, ‘Sztetyna Czerwona’, ‘Sztetyna Zielona’, ‘Titówka’, ‘Truskawkowe Nietschnera’, ‘Wargul Woroneżski’, ‘Winter Banana’, ‘Zailijskoje’, ‘Zorza’, ‘Żeleźniak’.

A list of designated pear varieties/cultivars in the Bolestraszyce Arboretum collection:

‘Bera Boska’, ‘Bera Diela’, ‘Bergamota Letnia’, ‘Cukrówka’, ‘Dobra Szara’, ‘Dr Jules Guyot’, ‘Dziekanka Lipcowa’, ‘Faworytka’, ‘Józefinka’, ‘Konferencja’, ‘Paryżanka’, ‘Pruchniczanka’. Since its creation, the caretakers of the pomological collection at the Arboretum in Bolestraszyce have been Krystyna Jarosińska (1987-1989), Kazimierz Radochoński (1990-1994), Grzegorz Poznański (1995-1997), Tadeusz Rusinowski (1998-2000), Elżbieta Żygała (2001 to date).

Table 1. Characteristics of the apple and pear orchards from the Bolestraszyce Arboretum pomological collection (as of 2020)

¹ varietal example – a donor of genetic material found in the field

²Number of designated examples - those with a **varietal/cultivar** and verified name in fruit-bearing orchards or a **varietal/cultivar** name established in the field in non-fruit-bearing orchards

In 2004, a geodetic survey took place where every tree in the orchard was given an inventory number along with information such as place of origin, date of collection, date of introduction to the collection, and the name of the variety/cultivar. This information was then entered by Dagmara Lib into the Arboretum’s database of dendroflora (Fig.6).

COOPERATION WITH THE NATIONAL CENTRE FOR PLANT GENETIC RECOURCES IN RADZIKÓW

The pomological collection was developed as a statutory activity from its own financial resources. In 2004 it was incorporated, as a field collection, into the National Centre for Genetic Resources in Radzików (KCRZG). From that moment research and work related to preserving the collection have been partially financed by the Multi-Annual Ministry of Agriculture and Rural Development. Accordingly, between 2004-2007, on the basis of agreements concluded with the Plant Breeding and Acclimatisation Institute in Radzików, a research project entitled in situ and ex situ protection of old fruit trees in Podkarpackie voivodeship was implemented. As part of the task the botanical and functional characteristics of genetic samples of utility plants and their pathogens were catalogued, evaluated and characterised ex situ, along with in situ field cataloguing and observations of individual varieties/cultivars. Since 2015, the research service “Maintaining the collection of old varieties of fruit trees at Bolestraszyce” has been run on the basis of contracts concluded with the Institute of Horticulture in Skierniewice, also within the framework of the Multi-Annual Programme.

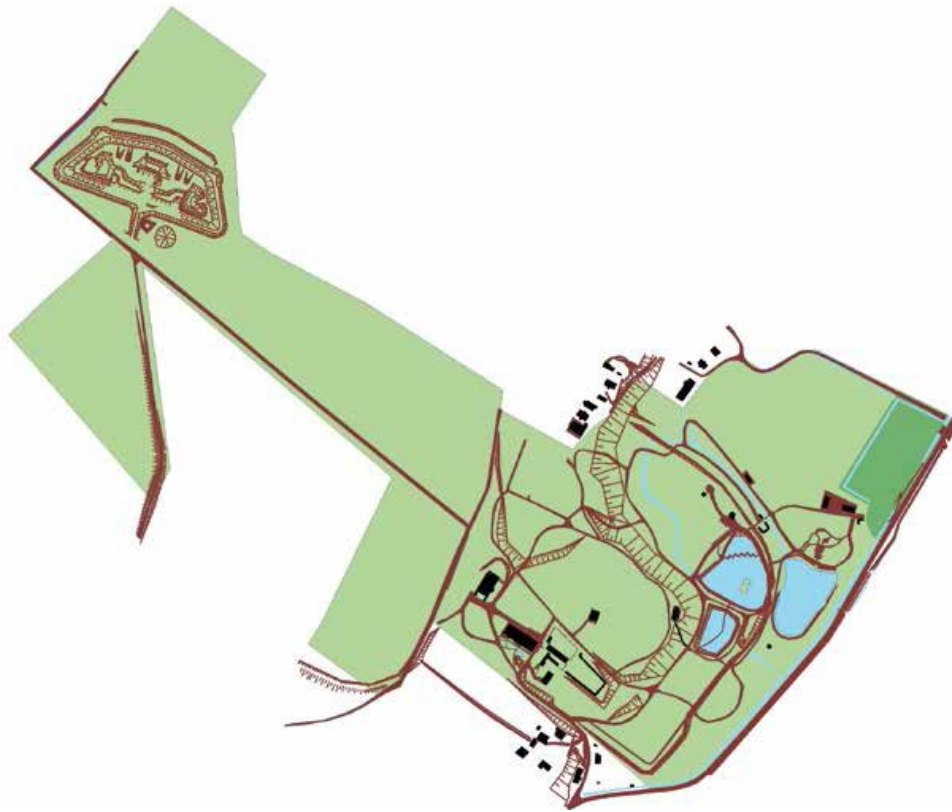


Fig. 6. The pomological collection of the Bolestraszyce Arboretum. 1. The Jerzy Piórecki orchard, established between 1986-1991, 2. The New Jerzy Piórecki orchard (1997), 3. The pear orchard (2004), 4. The Orchard below the Fort (2007-2009), 5. The Orchard behind the Fort (2009), 6. Experimental Cornelian cherry orchard (2009), 7. The collection of trees and shrubs with edible fruits (2010), 8. The “Kresy” Orchard (2011).

Since 2004, systematic observations have been conducted on the flowering, fruiting and disease-susceptibility of individual examples in the collection and, since 2008, their characterisation in terms of botanical and functional characteristics. Fifty-nine characteristics were observed annually for selected examples from the collection: 14 tree traits, 10 shoot traits, seven leaf traits, five flower traits and 23 fruit traits. To date, characterisation of botanical traits has been completed for 517 apple trees and 46 pear trees. The identification of varieties, both those bearing fruit and those just entering the fruiting period, is systematically carried out.

Determining the correct variety name presents many difficulties. For this purpose, the descriptions contained in the following publications are used: Lichański (1903), Hrebnicki (1903-1906), Brzeziński (1929), Paschkiewitsch (1930), Simirenko (1961), Rejman (1976),

and pre-war horticultural magazines and catalogues and price lists from nurseries in former Galicia. It is also very helpful to search for archive material, which is used during fieldwork as well for identifying various varieties (Żygała et al. 2011, Żygała 2018).

Field surveys of surviving old apple and pear trees continue, providing an insight into the surviving stock, as well as for collecting material to augment the collection. Every year, reports are prepared and submitted on the observations made, botanical characteristics, work carried out in the collection and in the field. Information from the database maintained at the Arboretum is compiled and, as passport data, transferred to the database managed by the KCRZG in Radzików, and then made available through the EGISET system for access to the genetic resources of useful plants.

In addition, within the framework of the Programme for the Protection of Cultural Heritage Abroad, financed by the Ministry of Culture and National Heritage, research on natural and cultural heritage in the field of historic park and garden layouts, including preserved manor orchards, was carried out in 2013-2019 through the project “Inventory of Garden Layouts in the Former ‘Kresy’”.

EDUCATION AND PROMOTION

For promotional purposes, fruit from individual species and varieties are presented during various events organised at the Arboretum, such as the *Majówka pod dereniem i jabłonią* (May holiday under the cornelian cherry and apple trees) and the *Festiwal derenia jadalnego* (Festival of edible cornelian cherry), as well as during regional horticultural and food fairs. Fruit exhibitions are combined with fruit tasting (Fig. 7). To disseminate knowledge about old apple varieties, a catalogue of varieties (Żygała and Piórecki 2014) and a calendar for 2019, with drawings and descriptions of varieties from the collection, have been published.

An important and popular element of the Arboretum's activities, popularising pomological knowledge, are the workshops and training courses held in the orchards at Bolestraszyce, as well as in the most interesting preserved historical fruit orchards in the Podkarpackie Voivodeship.

A series of workshops were held in cooperation with the ‘Dziedzictwo Przyrodnicze’ Foundation on the care and identification of old varieties of fruit trees, as well as the grafting of fruit trees. Similar activities have taken place in the Jawornik Polski district in cooperation with the ‘Tradycyjna Zagroda’ Foundation, where apple tree varieties in old orchards were identified; these are to become elements of the planned cultural and natural history trail.

In recent years, a series of workshops have also taken place in Magurski National Park (MPN), focusing on the identification of old varieties of apple trees in the orchards located in the park's buffer zone. These entail practical lessons on grafting fruit trees and principles of care for old, neglected orchards. In cooperation with the Podkarpacki Ośrodek Doradztwa Rolniczego (Podkarpackie Agricultural Advisory Centre), training courses and workshops have been run on the identification of old varieties and the establishment and management of a traditional orchard (Fig . 8).



Fig.7. Exhibition of fruits from the Bolestraszyce collection, photo N. Piórecki

Within the framework of cooperation with Wrocław University Botanical Garden, several editions of the “*Smak zapomnianych odmian jabłek*” (The taste of forgotten apple varieties) outdoor event have been organised there.

Participation in various working meetings with pomologists dealing with old varieties allowed for the exchange of experience and broadening of knowledge in this field. These included the annual "*Środkowo-europejskie Dni Pomologów*" (Central European Pomological Days) in Mużaków, Bad Muskau, Germany, as well as "EUROPOM 2017" in Olomouc, Czech Republic, and "Fruits et Nature en Revermont 2018" in Burg, France.

PROMOTIONAL PRODUCTS

As there is limited knowledge about old varieties and especially knowledge of their suitability for processing, it is difficult to determine which varieties are most suitable for which type of processing. Some information can be found in old publications, but only after performing our own trials with selected varieties can we speak with certainty about suitability for processing. Through our own experience, we have developed expertise about which varieties are suitable for producing traditional products that take into account modern tastes. Our practical work has made it possible to select varieties that are particularly suitable for the production of specific preparations, i.e., for cold-pressed, unfiltered juices — ‘Kandil Sinap’, ‘Boiken’, ‘Grochówka’, ‘Kosztela’, ‘Różanka Berneńska’; for drying, due to its spicy aroma — ‘Szara Reneta Francuska’, ‘Pepina Parkera’; for whole fruits in pickled cabbage on account of their flavour — ‘Pepina Parkera’ i ‘Reneta Kanadyjska’; for candying, because its flesh doesn’t break down — ‘Jonathan’; for vinegars, because of its light smooth skin — ‘Cytrynówka’; and finally, for jams, given their taste and texture — ‘Krótkonóżka Królewska’, ‘Piękna z Boskoop’ and ‘Reneta Kulona’.



Fig. 8. **Variety** recognition workshops in Bolestraszyce orchards, 2018, photo Arboretum Bolestraszyce

In the coming years, it is planned to continue work on testing the suitability of the varieties in the collections, including the valuable local varieties. Work has also begun on using old, local recipes to produce a product that was known and produced traditionally in the Podkarpackie region (Żygała et al. 2014). Experiments were conducted on the production of fruit vinegars (apple vinegar 2014, pear vinegar 2017 or cornelian cherry vinegar 2017). The result of this work was Anna Łocha's use of an old, local recipe for pickling whole apples in cabbage.

The first pickling took place in 2013 and the fruit was destined for tasting during the first edition of the open-air event — *Majówka pod dereniem i Jabłonią 2014* — organised during the apple blossom season in the 'Jerzy Piórecki Orchard'. The product was prepared annually for tasting during *Majówka* and also as a promotional product at various fairs, exhibitions and competitions. In July 2019, the Bolestraszyce Arboretum won first prize for its apples pickled in cabbage in the "*Nasze Kulinarne Dziedzictwo – Smaki Regionów*" (Our Culinary Heritage – Regional Flavours). The competition was organised by the Polish Chamber of Regional and Local Produce and the prizes were awarded by the Marshal of the Podkarpackie Voivodeship (Fig. 9-10).

Noteworthy among the pears is the large-fruited 'Guyot' variety which ripens in September and which can be used to make pears in syrup, the local 'Panienka' (Brzeziński 1929) variety, which ripens in August and is excellent for drying. The highly aromatic summer variety 'Dobra Szara' is also suitable for drying, as well as for cold-pressed juices. In the Pruchnik area, the very prolific local 'Pruchniczanka' (Piórecki and Żygała 2007) was found, which is known as a variety for preparing pears in vinegar.

RESEARCH - FRUITS

Among the biologically active compounds determined were polyphenols [219.9 (ecotype 13901) — 1081.7 mg/100g dry mass (d.m.) (ecotype 1966)], triterpenes — compounds found in the waxy layer on the fruit skin [442.3 (ecotype 13941) — 3033 mg/100g d.m. m. (ecotype 1966)], carotenoids found mainly in the skin [23.6 (ecotype 13946) — 156.3 mg/kg d.w. (ecotype 2015)] and chlorophylls also found mainly in the skin [22.9 (ecotype 1994) — 119.1 mg/kg d.w. (ecotype 2015)]. In all the pears studied, ursolic acid was the main triterpene (accounting on average for 72% of all tri-terpenes), followed by oleanolic acid (mean 19%) and betulinic acid (mean 9%). Among the carotenoids, 9-cis--carotene predominated, while chlorophyll A was the predominant chlorophyll. Three in vitro tests were used to assess the antioxidant properties of the pears: two tests based on measurements of the DPPH and ABTS radical scavenging capacity and one test based on the measurement of ferric reducing power (FRAP). The antioxidant potential, as well as the content of bioactive compounds of the pears tested, depended significantly on the ecotype.



Fig. 9. First Prize in the "Nasze Kulinarne Dziedzictwo - Smaki Regionów" competition for apples pickled in cabbage, photo Bolestraszyce Arboretum



Fig. 10. Apples pickled in cabbage, photo Bolestraszyce Arboretum

Of all the pears, ecotype 1966 was distinguished by the highest antioxidant potential, as well as the highest content of polyphenols and triterpenes. The results of the above research were presented at the VII International Conference "Quality and Safety in the Food Production Chain" in Wrocław (23-24.06.2016) and published in the conference materials (Kolniak-Ostek et al. 2016).

In the following year (2016), the physicochemical diversity of 44 ecotypes and varieties of pear fruit was assessed as part of a master's thesis. On the basis of the study, it was observed that the fruits were characterised by high variability in terms of both physical and chemical properties. Fruit weight ranged from 30 g (ecotype 2022) to 256 g (ecotype 13937), length from 40 mm (ecotype 1937) to 89 mm (ecotype 13937), and width from 37 mm (ecotype 2022) to 76 mm (ecotype 13937). The contents of sugars, pectin and ash, the mineral compounds, were at levels of: 4.8% fresh weight (f.w.) (ecotype 13200) - 12.0% f.w. (ecotype 13290), 0.5% f.w. (ecotype 13935) - 1.5% f.w. (ecotype 13844) and 0.2% f.w. (ecotype 13918) - 0.6% f.w. (ecotype 13263). Among sugars, fructose was the highest (3-10% a.m.), followed by sucrose (up to 4% a.m.) and glucose (up to 3% a.m.). Total acidity was not high, ranging from 0.12% f.w. (ecotype 13200) to 0.82% f.w. (13290) in terms of malic acid. The vitamin C content of the fruit was low, ranging from 0.6-5.3 mg/ 100 g b.w. Analysis of the results of the antiproliferative activity showed that pears with red skin had higher activity than those with green or yellow skin. The pear trees harvested at the Arboretum in 2017, as was the case with the fruit from the 2016 harvest, showed great diversity in morphological, chemical and antioxidant properties. It was additionally observed that the fruit of the ecotypes and cultivars studied in the two consecutive seasons were characterised by different contents of polyphenolic compounds, i.e., fruit from the 2017 harvest contained more of these compounds than fruit from the 2016 harvest, indicating that not only the ecotype and cultivar, but also the harvest season has a significant effect on the content of active compounds. The results of this research were presented in poster form at the scientific symposium "*Zasoby genowe roślin użytkowych na rzecz hodowli*" (Genetic resources of crop plants for breeding), held in Kazimierz Dolny on 6-8 September 2017 and published in the conference materials (Sznajder et al. 2017).

The great diversity of pear fruit from the Bolestraszyce collection, confirmed by laboratory tests, allows the most interesting forms to be selected as good material for

cultivar registration, and the identified varieties can be propagated and offered for cultivation in the area where they were found.

In September 2017, apples of 37 old varieties and ecotypes from the Bolestraszyce collection were collected for chemical tests at the Department of Fruit, Vegetable and Plant Nutraceutical Technology of the Wrocław University of Life Sciences. As part of two Masters' theses, the diversity of material obtained from the Arboretum was assessed. The evaluation was based on the chemical composition (content of dry mass, extract, ash, pectin, vitamin C, titratable acidity, amount of malic acid, total sugars, fructose, glucose, sucrose, sorbitol) and the content of polyphenolic compounds measured by spectrophotometry (content of total polyphenols) and by HPLC chromatographic separation (content of red anthocyanin pigments, phenolic acids, procyanidins or flavanols).

The sugar content of the apples studied ranged from 8.49% f.w. (ecotype 170/3711) to 15.30% f.w. (ecotype 491/3355). The predominant sugar was fructose occurring at 5.55-10.46% f.w., followed by glucose (0.64-4.03% f.w.), sucrose (0.15-2.67% f.w.) and sorbitol (0.05-1.06% f.w.). Total acidity ranged from 0.30% f.w. ('Cukrówka Litewska') to 1.78% f.w. (ecotype 170/3711) — of which, malic acid alone was 0.18-1.53 g/100 g. Using the data from the sugar and acid determinations, the ratio of these two groups of compounds responsible for the taste and purpose of the apples was calculated. This ratio plays an increasingly important role, for example, in the selection of apples into individual quality groups and thus in the division of ecotypes and varieties according to their use value. However, it should be noted here that a high sugar content is not always responsible for the sweet taste of the fruit, but rather a low organic acid content.

The sugars-to-acids ratio of Bolestraszyce apples ranged from 4.77 (ecotype 170/3711, whose fruit contained the least sugars and the most organic acids) to 40.82 ('Cukrówka Litewska' - a variety whose fruit contained a lot of sugars and few acids). According to the literature, apples with a ratio of sugars to acids above 20 are sweet and suitable for direct consumption. They are classified as dessert fruit, while apples with a sugar-to-acid ratio of less than 20 are suitable for processing (Begić-Akagić et al. 2014). Taking this division into account, of the 37 old apple varieties and ecotypes studied, nine are defined as dessert varieties: 'Wargul Woroneżski', 'Fameuse', 'Sinap z Ałma Aty', 'Kantówka Gdańska', 'Rapa Zielona', 'Bernier Rose', 'Cukrówka Litewska',

ecotype 2949 and ecotype 491/3355. The other varieties and ecotypes, which have a sugar-to-acid ratio of less than 20, can be classified as processing varieties, i.e., best used for the preparation of jams, juices, compotes, dried fruit, purees or creams.

In order to check which ecotypes and varieties are most suitable for the production of jams, or filtered and unfiltered (cloudy) juices, the pectin content of the apples was determined. The amount of these compounds in the fruit ranged from 0.34% f.w. to 2.54% f.w.. Varieties with the lowest pectin content were 'Wargul Woroneński' (0.34% f.w.) and 'Cukrówka Litewska' (0.42% f.w.), while those with the highest pectin content were 'Żeleźniak' (2.53% f.w.) and 'Jabłko Gruszkokształtne' (2.54% f.w.). The high content of pectin, which exhibits thickening properties, indicates good suitability of the fruit for jam production. Pectin content can also play a significant role in the selection of fruit for home juice production. For clear juices, varieties or ecotypes with juicy fruit with a low pectin content should be chosen, while juicy fruit with a higher pectin content should be chosen for more valuable naturally cloudy juices. In cloudy juices, it is the pectin compounds that cause natural turbidity and are responsible for its stability.

Apples contain polyphenolic compounds and, as they are widely available and readily consumed in the daily diet, are a valuable source of these compounds. Among the polyphenols determined in Bolestraszyce fruit were: colourless procyanidins, phenolic acids, dihydrochalcones and yellow flavanols. Among the 37 apple cultivars and ecotypes tested, 23 were red-skinned, including one ecotype with red flesh (ecotype 3059), and in these red anthocyanins were additionally determined. The total polyphenol content of the fruit tested was between 346 mg/100 g d.m. ('Berner Rose') and 2040 mg/100 g d.m. (ecotype 3059 with red flesh). Among the samples containing more than 1,000 mg/100 g d.m. were mainly red-skinned fruits — two ecotypes: 3059 (2039.73 mg/ 100 g d.m.) and 2771 (1121.00 mg/100 g d.m.) and two varieties: 'Jabłko Gruszkokształtne' (1260.74 mg/ 100 g d.m.) and 'Rapa Zielona' (1079.70 mg/100 g d.m.), but also two green-skinned varieties 'Reneta Osnabrück' (1293.03 mg/100 g d.m.) and 'Cukrówka Litewska' (1132.39 mg/100 g d.m.). In terms of the content of total polyphenols and individual compounds such as anthocyanins, procyanidins or phenolic acids, the red-fleshed ecotype stood out in particular, as it contained the most bio-components, out-competing the other varieties by at least a factor of two. This ecotype also had the highest antiradical activity. Among the other cultivars and ecotypes, the best health-promoting properties were

characterised by green-skinned fruit, such as 'Reneta Osnabrück' and 'Cukrówka Litewska', and red-skinned fruit, such as 'Jabłko Gruszkokształtne' and ecotype 2771. In terms of vitamin C content, the cultivar 'Ontario' stood out, with 100 g of fresh fruit containing 14.61 mg of this vitamin. From the above data, it can be seen that among the varieties and ecotypes in the Bolestraszyce collection, there are many apple trees worth promoting in particular to local consumers.

RESEARCH — PROCESSES

In order to confirm the assessment of the suitability of selected varieties for processing into specific products, cooperation continued with Alicja Kucharska from the Department of Fruit, Vegetable and Plant Nutraceutical Technology at the Wrocław University of Life Sciences. Studies conducted in laboratories were aimed at assessing the basic chemical composition and determining the content of colourless polyphenolic compounds and the antioxidant properties of selected varieties and ecotypes of apples and pears, as well as products prepared in the Arboretum according to old reconstructed recipes (pickled apples in cabbage, apple, pear and cornelian cherry vinegars or naturally cloudy apple juices from the respective variety). The first analyses of the chemical composition of the sauerkraut apple were carried out in 2018. The product was prepared from fruit of the 'Pepina Parker' and 'Reneta Kanadyjska' varieties from the 2017 harvest.

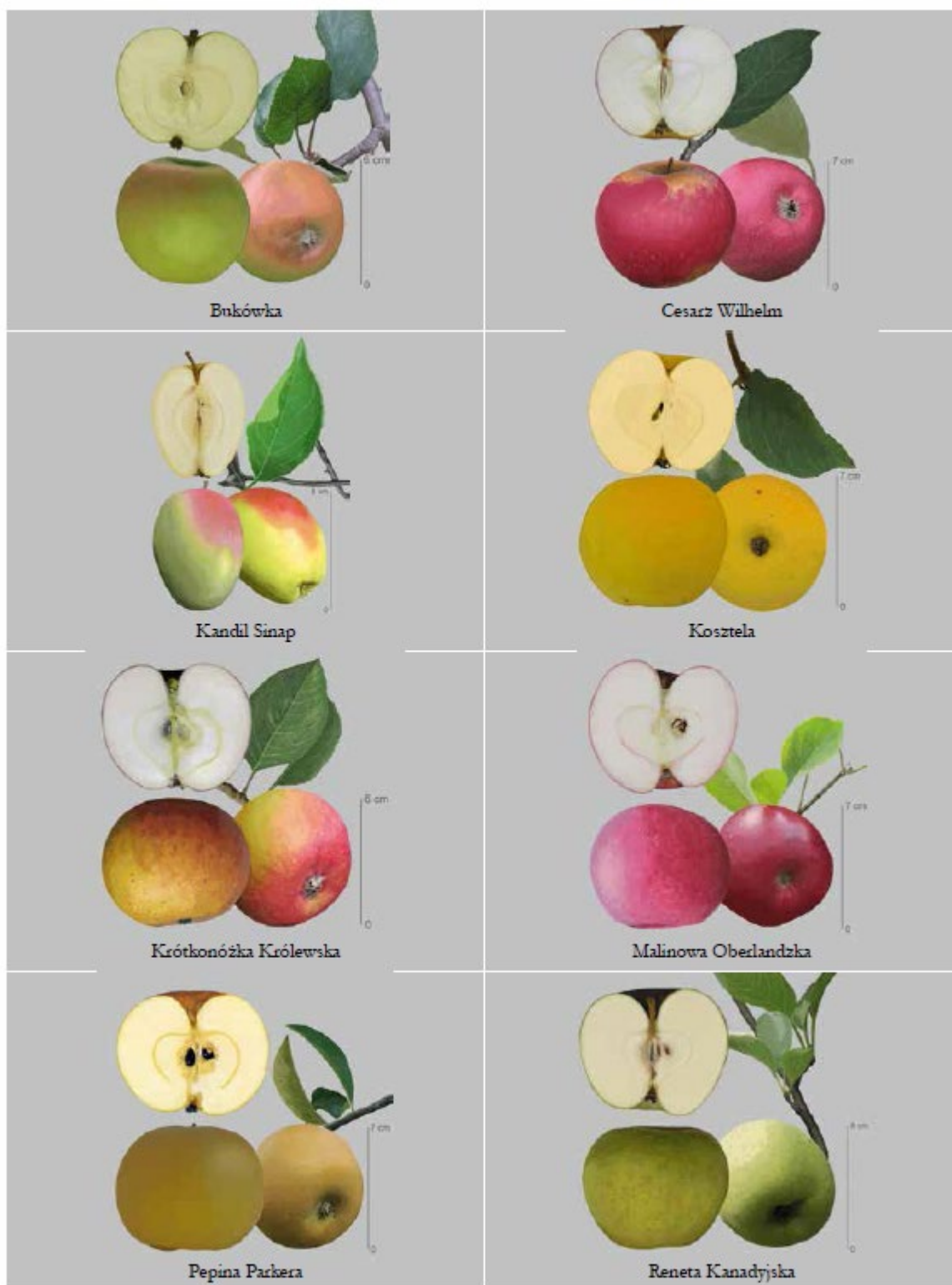


Fig. 11. Apple tree varieties from the Bolestraszyce collection, drawings J. Rylke



Charlamowskie



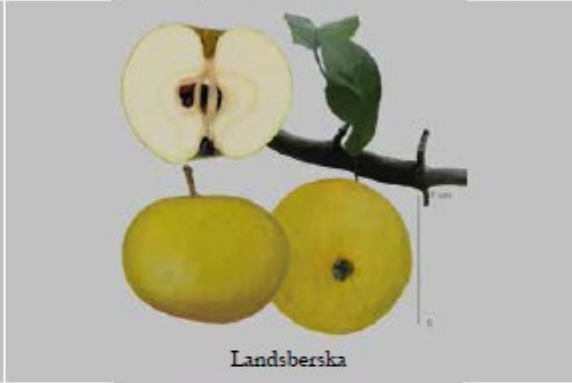
Jakub Lebel



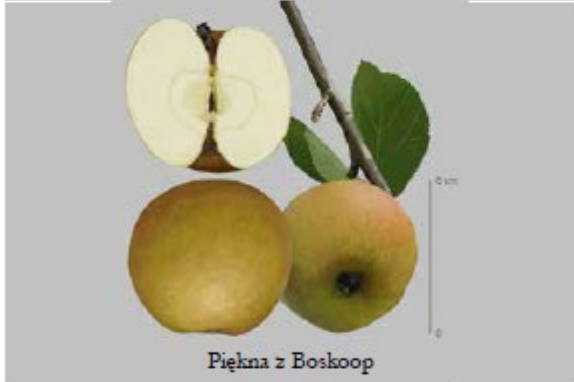
Kalwilla Jesienna Czerwona



Koksa Pomarańczowa



Landsberska



Piękna z Boskoop



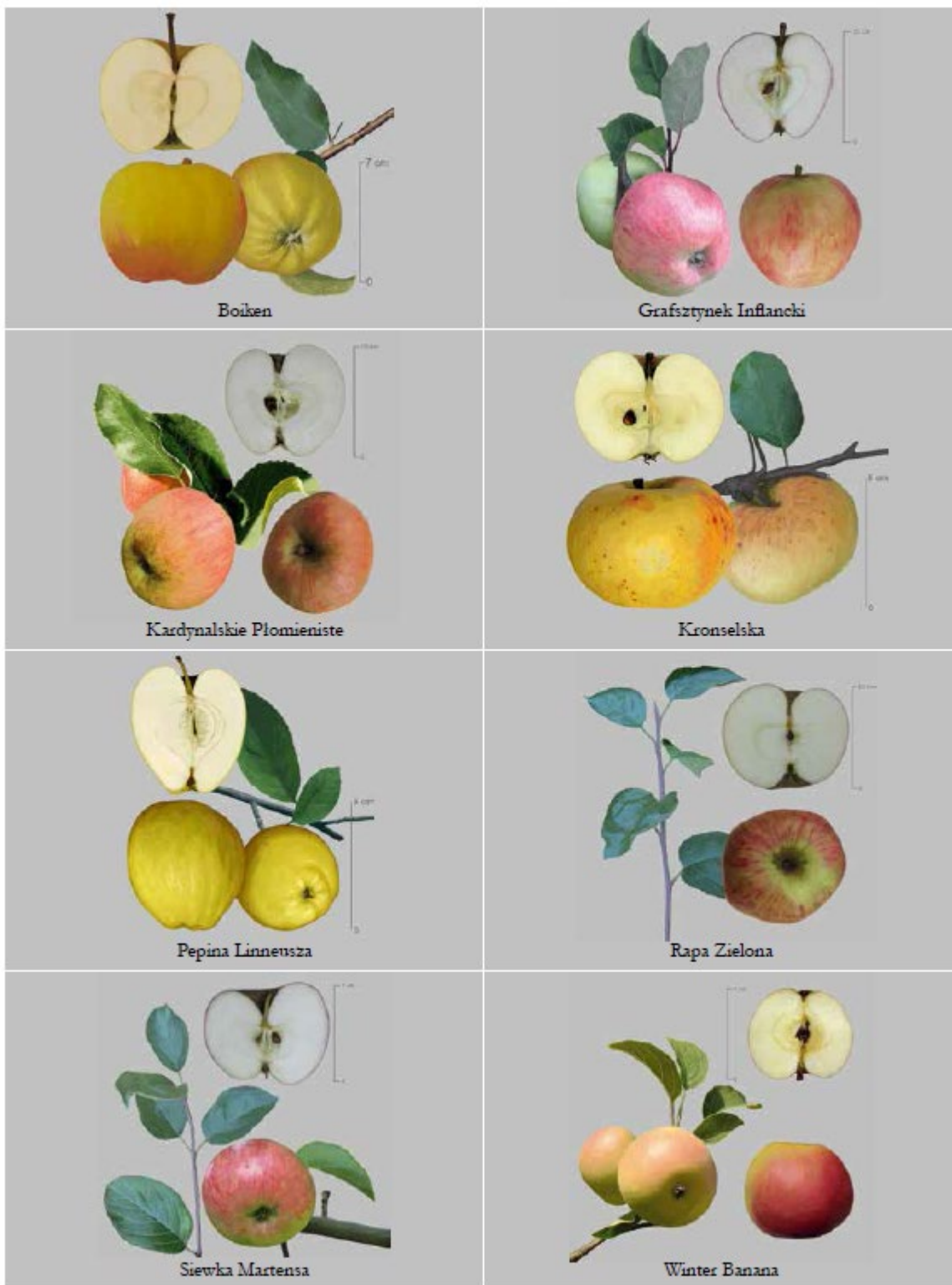
Truskawkowe Nietschnera



Złota Reneta



Żeleźniak



At the Arboretum, fruit of ecotype '170' was selected from the 2012 harvest to produce cloudy apple juice. The apples were selected on the basis of an assessment of their acidity, exceptionally high pressing capacity and stability of juice turbidity. The cloudy juice obtained at the Arboretum was evaluated at Wrocław University of Life Sciences (UPWr), showing a higher content of

bioactive components, including polyphenols, and a higher degree of turbidity in juice without pasteurisation than after pasteurisation. For vitamin C, the difference was twofold in favour of juice without pasteurisation (8.5 mg/100 ml juice). The degree of turbidity of the juices ranged between 341 and 356 NTU (for comparison, the turbidity of clear juices should not exceed a value of 5 NTU). The results of the above-described research were presented poster form at the 3rd International Conference "Plant - the source of research material" in Lublin (16-18.10.2013) and published in the conference materials (Kolniak-Ostek et al. 2013). Cloudy juices are a more valuable product than clear juices, so it is important to promote this product to consumers and to search for the best apple varieties and ecotypes for this type of product.

In 2013, cloudy juices were made, but this time from '1960' ecotype pears and in the UPWr laboratory. The aim of this research was to evaluate the effect of the addition of L-ascorbic acid on pear juice quality. Based on the results obtained, a higher degree of brightness and a higher viscosity of the juice with the addition of the antioxidant was observed compared to the control sample. The juice with added L-ascorbic acid was also characterised by a higher degree of turbidity, but the stability of this turbidity was lower than that of the control juice. The results of this research were presented in poster form at the 6th International Conference "Quality and Safety in the Food Production Chain" in Wrocław (26-27.06.2014) and published in the conference materials (Kolniak-Ostek et al. 2014).

The basic chemical composition of the products made in the Arboretum, such as pickled apples in cabbage or apple, pear and cornelian cherry vinegars, was determined in the UPWr laboratory, including: the content of sugars, organic acids, vitamin C and polyphenols. The results of these analyses showed the high value of products traditionally prepared in the Arboretum according to old recipes. They will provide material for the preparation of studies for a wider audience interested in the topic.

The physicochemical and antioxidant analyses conducted in the laboratory of the Department of Fruit, Vegetable and Plant Nutraceutical Technology confirmed the great diversity of pear and apple tree fruit from the Bolestraszyce collection and identified the most interesting forms that constitute good material for the registration of varieties, promotion among local consumers or the production of valuable products, including traditional ones.

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