Price lists for amber products as a tool for expert evaluation: gemological and legal principles

Petro Baranov * [a], Roman Kirin ** [b], Olena Slyvna * [c]**

* Doctor of Geology, Professor, Dnipropetrovsk SRFC of the MIA of Ukraine, Dnipro, Ukraine, ORCID: https://orcid.org/0000-0002-3367-4277, e-mail: pn2dsbaranov@gmail.com

** Doctor of Law, Docent, Dnipropetrovsk SRFC of the MIA of Ukraine, Dnipro, Ukraine, ORCID: https://orcid.org/0000-0003-0089-4086, e-mail: kirinrs62@gmail.com

*** PhD in Geology, Dnipropetrovsk SRFC of the MIA of Ukraine, Dnipro, Ukraine, ORCID: https://orcid.org/0000-0002-7063-1938, e-mail: e.slivna@gmail.com

[a] Methodology, resources, software.
[b] Conceptualization, Visualization, Writing – original draft.
[c] Formal analysis, data curation, editing.

DOI: 10.32353/khrife.3.2024.07 UDC [338.5:549.892.1](343.98)
Received: 02.07.2024 / Reviewed: 05.07.2024 / Accepted for printing: 25.09.2024 / Available online: 30.09.2024

The purpose of this research paper is to develop an algorithm for compiling price lists for amber products based on real market data for necklaces and beads. For achieving the goal (with the help of general scientific and special methods of scientific cognition), consumer properties of products (color, weight, size, presence of inclusions and cracks, transparency, processing quality, price) were analyzed and a database was created that will contribute to solving theoretical and applied issues. In order to meet the needs of the modern market, price lists for amber products have been developed based on economically determined and understandable calculations and which are one of the sources of objective and reliable results in expert and evaluation activities, and are also relevant in economic geology (for clarifying feasibility of industrial development of mineral deposits). Objectivity and reliability of the obtained results is guaranteed by the software created according to real quality indicators of raw ma-

This article is translation of the original Ukrainian content, which source is available at the link: *https://khrife-journal.org/index.php/journal* (translated by Andriy Bublikov). The author acknowledges translation as corresponding to the original.

terials (color, weight, size, transparency) and the technological production procedure of commercial products. The cost indicator of raw materials of 30% of the product cost is proposed to be considered as the limit below which the production of amber balls is unprofitable.

Keywords: *amber; forensic examination; evaluation; cost; algorithm; price list; market.*

Research Problem Formulation

Determining the cost of amber products is one of the urgent issues in modern forensic expert practice. The lack of State prices for amber products causes significant fluctuations in the prices of amber products that does not allow to correctly calculate their value and reduces the quality of forensic expert evaluation in general.

The results of our research modern amber market in Ukraine indicate that available market prices for raw amber and products from it are obviously not stable (most often due to the fact that the modern world amber business is not structured) and prices depend on the availability of raw materials on the market. In other words, the price lists are based on comparative prices, and they vary significantly. In addition, on the territory of Ukraine, unfortunately, illegal amber mining is widespread and there is practically no public procurement of raw materials that leads to complete confusion in pricing policy and complicates the work of forensic gemologist.

Currently, all trade agreements and expert evaluation of this stone in Ukraine are carried out according to the price lists for raw materials and amber products from the reference publication: *Handbook of Prices of Precious and Decorative Stones* bulletin [1], which is published 4 times a year by the State Gemological Center of Ukraine of the Ministry of Finance of Ukraine (hereinafter referred to as *SGCU*) and the basis of information for which is price analysis (usually in European market).

Price lists for raw amber are of special importance for geological and economic evaluation of its deposits which purpose is to analyze all factors of the object's industrial value, calculate technical and economic indicators and prepare a conclusion about the economic efficiency of further work. Therefore, geological and economic evaluation of deposit of this mineral consists in justifying feasibility of its industrial development.

Legislative changes adopted at the end of 2019 regarding provision of amber-bearing subsoils for use contributed to legalization and growth of amber mining volumes. In 2023, 39.2 tons of amber were mined in Ukraine, that is, 15 times more than in 2019. In addition, in 2023, 35.4 million hryvnias were paid in rent for the use of amber-bearing subsoil, 30% of which was directed to budgets territorial communities [2].

Typically, the cost of such objects is determined according to the price lists approved by the Ministry of Finance of Ukraine. However, modern business (investor) needs to evaluate deposits of stone

1 Див., напр.: Довідник цін коштовного та декоративного каміння. 2024. № 2(61). 44 с.

2 Електронні торги. Результати 2019—2023 / Державна служба геології та надр України : офіц. сайт. URL: https://www.geo.gov.ua/wp-content/uploads/presentations/ukr/statistika-elektronnix-torgiv.pdf (date accessed: 22.06.2024).

processing raw materials, taking into account the cost of final marketable products (specific products) based on technical and economic calculations [3].

Currently, the market for amber products is not controlled by the State, it develops chaotically, mostly by fluctuating prices several times, and sometimes several orders of magnitude. The absence of state prices for amber products forces the market to formulate its pricing policy, which causes certain difficulties in calculating the cost of amber products in modern expert practice.

In this regard, we propose an algorithm developed by us for compiling price lists for amber products (on the example of balls and beads from balls).

Article Purpose

Since currently there is an urgent need for alternative price lists based on the real amber market data, the authors of this study set out to develop an algorithm for compiling price lists for amber products based on the real market of amber beads and balls, for which they analyzed the consumer properties of amber beads and balls (color, weight, size, existence of inclusions and cracks, transparency, quality of processing, price) and created a database for these products based on the results of processing commercial websites, trading platforms, foreign and domestic exhibitions.

Research Methods

Methodological basis of the research is general scientific and special methods of scientific cognition. The method of system-structural analysis contributed to the analysis of norms of domestic legislation regulating the extraction, production and use of precious and semi-precious stones, control over operations with them and the rules of their attestation, the formulation of critical comments regarding price lists for amber as a precious stone of organogenesis Statistical, mathematical, physical and other special research methods made it possible to evaluate amber products within the limits of gemological examination with the aim of general geological and economic evaluation of amber deposits in Ukraine.

In order to increase objectivity and reliability of expert evaluation of amber, we have developed a computer program that makes it possible to form price lists for amber products in a calculated way while using real indicators of color, mass, size, yield suitable during the production of amber products for jewelry.

Analysis of Essential Researches and Publications

Analysis of research papers of domestic [4] and foreign authors [5] who directly or indirectly investigated the pricing of amber [6]

3 Рудько Г. І., Литвинюк С. Ф. Родовища бурштину України та їх геолого-економічна оцінка / за ред. проф. Г. І. Рудька. Київ — Чернівці, 2017. 240 с.

4 Беліченко О. П., Ладжун Ю. І., Татарінцев К. В., Гаєвський Ю. Д., Максюта О. В., Кравченко М. О. Сучасний стан та динаміка розвитку ринку бурштину. *Коштовне та декоративне каміння*. 2021. № 1 (103). С. 20—26. URL: https://www.gems.org.ua/jurnal/archive/2021/N1(103)/image/stat4.pdf (date accessed: 22.06.2024).

5 Rippa A., Yang Y. The Amber Road: Cross-Border Trade and the Regulation of the Burmite Market in Tengchong, Yunnan. *TRaNS: Trans-Regional and National Studies of Southeast Asia*. 2017. Vol. 5. Is. 2. Pp. 243—267. DOI: 10.1017/trn.2017.7 (date accessed: 22.06.2024).

6 Bilham N. T. Responsible mining and responsible sourcing of minerals: opportunities and challenges for cooperation across value chains. *Geological Society, London, Special Publications*. 2021. Vol. 508. Pp. 161—186. DOI: 10.1144/SP508-2020-130 (date accessed: 22.06.2024).

products showed that almost no research was carried out in Ukraine directly related to the declared topic. In recent years, the authors of this article have paid attention to this problem [7], but there is a lack of thorough work, so the analysis of literary sources confirms the lack of information on the creation of price lists for amber products [8].

At the same time, it is clear that other factors influence the pricing of amber, such as costs (overhead, marketing, material, labor, etc.) and the ratio of supply and demand, ultimately depending on behavior strategy in the market of leading companies in the extraction and processing of amber. Today, the domestic amber market, unfortunately, is aimed at selling only raw materials [9], but we hope that over time Ukraine will export ready-made amber products.

All of the above confirms that the assessment of amber is one of urgent [10] and pressing issues of evaluation and expert activity [11] in Ukraine.

The lack of recognized approaches to determining prices necessitates the development of alternative price lists for amber products based on the data of the modern amber market.

Main Content Presentation

Currently, there is a fairly rich range of amber products on world market, besides, each of its varieties is characterized by certain price indicators, which directly depend on the quality of raw materials, the quality of the product and the demand for it. Analysis of the modern amber market shows that the most interesting objects of study are the product and its prices. Since the current amber market in Ukraine is unstable and controversial, a number of issues on the pricing of goods from it have not been resolved to this day affecting primarily a significant range of prices: for example, between amber in raw materials and products from it, between equivalent products of different quality, etc.

In order to identify the main features that affect the pricing of beads and amber balls, the authors made an attempt to identify the main ways to solve the raised issues.

One of the most urgent issues for domestic manufacturers of amber products is the lack of clear and transparent mechanisms for product pricing and sales.

Currently, expert evaluation and quality control of raw materials and products

7 Baranov P., Korotaiev V., Slyvna O. Features of pricing of amber products in modern conditions. *Forensic Herald*. 2023. № 2 (40). Pp. 68—76. DOI: 10.37025/1992-4437/2023-40-2-68 (date accessed: 22.06.2024).

8 Kirin R. S., Baranov P. M., Korotaiev V. M., Shevchenko S. V. Algorithm for the formation of price lists for raw amber taking into account individual consumer characteristics. *Naukovyi Visnyk Natsionalnoho Hirnychoho Universytetu*. 2023. № 1. Pp. 20—25. DOI: 10.33271/nvngu/2023-1/020 (date accessed: 22.06.2024).

9 Ільчишен І. Бурштин може приносити в Україну додатковий капітал. *Nadra info*. 15.02.2024. URL: https://nadra.info/2024/02/ihor-ilchishen-amber-can-bring-additional-capital-to-ukraine/ (date accessed: 22.06.2024).

10 Беліченко О. П., Ладжун В. І., Татарінцева К. В. Атестація та експертна оцінка дорогоцінного каміння органогенного походження (бурштин) : навч. посіб. Київ, 2017. 20 с.

11 Беліченко О. П., Татарінцева К. В., Ладжун Ю. І., Гаєвський Ю. Д., Максюта О. В., Кравченко М. О. Наукове обґрунтування розроблення та оновлення технічних умов і методичних документів ДГЦУ з атестації та експертної оцінки дорогоцінного каміння, дорогоцінного каміння органогенного утворення. *Коштовне та декоративне каміння*. 2022. № 4. С. 15—18.

made of precious stones, precious stones of organogenesis origin (in particular, amber [12]) and semiprecious stones (hereinafter referred to as *GS*) is carried out by the SGCU (Part 4 of Art. 15 of the Law of Ukraine: On State Regulation of Mining, Production and Use of Precious Metals and Precious Stones and Control over Transactions with Them [13], hereinafter referred to as the *Gemological Law*). As mentioned above, summarizing the information on the dynamics of price indicators for precious stones in raw materials and products in the markets for the sale of goods, the SGCU publishes information and reference publication on a quarterly basis, namely: *Price Guide for Precious and Decorative Stones* the bulletin [14], the information of which is based on price analysis (usually the European market).

The main criteria for assessing the quality of amber (according to the current price lists): mass, texture, shape, surface of the sample, cracking, presence of inclusions. At the same time, the current price lists contain ambiguous concepts, which causes problems in the work of the expert and the appraiser, affects the objectivity of determining the quality of amber (therefore, its value) and does not at all correspond to the basic principles of forensic examination — objectivity and completeness of research. In addition, these price lists do not reflect the real prices for Ukrainian amber and amber products, since they are formed at European prices.

In accordance with Art. 9 of the Gemological Law, the [15] payment of *GS*, which is purchased to the State Fund of Precious Metals and Precious Stones of Ukraine (hereinafter referred to as State *Fund*) and which is stored in the State Repository of Precious Metals and Precious Stones of Ukraine (hereinafter referred to as the State Repository), as well as the sale of valuables from the State Repository are carried out at market prices effective on the day of sale.

At the same time, the concept of *market price* for amber can be described as follows:

- this is the price at which amber is transferred to another owner, provided that the seller wishes to transfer it and the buyer wishes to receive it on a voluntary basis;
- seller of amber and its buyer: a) are mutually independent legally and in fact; b) have sufficient information about amber, as well as about prices that have developed in its market (in their default homogeneous *GS*) in comparable economic (commercial) conditions (subclause 14.1.219 of the Tax Code of Ukraine [16], hereinafter referred to as Tax Code of Ukraine).

In addition to the pricing policy for *GS*, the gemological legislation of Ukraine, re-

12 Kirin R. S. Legal support for the evaluation and sale of objects of gemological relations. *Forum of Rights*. 2024. No. 78 (1). P. 65-76. DOI: 10.5281/zenodo.10869348 (date accessed: 22.06.2024).

13 Про державне регулювання видобутку, виробництва і використання дорогоцінних металів і дорогоцінного каміння та контроль за операціями з ними : Закон України від 18.11.1997 р. № 637/97-ВР (зі змін. та допов.). URL: https://zakon.rada.gov.ua/laws/show/637/97-%D0%B2%D1%80#Text (date accessed: 22.06.2024).

14 Довідник цін ... .

15 Про державне регулювання ... . URL: https://zakon.rada.gov.ua/laws/show/637/97-%D0%B2%D1%80#Text (date accessed: 22.06.2024).

16 Податковий кодекс України від 02.12.2010 р. № 2755-VI (зі змін. та допов.). URL: https://zakon.rada.gov.ua/laws/show/2755-17#Text (date accessed: 22.06.2024).

ferred to above [17], regulates the following: amber extracted from the subsoil under a forward contract is purchased from the State Fund from the entities that extract and produce it in a sorted form, and the quality control of sorting and expert evaluation of amber is carried out by the SGCU according to the relevant directories [18].

Specifics of forward contract:

1) this is a civil law agreement, under which the seller undertakes in the future to transfer the asset to the buyer's ownership within a specified period of time under certain conditions, and the buyer undertakes to accept the asset within a specified period of time and pay the price specified in such agreement for;
2) forward contract is executed by supplying the asset and paying for it with funds or conducting cash settlements between the parties to the contract without supplying the asset;
3) all conditions are determined by the parties at the time of conclusion of the contract;
4) conclusion of forwards and their circulation is carried out outside the organizer of trade in standardized fixed-term contracts (subclause 14.1.45.3 of Tax Code of Ukraine [19]).

Therefore, in order to determine the cost of an amber product, it is necessary to know the prices for amber in raw materials, as well as to estimate the costs of manufacturing product.

In accordance with the legislation, SGCU conducts independent examination and controls the quality of raw materials and products from *GS*, as well as products with them, expert evaluation of *GS* enrolled in the State Fund, conducts gemological studies of raw materials, and performs other work related to independent forensic examination of *GS* [20].

Therefore, the *GS* assessment should take into account its cost according to the expert opinion, determined on the basis of the *GS* gemological examination according to the price lists published in the Periodic Price Guide for Precious and Decorative Stones [21] and which are valid on the date of assessment.

In order to fulfill this task, the price lists of the SHCU were used excluding value added tax (hereinafter referred to as *VAT*), which defined such parameters as variety, fraction size, cost in US dollars per 1 kg ($/kg; *see Table 1 on page 74*).

The estimated cost of amber of the 1st quality group (1st grade) is calculated based on the results of a detailed examination in SGCU.

In addition to the price lists for raw materials, SGCU forms prices for amber products, which in many respects do not structure prices in the market but, on contrary, create certain problems.

17 Kirin R., Baranov P., Koziakov I. Gemological Law of Ukraine: formation Problems and development Prospects. *Вісник Київського національного університету імені Тараса Шевченка. Геологія.* 2021. Т. 2. № 93. С. 6—14. DOI: 10.17721/1728-2713.93.01 (date accessed: 22.06.2024).

18 Про видання довідників оптових цін на діаманти, дорогоцінне, напівдорогоцінне та декоративне каміння : постанова КМУ від 31.05.1995 р. № 369. URL: https://zakon.rada.gov.ua/laws/show/369-95-%D0%BF#Text (date accessed: 22.06.2024).

19 Податковий кодекс … . URL: https://zakon.rada.gov.ua/laws/show/2755-17#Text (date accessed: 22.06.2024).

20 Про державне регулювання … . URL: https://zakon.rada.gov.ua/laws/show/637/97-%D0%B2%D1%80#Text (date accessed: 22.06.2024).

21 Довідник цін … .

Table 1

Prices for amber in raw materials that correspond to the price level of small wholesale trade lots (excluding VAT), $/kg [22]

Mass fraction of amber, g	Quality group				Layered amber	Dirty, foamy amber
	1-st	2-nd	3-rd	4- th		
Up to 2	80	40	20	20	20,00	20,00
2—5	182	130	104	65	20,00	20,00
5—10	350	250	200	125	85.00	50.00
10—20	784	560	448	280		
20—50	1659	1185	948	593		
50—100	2191	1565	1252	783	400.00	
100—200	2702.	1930	1544	965		
200—300	3346	2390	1912	1195		
300—500	3486	2490	1992	1245		
500—1000	Collectively					
Over 1000	Collectively					

The very name of the price list "Amber and amber pressed in decorative elements" (*see Table 2*) does not meet the requirements of the Law of Ukraine "On Forensic Examination" [23], since the origin of amber, like other precious stones, is an important argument and the main indicator in court proceedings as the main criterion of monetary value. For the consumer or amateur, the natural origin of amber is a magical indicator, so it is incorrect to evaluate amber according to Table 2 (both from legal and consumer positions).

Table 2

Prices for amber and amber pressed in decorative elements, excluding VAT, $/year [24]

Balls							
Size, mm	Up to 6	6—10	10—15	15—20	20—25	25—30	Over 30
Estimated value, $/g	0.6—1.8	2.3	3.6	9.0	11.5	14.5	16.4
Caboshons, rotation bodies, plates, etc.							
Weight, *g*	Up to 2	2—5	5—10	10—20	20—30	Over 30	
Estimated value, $/g	0.7—1.8	2.8	3.9	4.4	6.8	8.4—27.0	
Tumbled elements in jewelry items (necklaces, bracelets, etc.)							
Size, mm	4—10		10—30			30—60	
Estimated value, $/g	0.26		0.52			0.62	

Note: Defect group A, defects are invisible to the naked eye. The estimated cost of non-drilled tapped elements is reduced by 30%.

22 Довідник цін ... .

23 Про судову експертизу : Закон України від 25.02.1994 р. № 4038-XII (зі змін. та допов.). URL: https://zakon.rada.gov.ua/laws/show/4038-12#Text (date accessed: 22.06.2024).

24 Довідник цін ... .

It is worth noting the following: the cost of drilling, which is 30% of the cost of the bullet, does not meet the standards of the modern technological process, since drilling is a maximum of 5-10% of the bullet cost.

The structure of Table 2 itself causes certain inconveniences for the appraiser: the size of the bullet is given in mm, and the price is given in $/g, that is, to calculate the cost of the bullet, its volume and then weight should be determined first. For example, we give the calculation of the cost of bullets according to the price lists of SGCU (*see Table 1*).

The costs for manufacture of bullets and their implementation are determined on the basis of the processing of experimental data obtained during multifactor experiments, other parameters of the technological process are also obtained (yield of suitable). All this indicates that the cost of raw materials for the manufacture of balls on average is 30% of the cost of the product, and the yield is 30% (this is the lower limit, below which the manufacture of balls is unprofitable).

Thus, the cost of products is determined by the following formula:

$C_{вир.} = (C_{сир.} \times M_{зраз.}) \div (C_{сир.\ \%} \div C_{вир.\ \%})$, where:

$C_{вир.}$ is the product cost, $;

$C_{сир.}$ is the cost of raw materials, $/g;

$M_{зраз.}$ is sample weight, g;

$C_{сир.\ \%}$ — the cost of raw materials in the ball is 30%;

$C_{вир.\ \%}$ — cost of the product is equal to 100%.

The results of calculations (*see Table 3*), as evidenced by practice and marketing research, are far from reality and contradict existing amber market.

Table 3

Results of calculations of the cost of amber balls

Seq. No.	Bullet size, mm	Bullet weight, g	Cost of amber in a bullet, $/h	Bullet cost, $	Estimated cost of raw materials, $/year
1	6	0.12	0.6—1.8	0.07—0.22	0.05
2	6—10	0.12—0.56	2.3	0.276—1.29	0.21—0.21
3	10—15	0.56—1.70	3.6	2.01—6.12	0.32—0.32
4	15—20	1.70—4.47	9.0	15.3—40.23	0.81—0.81
5	20—25	4.47—8.73	11.5	51.41—100.36	1.04—1.02
6	25—30	8.73—15.08	14.5	126.86—218.66	1.29—1.31
7	> 30	15.08	16.4	247.31	1.48

The above calculations are somewhat surprising: a discrepancy between the prices of the price list is clearly visible.

For example:

- in line 1, a 6 mm ball costs $0.07 (2.8 UAH). It is not clear how a ball with a size of up to 6 mm can cost $0.6-1.8 (a difference of 3 times) and by what criteria it is necessary for its evaluation;
- in line 2, a 10 mm ball costs $1.29, and in line 3, a ball of the same size costs $2.01.

This situation is typical for bullets of 15, 20, 25 and 30 mm in size.

Further calculation of the cost of the products was carried out with the help of *AMBER-3* software. As a result of analytical data processing, we received a table (price list) with the following parameters:

mass of the sample (fractions), mass of the ball in g; ball size (diameter) in cm and the results of calculating the cost of balls for three grades of amber (q.v. *Table 4*), since the 4th grade of amber is not used for making balls.

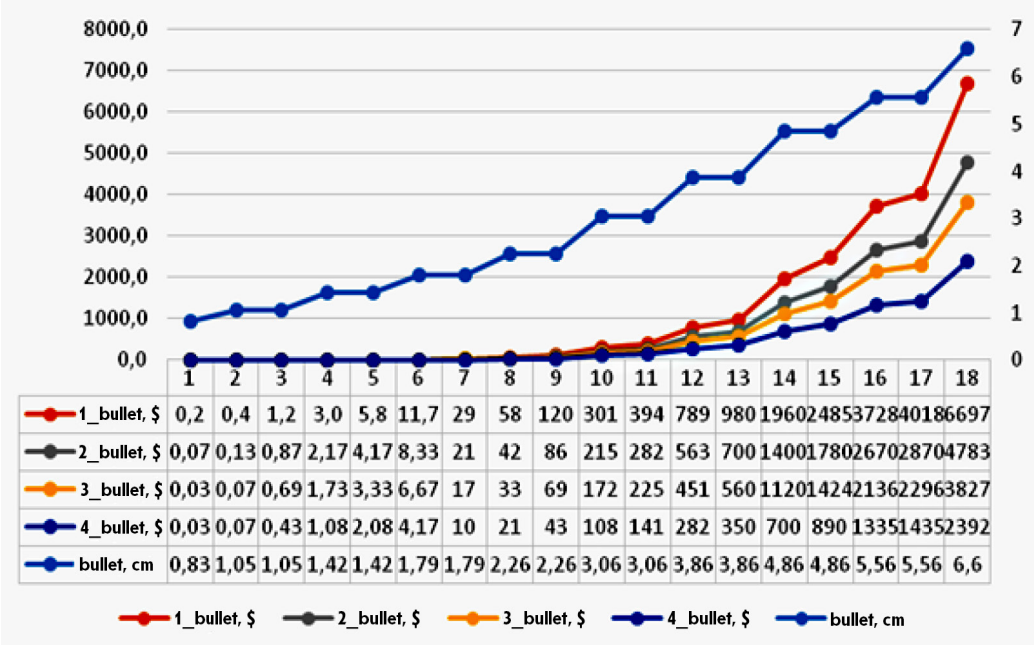
Table 4

Price list on an amber ball according to the calculations of *AMBER-3* software

Sample weight (g)	Bullet weight, g	Bullet diameter, cm	Cost of balls, $		
			1st grade	2nd grade	2nd grade
1	0.3	0.83	0.27	0.13	0.07
2	0.6	1.05	0.53	0.27	0.13
2	0.6	1.05	1.21	0,87	0.69
5	1.5	1.42	3.03	2.17	1.73
5	1.5	1.42	5.83	4.17	3.33
10	3	1,79	11.67	8.33	6.67
10	3	1,79	26.13	18.67	14.93
20	6.01	2.26	52.27	37.33	29.87
20	6.01	2.26	110.60	79.00	63.20
50	15.02	3.06	276.50	197.50	158.00
50	15.02	3.06	365.17	260.83	208.67
100	30.03	3.86	730.33	521.67	417.33
100	30.03	3.86	900.67	643.33	514.67
200	60.06	4.86	1801.33	1286.67	1029.33
200	60.06	4.86	2230.67	1593.33	1274.67
300	90.09	5.56	3346.00	2390.00	1912.00
300	90.09	5.56	3486.00	2490.00	1912.00
500	150.15	6.6	5810.00	4150.00	3186.67

These results demonstrate the direct dependence of the cost of the bullet on its parameters (*see Fig. 1*). In addition, the cost of lightweight bullets is very low, and starting from a weight of more than 200 g., the cost increases dramatically. In any case, the results obtained provide the key to understanding the formation of prices for amber balls.

As we can see from the table.1, the cost of an amber sample of the same weight, but of different fractions, varies significantly. For example, the weight of a 2 g sample from the 2-5 g fraction exceeds the value of the same sample from the up to 2 g fraction three times (!). This is clearly visible in the graph (q.v. *Fig. 1*), where the curve of price lists forms a kind of staircase during the transition from one fraction to another. A reasonable question arises: how much will a ball with a weight of 3 or 4 g, that is, a ball whose weight is between the extreme values of the fraction, cost?



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1_bullet, $	0,2	0,4	1,2	3,0	5,8	11,7	29	58	120	301	394	789	980	1960	2485	3728	4018	6697
2_bullet, $	0,07	0,13	0,87	2,17	4,17	8,33	21	42	86	215	282	563	700	1400	1780	2670	2870	4783
3_bullet, $	0,03	0,07	0,69	1,73	3,33	6,67	17	33	69	172	225	451	560	1120	1424	2136	2296	3827
4_bullet, $	0,03	0,07	0,43	1,08	2,08	4,17	10	21	43	108	141	282	350	700	890	1335	1435	2392
bullet, cm	0,83	1,05	1,05	1,42	1,42	1,79	1,79	2,26	2,26	3,06	3,06	3,86	3,86	4,86	4,86	5,56	5,56	6,6

Fig. 1 Graph of the cost distribution of balls of different varieties of amber

The stair graph of bullet size looks illogical. For example, balls of the same size of 1.05 cm (serial numbers 2 and 3) have different values: one is worth $0.07 and the other is $0.43). In order to eliminate this shortcoming, let's make a table.5 with an interval of 1 g, and the cost of the fraction will be divided equally. For example, the cost of the 2-5g fraction starts at $60/kg ($0.060/g) and ends at $182/kg ($0.182/g). Subtract the first value from the last value and divide it into three intervals, as a result we will get the value by which each interval will increase:

(182 – 60) ÷ 3 = $40.6/kg

(in this way we will extend to 500 g).

Table 5

Price list on an amber ball according to the calculations of *AMBER-3* software

Sample weight (g)	Bullet diameter, cm	Bullet price by quality group, $		
		1st grade	2nd grade	3rd grade
1.00	**0.85**	**0.20**	**0.07**	**0.03**
2.00	1.07	0.40	0.13	0.07
3.00	1.23	1.00	0.56	0.41
4.00	1.35	1.88	1.24	0.96
5.00	**1.46**	**3.03**	**2.17**	**1.73**
6.00	1.55	4.44	3.08	2.46
7.00	1,63	6.07	4.15	3.31

Continuation of Table 5

Sample weight (g)	Bullet diameter, cm	Bullet price by quality group, $		
		1st grade	2nd grade	3rd grade
8.00	1.71	8.00	5.39	4.29
9.00	1.77	10.20	6.78	5.40
10,00	**1.84**	**11.67**	**8.33**	**6.67**
11.00	1.90	16.06	10.52	8.43
12.00	1.95	19.48	13.00	10.40
13.00	2.00	23.18	15.69	12.57
14.00	2.05	27.25	18.62	14.93
15.00	2.10	31.60	21.85	17.50
16.00	2.15	36.32	25.28	20.27
17,00	2.19	41.31	29.01	23.23
18.00	2.23	46.68	32.94	26,40
19.00	2.28	52.38	37.18	29.77
20,00	**2.31**	**58.33**	**41.67**	**33.33**
22,00	2.39	68.71	49.06	39.23
24,00	2.46	79.92	57.04	45.60
26.00	2.53	91.95	65.69	52.43
28.00	2.59	104.81	74.85	59.73
30.00	2,65	118.50	84.60	67.50
32.00	2.71	133.01	94.93	75.73
34.00	2.76	148.35	105.97	84.43
36.00	2.82	164.52	117.48	93.72
38,00	2.87	181.51	129.58	103.36
40.00	2.92	199.33	142.27	113.47
42.00	2.96	217.98	155.54	124.04
44.00	3.01	237.45	169.40	135.08
46.00	3,05	257.75	183.85	146.59
48.00	3.10	278.88	198.88	159.20
50.00	3.14	301.00	215.00	172.00

As a result of processing the calculated data, we obtain a smooth curve of the size and cost of the bullets (*see Fig. 2*). Such a graph is logical and understandable, and the question of how much a bullet weighing 3 g or 4 g costs does not arise.

Thus, if you know the cost of one ball, you can calculate the cost of a necklace, that is, multiply the number of beads in a string by the cost of the balls, taking into account the cost of work on assembling the necklace. In the table6 shows the results of calculating the cost for ball necklaces of different grades. The Pearson correlation coefficient is 0.78, indicating a strong relationship between bead size and bead value.

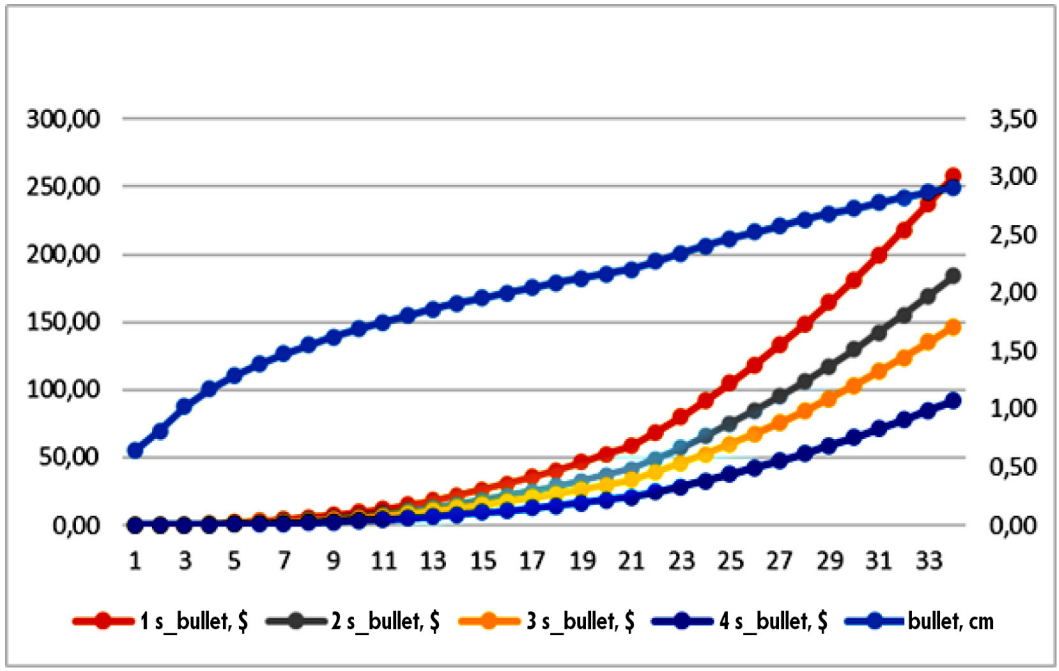


Fig. 2. Dependence of the cost of balls on their size

Table 6

The cost of a necklace-ball from different varieties of amber

Thread length, cm	Bullet diameter, cm	Number of beads	The price of a necklace-ball by quality groups, $		
			1st grade	2nd grade	3rd grade
48	0.85	56	12.42	4.35	1.86
48	1.07	45	19.74	6.41	3.45
48	1.23	39	42.93	24.04	17.60
48	1.35	36	73.53	48.50	37.55
48	1.46	33	109.58	78.48	62.56
50	1.55	32	157.55	109.29	87.29
50	1,63	31	204.82	140.03	111.69
50	1.71	29	257.31	173.36	137.98
52	1.77	29	329.63	219.11	174.51
52	1.84	28	362.78	258.95	207.35
52	1.90	27	483.49	316.71	253.79
52	1.95	27	571.41	381.33	305.07
52	2.00	26	662.95	448.73	359.50
52	2.05	25	760.34	519.54	416.58

Continuation of Table 6

Thread length, cm	Bullet diameter, cm	Number of beads	The price of a necklace-ball by quality groups, $		
			1st grade	2nd grade	3rd grade
52	2.10	25	860.72	595.15	476.67
52	2.15	24	966.28	672.57	539.28
52	2.19	24	1078.96	757.70	606.74
52	2.23	23	1197.35	844.92	677.17
52	2.28	23	1314.09	932.76	746.86
52	2.31	23	1444.36	1031.83	825.31
52	2.39	22	1644.44	1174.16	938.89
52	2.46	21	1858.30	1326.30	1060.29
52	2.53	21	2078.87	1485.17	1185.37
52	2.59	20	2314.72	1653.06	1319.13
52	2,65	20	2557.81	1826.08	1456.98
52	2.71	19	2807.44	2003.69	1598.43
52	2.76	19	3074.50	2196.19	1749.78
52	2.82	18	3337.07	2382.93	1900.99

Let us sum up the subtotals. If we compare the estimated prices for necklaces with their market prices, it becomes clear that the cost of the former is much lower than the latter. For example, the average estimated cost of a bead-ball (the size of beads is from 0.63 to 2.63 cm) is $937, and in the «Янтар Полісся» company (the size of beads is from 0.7 to 2.5 cm)– $2255 (excluding the color of amber according to the price lists), that is, we observe a difference of 2.4 times [25].

Instead, the estimated cost of beads from small beads is very low, which cannot be said about their market prices. Publication 2022 [26] states that the estimated cost of raw materials does not coincide with the price lists of the SGCU, as a result of which the cost of a necklace with a small diameter of beads is overestimated.

At the same time, the market and estimated prices for beads with large beads are very close. Currently, a necklace with a bead diameter of more than 2 cm is extremely rare on the market, while necklaces with a small bead diameter are in excess.

Thus, the simulation results obtained using *the* Amber-3 software are aimed at standardizing calculations and increasing objectivity of research. With this approach, you can set any weight of the sample (fraction), any size interval between samples and get forecast prices for new amber products, that is, form a price list for the goods.

25 Baranov P., Slyvna O., Korotaiev V. Price lists for amber and their significance in market and planned regulation of the economy. *Forensic Herald*. 2024. № 1 (41). Pp. 19—31. DOI: 10.37025/1992-4437/2024-41-1-19 (date accessed: 22.06.2024).

26 Kirin R., Baranov P., Shevchenko S., Korotayev V. Method of price formation of amber samples on the basis of gemmological-consumer indicators. *Journal of Geology, Geography and Geoecology*. 2022. Vol. 31. № 2. Pp. 321—332. DOI: 10.15421/112230 (date accessed: 22.06.2024).

Conclusions

Gemological and legal principles of an accessible level of objectivity in determining the value of amber spheres and necklaces based on state price lists for amber and experimentally determined technological parameters for the manufacture of amber products are substantiated. Most often, the estimated value of amber in Ukraine is determined by a monopoly based on the results of State gemological examination.

The cost of amber raw materials for the manufacture of balls, the cost of manufacturing balls, their implementation and other parameters of the technological process (yield of suitable) are determined on the basis of the processing of experimental data obtained during multifactorial experiments. The results of the latter confirmed that the cost of raw materials for the manufacture of bullets on average is 30% of the cost of the product, and the yield of suitable products is 30%. We propose to consider this indicator as the lower limit at which manufacture of bullets is unprofitable.

Algorithm for determining the value of amber products has been developed, which is based on the dependence of the commercial value of the product on gemological and physical quantitative and qualitative indicators (as well as the estimated value of raw materials) and which allows (using the example of calculating the value of balls and beads from balls) to offer reasonable price lists for amber products and compile improved price lists for amber raw materials.

It is argued that the results of the application of the Amber-3 software provide an integrated approach to calculating the cost of the *raw material — product* metonymic model and increase the objectivity of the relevant studies due to the ability to vary the weight of the sample (fraction), the interval between samples, geometric and qualitative parameters of the individual product components.

Прайс-листи на вироби з бурштину як інструмент експертного оцінювання: гемолого-правові засади

Петро Баранов,
Роман Кірін,
Олена Сливна

Мета цієї праці — розробити алгоритм складання прейскурантів на вироби з бурштину за даними реального ринку намиста й кульок. Для досягнення мети (за допомогою загальнонаукових і спеціальних методів наукового пізнання) проаналізовано споживчі властивості виробів (колір, вагу, розмір, наявність включень і тріщин, прозорість, якість оброблення, ціну) та створено базу даних, яка сприятиме розв'язанню теоретичних і прикладних питань. На задоволення потреб сучасного ринку розроблено прайс-листи на вироби із бурштину, які ґрунтуються на економічно обумовлених і зрозумілих розрахунках і які є одним із джерел об'єктивних і надійних результатів в експертній та оцінній діяльності, а також актуальні в економічній геології (для з'ясування доцільності промислового розроблення родовищ корисних копалин). Об'єктивність і надійність здобутих результатів гарантовано програмним забезпеченням, створеним за реальними показниками якості сировини (кольором, масою, розміром, прозорістю) і технологічного процесу виробництва товарної продукції. Показник вартості сировини у 30 % від вартості виробу запропоновано вважати межею, нижче за яку виготовлення бурштинових куль позбавлене рентабельності.

Ключові слова: *буршти́н; експертиза; оцінювання; вартість; алгоритм; прейскурант; ринок.*

Financing

This research did not receive any specific grant from funding institutions in the public, commercial or non-commercial sectors.

Disclaimer

Founders had no role in the research design, data collection and analysis, decision to publish or manuscript preparation.

Participants

The author has contributed solely to intellectual discussion underlying this document, case law research, writing and editing, and assumes responsibility for its content and interpretation.

Declaration of Competing Interest

Authors declare no conflict of interest.

References

Baranov, P., Korotaiev, V., Slyvna, O. (2021). Features of pricing of amber products in modern conditions. *Forensic Herald*. 2023. № 2 (40). DOI: 10.37025/1992-4437/2023-40-2-68.

Baranov, P., Slyvna, O., Korotaiev, V. (2024). Price lists for amber and their significance in market and planned regulation of the economy. *Forensic Herald*. № 1 (41). DOI: 10.37025/1992-4437/2024-41-1-19.

Belichenko, O. P., Ladzhun, V. I., Tatarintseva, K. V. (2017). Atestatsiia ta ekspertna otsinka dorohotsinnoho kaminnia orhanohennoho pokhodzhennia (burshtyn) [Certification and expert evaluation of precious stones of organogenesis origin (amber)] : navch. posib. Kyiv [in Ukrainian].

Belichenko, O. P., Ladzhun, Yu. I., Tatarintsev, K. V., Haievskyi, Yu. D., Maksiuta, O. V., Kravchenko, M. O. (2021). Suchasnyi stan ta dynamika rozvytku rynku burshtynu [Current state and dynamics of the amber market development]. *Koshtovne ta dekoratyvne kaminnia*. № 1 (103). URL: https://www.gems.org.ua/jurnal/archive/2021/N1(103)/image/stat4.pdf [in Ukrainian].

Belichenko, O. P., Tatarintseva, K. V., Ladzhun, Yu. I., Haievskyi, Yu. D., Maksiuta, O. V., Kravchenko, M. O. (2022). Naukove obgruntuvannia rozroblennia ta onovlennia tekhnichnykh umov i metodychnykh dokumentiv DHTsU z atestatsii ta ekspertnoi otsinky dorohotsinnoho kaminnia, dorohotsinnoho kaminnia orhanohennoho utvorennia [Scientific substantiation of the development and updating of technical conditions and methodological documents of the State Scientific Center for Certification and Expert Evaluation of Precious Stones, Precious Stones of organogenesis Formation]. *Koshtovne ta dekoratyvne kaminnia*. № 4 [in Ukrainian].

Bilham, N. T. (2021). Responsible mining and responsible sourcing of minerals: opportunities and challenges for cooperation across value chains. *Geological Society, London, Special Publications*. Vol. 508. DOI: 10.1144/SP508-2020-130.

Dovidnyk tsin koshtovnoho ta dekoratyvnoho kaminnia [Handbook of Prices of Precious and Decorative Stones]. (2024). № 2 (61) [in Ukrainian].

Elektronni torhy. Rezultaty 2019—2023 [Electronic bidding. Results 2019—2023] / Derzhavna sluzhba heolohii ta nadr Ukrainy : ofits. sait. URL: https://www.geo.gov.ua/wp-content/uploads/presentations/ukr/statistika-elektronnix-torgiv.pdf [in Ukrainian].

Ilchyshen, I. (2024). Burshtyn mozhe prynosyty v Ukrainu dodatkovyi capital [Amber can bring additional capital to Ukraine]. *Nadra info*. 15.02.2024. URL: https://nadra.info/2024/02/ihor-ilchishen-amber-can-bring-additional-capital-to-ukraine/ [in Ukrainian].

Kirin, R. S. (2024). Legal support for the evaluation and sale of objects of gemological relations. *Forum of Rights*. No. 78 (1). DOI: 10.5281/zenodo.10869348.

Kirin, R. S., Baranov, P. M., Korotaiev, V. M., Shevchenko, S. V. (2023). Algorithm for the formation of price lists for raw amber taking into account individual consumer characteristics. *Naukovyi Visnyk Natsionalnoho Hirnychoho Universytetu*. № 1. DOI: 10.33271/nvngu/2023-1/020.

Kirin, R., Baranov, P., Koziakov, I. (2021). Gemological Law of Ukraine: formation Problems and development Prospects. *Visnyk of Taras Shevchenko National University of Kyiv. Geology*. T. 2. № 93. DOI: 10.17721/1728-2713.93.01.

Kirin, R., Baranov, P., Shevchenko, S., Korotayev, V. (2022). Method of price formation of amber samples on the basis of gemmological-consumer indicators. *Journal of Geology, Geography and Geoecology*. Vol. 31. № 2. DOI: 10.15421/112230.

Rippa, A., Yang, Y. (2017). The Amber Road: Cross-Border Trade and the Regulation of the Burmite Market in Tengchong, Yunnan. *TRaNS: Trans-Regional and National Studies of Southeast Asia*. Vol. 5. Is. 2. DOI: 10.1017/trn.2017.7.

Rudko, H. I., Lytvyniuk, S. F. (2017). *Rodovyshcha burshtynu Ukrainy ta yikh heoloho-ekonomichna otsinka* [Deposits of amber of Ukraine and their geological and economic assessment] / za red. prof. H. I. Rudka. Kyiv — Chernivtsi [in Ukrainian].

Baranov, P., Kirin, R., Slyvna, O. (2024). Price lists for amber products as a tool for expert evaluation: gemological and legal principles. *Theory and Practice of Forensic Science and Criminalistics*. Issue 3 (36). P. 84—99. DOI: 10.32353/khrife.3.2024.07.