Universitatea
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Contributions regarding the red deer trophies (*Cervus elaphus L.)* from Romania

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BRAȘOV, 2023

Universitatea Transilvania din Brașov

CONTENT

INTRODUCTION

The red deer (*Cervus elaphus* L.) is perhaps the most widespread and diversified species of the Cervidae family, serving as a symbol in European culture. It adorns coats of arms, monuments, inspires legends, appears in poetry and songs, and castles are even built in its honor where trophies are displayed. Throughout history, hunting and managing this animal have sparked profound passions (Geist, 1998).

Trophies, regardless of their size, can be used as educational material in schools and for training hunters, representing a way to capitalize on and learn from hunting experiences and wildlife population management. They hold sentimental value for hunters and can serve as concrete examples in the process of learning and understanding artificial selection (Cotta et al., 2001). It is essential to mention that the profound passions associated with hunting and wildlife management can vary in intensity and how they are perceived by individuals. Each person can experience and interpret these activities in a personal and unique way, depending on their values, experiences, and perspectives. Furthermore, hunting and management can provide opportunities for testing skills and knowledge, as well as taking responsibility in the management and conservation of natural resources.

Hunting trophies express a series of specific elements that can be analyzed, quantified, and ranked. Through measurement, morphometric elements, as well as other appreciable characteristics of the trophy, gain a mathematically defined value, which is then converted into scores through a calculation formula. The methodology for evaluating trophies represents a specific vision regarding the identification, appreciation, and promotion of certain parameters considered by specialists to be the most important. The selection of species and types of trophies that can be evaluated is closely related to the evolution and technical norms of each methodology (Spătaru et al., 2021).

This paper analyzes the composition and peculiarities of the evaluation methods and parameters of red deer (*Cervus elaphus* L.) trophies using the methodologies of CIC, Rowland Ward, Safari Club International, and supplementary methods like Nadler and Carpathian as a common starting point (Spătaru et al., 2021). Additionally, it focuses on analyzing the peculiarities and the relationship between measurable parameters, methods, and trophy performances in Romania.

Although seemingly a traditional and aesthetic matter, trophy evaluation has produced specific effects over time, including exhibitions, national and international rankings, as well as cultural, social, and economic implications. The practical and significant utility of trophy quality is represented by the correlation between the genetic value of species (gene pool), specific environmental conditions, and the results of species management activities (Spătaru et al., 2021).

By evaluating trophy quality and understanding its correlation with the gene pool and species management, progress can be made in wildlife population management actions, ensuring the preservation and improvement of genetic diversity and trophy quality in the long term. The proposed aim of this paper is to provide a detailed perspective on the architecture, the relationship between parameters and performance characteristics, both historical and current, of red deer trophies in Romania. The work focuses on determining and interpreting trophy-related data, including dimensions, weight, growth patterns, age, and any other relevant parameters, as well as forming an overview of the historical evolution of the results recorded for this species in Romania and the effects of the trophy evaluation phenomenon. Through this, a deeper understanding of the evolution and quality of red deer trophies in Romania will be achieved, contributing to the proper management and conservation of this species.

CHAPTER 1. STATE OF THE ART

1.1 Species systematic, taxonomic classification, distribution

The red deer (*Cervus elaphus* L.) belongs to the following taxonomic classification:

- Class: ***Mammalia***
  - Order: ***Artiodactyla***
    - Suborder: ***Ruminantia***
      - Family: ***Cervidae***
        - Genus: ***Cervus***
          - Species: ***Cervus elaphus hippelaphus***

The red deer (*Cervus elaphus* L.) is the most well-known and widely distributed species in the world, with over 22 subspecies. According to Dolan (1988), Whitehead (1993), and Wagenknecht (1996), the following are the main subspecies based on their locations:

- *Cervus elaphus elaphus* Linné 1758: Southern Sweden
- *Cervus elaphus atlanticus* Lönneberg 1908: Southwestern Norway
- *Cervus elaphus scoticus* Lönneberg 1908: Scotland and England
- *Cervus elaphus hippelaphus* Erxleben 1777: Central and Eastern Europe, from the Pyrenees to Belarus and from Denmark to Italy and the Balkans
- *Cervus elaphus hispanicus* Heimer 1909: Iberian Peninsula
- *Cervus elaphus corsicanus* Erxleben 1777: Corsica and Sardinia
- *Cervus elaphus maral* Gray 1850: Asia Minor, Caucasus, Crimea, and Iran.

According to the International Union for Conservation of Nature (IUCN), the species *Cervus elaphus* includes the following subspecies:

- *Cervus elaphus atlanticus*, Lönneberg 1908: Norway
- *Cervus elaphus barbatus*, Banett 1833: Algeria, Tunisia, Morocco
- *Cervus elaphus bolivari*, Cabrera 1911: Northern Spain
- *Cervus elaphus brauneri*, Charlemagne 1920: Europe, former USSR
- *Cervus elaphus corsicanus*, Erxleben 1777: Corsica and Sardinia
- *Cervus elaphus elaphus*, Linne 1758: Sweden
- *Cervus elaphus hippelaphus*, Erxleben 1777: Belgium
- *Cervus elaphus hispanicus*, Hilzheimer 1909: Southern Spain
- *Cervus elaphus maral*, Ogilby 1840: Iran, Turkey, former USSR
- *Cervus elaphus montanus*, Botezat 1903: Carpathians.

Figure 1. *Cervus elaphus distribution according to IUCN 2018. Version 2022-2*

1.2 Species morphology, ecology and ethology

1.2.1 Morphology

Cerbul comun (*Cervus elaphus* L.), numit în trecut și "cerb carpatin" este cel mai de seamă reprezentant al familiei *Cervidae* (Clutton-Brock, 2002) și specia de vânat mare situată pe primul loc din perspectiva interesului cinegetic și faunistic, cât și al ponderii economice (Micu, 1978). Cotta et al (2001) precizează faptul că o încercare de a deosebi subspecii ale cerbului din interiorul arealului european, în baza criteriilor de tip formă generală, greutatea corporală sau forma coarnelor pare a fi o intenție nereușită.

The red deer (*Cervus elaphus* L.), formerly known as the "Carpathian deer," is the most prominent representative of the Cervidae family (Clutton-Brock, 2002) and the most significant large game species in terms of hunting and faunistic interest, as well as economic importance (Micu, 1978). According to Cotta et al. (2001), attempting to distinguish subspecies of red deer within the European range based on criteria such as general body shape, body weight, or antler shape appears to be unsuccessful.


Figure 2. *Mature red deer (Cervus elaphus L.). Foto: Spătaru Cezar Georgian*

Morphometric dimensions vary depending on sex, age, and season: the male, called "stag" or "bull," has an average weight of 240-250 kg, exceptionally exceeding 310 kg, with a head and body length of up to approximately 240-250 cm and a height at the withers of 152-155 cm; while the female, called "hind" or "doe," has an average weight of about 80-130 kg (Cotta et al., 2001).

The summer coat color is generally reddish on the upper part of the body and much lighter, a yellowish-white, on the abdomen; the winter coat is darker in color than the summer coat; nuances can vary from one individual to another within the same deer population (Cotta et al., 2001).

The dental formula of the red deer is similar to other ruminant species: I (incisors) 0/3 C (canines) (1)/1 P (premolars) 3/3 M (molars) 3/3 = 34 (32). Due to the deposition of secondary dentin, the dentition can present characteristic patterns that can be used to determine the age of the individual (Brown, 1991). The complete growth of permanent teeth is finished around 4 years of age, approximately at 42-44 months old, based on which the age can be determined up to 3.5 years. Subsequently, tooth wear level and skeletochronology can be used to determine the age (Azorit et al., 2002). The canines in the lower jaw have a shape similar to incisors and are joined to them, while the canines in the upper jaw have a lack of enamel and a darker color, making them a secondary trophy highly appreciated by hunters for creating hunting decorations (Cotta et al., 2001).

The bony protrusions on the head of the red deer (*Cervus elaphus* L.), which develop regularly each year on two specific prominences of the frontal bones (frontal cylinders), are called antlers. Antlers are a secondary sexual characteristic found only in males (Cotta et al., 2001). From an evolutionary perspective, antlers appear in four families of ruminants - Cervidae, Giraffidae, Antilocapridae, and Bovidae (Kawtikwar et al., 2010) and are mainly composed of collagen protein and the mineral hydroxyapatite of calcium (HA). The process of antler growth influences the shape of the frontal cylinders, which are longer and thinner in young individuals and shorter and thicker in older individuals. These characteristics can be used to estimate age (Cotta et al., 2001). Specific terms have been used for the characterization of each individual part of the antlers (Isaković, 1968): coronets, main beam, tines or points, crown, or cup. In order of position, starting from the base towards the tip of the main beam, the following typical tines can be identified: brow tine - the first tine, bay tine - the second tine, tray tine - the third tine. Rarely, there is also the wolf tine (fourth tine); all the points positioned after the tray tine form the crown (Fig. 3). Apart from the bez tine, present in about one-third of stags and usually appearing at 4-5 years old (Cotta et al., 2001), a rarer presence is that of the wolf tine, positioned above the tray tine, which is included in the crown during the trophy evaluation process.

Antlers represent a unique model for basic research in the biology of the skeletal system because, through their annual growth and shedding, they are the only accessible bones in an animal without the need for surgical procedures (Harvey & Bradbury, 1991). Antlers are shed annually, starting from February to April, with older individuals shedding them earlier and younger ones shedding them later. After shedding, the growth of new antlers begins within approximately 10 days. The growth follows a specific order, starting with the main beam, followed by the brow tine, bay tine if present, tray tine, and finally, the crown tines. The entire process takes about 120-130 days (Cotta et al., 2001). The cleaning and coloring of antlers occur in July-August. The weight of the antlers, together with the entire upper jaw, ranges from 7 to 15 kg, with an average of 8 kg for stags aged 10-12 years. The antlers alone represent up to 4-5% of the total weight of the deer (Cotta et al., 2001). For their growth, antlers require partial demineralization of the skeleton, as the diet cannot provide sufficient mineral quantities for their rapid growth (Meister, 1956; Muir et al., 1987), which can reach 2-4 cm per day (Goss, 1983).

Hence, there are opinions suggesting that antler size is not an indicator of a male's strength but rather an indicator of nutrition and habitat quality.

Antlers of cervids have drawn attention since ancient times, starting from prehistoric eras and continuing to the present day. Hunters pay special attention to these creations as valuable trophies. As a result, deer trophies in museums and hunting collections attract attention and become objects of research aimed at active management to obtain specimens worthy of trophies (Bradvarović, 1997).

Figure 3. *Mature red deer (Cervus elaphus L.) in april, at the beggining of antler growth. Foto: Spătaru Cezar Georgian*

The normal sex ratio is considered to be 1:1 or 1:1.5, and maintaining this ratio is justified to prevent the potential over-multiplication of females, which could lead to a decrease in body weight and antler weight for males. This situation may result in young and weaker males actively participating in mating. On the other hand, if there is an overabundance of males, it can lead to intense competition among them during the rutting season, excessive movements in search of females, including the stronger ones, and consequently, it may destabilize the deer population (Cotta et al., 2001).

1.2.2 Ecology

The favorable habitat for red deer consists of extensive, quiet forests covering at least 5000 hectares, with fertile soil, rich in food, traversed by flowing waters, and with good marshes for bathing. Ideal food conditions are represented by deciduous forests or mixed forests of deciduous and coniferous trees, with agricultural enclaves or clearings, containing tree stands with normal age classes. This includes both areas with tender grass and saplings and middle-aged tree stands that provide good shelter, as well as mature tree stands that produce acorns, beech nuts, or other forest fruits. A significant portion of the red deer's diet consists of leaves from deciduous trees; therefore, pure coniferous forests do not constitute an ideal environment. However, the absence of deciduous trees is compensated by other valuable species in the understory, which also provide essential shelter (Cotta et al., 2001).

Although in Romania, red deer is mainly associated with forest and mountainous areas, the exception of its presence in lowland areas in the past is gradually becoming more common. After 1990, the appearance of red deer in the southern counties of the country, apparently

originating from Bulgaria, and the favorable environment, particularly represented by agricultural crops, led to an increase in body weight and antler size (Cotta et al., 2001).

The living environment of red deer significantly influences the numerical and qualitative ratio of their development. Although more resistant than roe deer to climatic conditions, the most critical period for red deer is winter, especially when the snow cover is thick and hinders access to food, particularly if it correlates with a year of poor acorn or beechnuts production (Cotta et al., 2001).

The distribution of red deer, considering the ecological demands and sensitivities of this species, is mostly along the Carpathian mountain range, from Maramureș to Oltenia, with the highest representation in the counties of Suceava, Harghita, Mureș, Covasna, and Brașov, and the lowest representation in the Apuseni Mountains (Cotta et al., 2001).

1.2.3 Ethology

The social behavior of red deer is gregarious, forming separate sexual and spatial herds for a large part of the year, but with relatively small distances between groups. This grouping is due to the efficiency in the collective effort of defense. It is observed that there are herds consisting of females, calves, and young males, and separate herds of middle-aged and older males. Mature or older males often live solitary and isolated for a significant part of the time. Intraspecific relationships may establish a linear hierarchy based on the frequency of individual contacts and the common living conditions and habitat (Buetzler, 1986). Herding of red deer occurs only from October to May (Cotta et al., 2001), during the winter period when natural or supplemental food is available in specific areas. Except for open areas in lowland regions, in mountainous areas, and during mild winters with ample natural food availability, female groups are less numerous. The advancement and development of vegetation and food sources in spring across larger areas of the habitat, along with the fawning and raising of offspring, lead to a gradual disintegration of herds and the dispersal of females.

The mating period, known as "the rut," occurs in the fall, between September 10th and October 10th, with its peak between September 20th and 30th. In the lowland areas, the rut starts slightly earlier but intensifies depending on the temperature; cold weather accelerates it, while warm weather delays it (Cotta et al., 2001). Approximately half of the females reach sexual maturity at around 16-17 months, and most of them at 28 months, while males become capable of reproduction much later, at 5-6 years of age. The gestation period lasts for 34 weeks (Cotta et al., 2001). The rut is the most dynamic period in the social life of red deer. During this time, females group together, reduce their movement range, and focus on attracting and mating with the most dominant male. The rut is marked by the females coming into estrus, leading to intense competitions through fights between the strongest males. At the peak of their reproductive cycle, the goal is for the dominant male to isolate and control the group of females, keeping weaker males, known as "satellite males," at a convenient distance. During this period, the presence of antlers is directly correlated with the peak of development. The herds formed during the rut generally consist of one male deer and 2-7 females (Cotta et al., 2001).

Red deer is a species active during twilight and dusk, maintaining this temporal characteristic both during feeding and the rut. The roaring of the males is undoubtedly the most impressive characteristic of red deer and represents a form of sexual behavior. This biological act is accompanied by a unique phenomenon in the animal world, which cannot be simply explained and serves as a means of communication between individuals and the herd. It includes a mosaic of homogeneous and heterogeneous sound signals (Bradvarovic, 2017). Temperature, atmospheric pressure, wind presence, and precipitation directly influence the intensity and dynamics of the rut. Sudden changes in meteorological factors at any stage of mating have a temporary effect on rutting

kinetics. High and stable air pressure improves bellowing, while low pressure calms it down. Low temperatures during nights and warm days reduce the intensity of bellowing, whereas clear and cool days, especially foggy mornings and after rain, intensify it. Rain has a positive effect on the rut, as it always lowers the temperature, resulting in more dynamic and intense bellowing after rainfall (Bradvarovic, 2017). Rutting locations are mainly represented by semi-open areas, including managed fields, clearings, patches of trees, as well as large, sparse, or bordering alpine forests (Cotta et al., 2001).

The food of the deer is strictly of vegetal origin. During the vegetation period, it feeds on herbs and tree leaves, including growing shoots. In winter, it consumes green herbaceous plants, as well as shoots, buds, and tree bark (Cotta et al., 2001). Additionally, the deer also consumes lichens, which can be found in logged areas and on trees with reduced vegetation, where these species grow. The deer finds abundant and quality food in logged areas, clearings, and adjacent agricultural fields, which is why it chooses resting places during the day near these areas. It generally prefers the edges of forests with fewer trees, where it can find a greater variety of food (Cotta et al., 2001).

1.3 Game trophy evaluation methodologies; importance, history, evolution.

1.3.1 The importance of game trophy evaluation methodology

From the perspective of hunting trophies, the late 20th century and the early 21st century mark an ascent through a reversal of perspectives and research directions. Specifically, the focus shifts from simple comparisons of trophy quality to discover "good" or "bad" hunting grounds, towards the development of mathematical evaluation models to appreciate the growth and pinnacle of trophy value. At the same time, other research directions come to light, including the exploration of the complexity of interactions between different game species and their habitats, the development of trophy value (Hell, 1983; Hell & Cimbal, 1974), the relationship between various trophy parameters and other physical characteristics (Drechsler, 1992a, 1992b; Stubbe, 1967), and the morphology of trophies from different populations (Hromas and Bakoš, 1994; Isaković, 1969; Munkačević, 1964). Additionally, an analysis of trophy management and production has also become possible (Marman, 1994). These results are essential as hunting is a significant economic branch, and optimizing trophy production is indispensable for overall development in the hunting economy.

Hunting trophies express a series of specific elements that can be analyzed, quantified, and ranked. With the evolution of hunting activities and traditions regarding trophy recognition, the initial visual and subjective appreciation has evolved over time towards the necessity of identifying parameters that can be measured based on a clear and objective methodology. Thus, through measurement, the morphometric elements and other appreciable characteristics of the trophy acquire a mathematically defined value, which can be translated into scores through a calculation formula. The methodology for evaluating trophies represents a specific vision for identifying, appreciating, and promoting certain parameters considered by specialists as the most important. The selection of species and types of trophies that can be evaluated is closely linked to the evolution and standardization of each methodology's technical norms (Spătaru et al., 2021).

The valorization of trophies has been achieved over time through hunting exhibitions. The evaluation of trophies, thus framed, expresses the quality of the game and, implicitly, the hunting stocks from different countries and regions, while also having cultural, social, and economic connotations. Based on the resulting data, specific characteristics can be formulated and determined. This also provides the possibility of making objective deductions over time regarding the vigor of populations (gene pool), their progress, and regression, as well as the seasonal conditions and directions in species management activities (Spătaru et al., 2021).

1.3.2 Game trophy evaluation methodologies; short history

Apparently a traditional and aesthetic matter, the evaluation of trophies has generated over time both specific effects related to hunting exhibitions and national and international rankings, as well as effects with cultural, social, and economic implications. Different perspectives from specialists regarding trophy morphology are expressed internationally through various evaluation methodologies. The practical and significant utility of trophy evaluation lies in the correlation between genetic value (gene pool), seasonal conditions, and the outcome of species management activities. It is worth noting that among all international trophy evaluation systems, there is mutual recognition between the Rowland Ward, CIC, and Boone & Crockett measurement systems (Spătaru et al., 2021).

1.3.2.1 International Council for Game and Wildlife Conservation – measurement methodology

To avoid subjectivity and move towards the development of objective criteria, the creation of clear instructions for trophy evaluation was one of the main objectives of establishing the International Council for Game and Wildlife Conservation (CIC). This event took place on February 5, 1930, in Berlin, and it was based on the results obtained at the Leipzig exhibition in the same year (1930). The evaluation formulas underwent further improvements at subsequent similar events in Warsaw in 1934, Prague in May 1937, and Berlin in November 1937, during the International Hunting Exhibition. The decisions made at these events confirmed the evaluation formulas, with minor modifications, and were adopted at the CIC General Assembly in Madrid in November 1952. These modifications were aimed at enhancing the objectivity and precision of hunting trophy evaluation, ensuring that the formulas were relevant and applicable to all specific game species in Europe and Africa. Further modifications to the evaluation formulas were approved at Düsseldorf in 1954 and Copenhagen in 1955. The improved international system was finalized during the Fifth International Hunting Exhibition in Budapest in 1971. However, unifying other aspects, objections, and suggestions was achieved only in November 1977 when a unified system was adopted (International Council for Game and Wildlife Conservation, 2012).

The current form of the trophy evaluation system, materialized in the form of a manual by the Trophy Evaluation Committee (TEB), was published in November 2014 following the 61st General Assembly in Milan in April 2014. The current methodology for trophy evaluation can be found in the most recent format in the "CIC Handbook for the Evaluation and Measurement of Hunting Trophies - 2019" (CIC, 2019). The trophy evaluation methodology developed by the International Council for Game and Wildlife Conservation (CIC) is one of the most widespread and widely used basic formulas in Europe. This methodology has been adapted nationally in most European countries and other regions worldwide, being adopted and used in over 50 countries globally (Spătaru et al., 2021).

1.3.2.2 Rowland Ward measurement methodology

At the end of the 19th century, in 1892, the first work on hunting trophies was published in England, titled "Horn Measurements and Weights of the Great Game of the World" by Rowland Ward (naturalist and taxidermist, 1848–1912). In 1896, with the second edition, the work was renamed "Records of Big Game," a name that was retained in subsequent editions. Over time, the book has become an important reference for trophy collectors and hunting enthusiasts and reached its 30st edition in 2019. The 31st edition of "Records of Big Game" by Rowland Ward will be published in the autumn of 2024 and will consist of two volumes; Volume 1 "Africa" and Volume 2 "America, Europe, Asia, and the South Pacific" (Spătaru et al.,

2021). Initially, hunting trophies were brought to London for evaluation, and later, by the end of 1930, a global network of specialized evaluators for trophy measurement was developed. During that period, the instructions for taking measurements were relatively simple and mainly involved measuring the length, spread, and circumference of the longest antlers or tusks, and the length of the pelts of large predator animals.

The most recent form of the current methodology for trophy evaluation can be found in "Rowland Ward's Measuring Handbook - 2020" (Spătaru et al., 2021).

1.3.2.3 SCI - Safari Club International measurement methodology

The measuring system of the Safari Club International (SCI) was developed by the founder and president of SCI, C.J. McElroy, in 1977. This measuring system was initially created for use in the publication "SCI Record Book of Big Game Animals" and in various award programs organized by SCI. Although there have been some modifications over time, the SCI measuring and scoring system has remained generally consistent and applicable globally.

The current form of the methodology can be found in the "SCI - Official Measurer's Manual handbook - 2019" (SCI, 2019; (Spătaru et al., 2021).

1.3.2.4 B&C - Boone and Crocket Club measurement methodology

In 1932, the first edition of the book "Records of North American Big Game" was published in the United States. This work covered a relatively small number of specimens and listed them based on a simple criterion, relying on the length and spread of antlers or skulls. Later, a committee of the Boone and Crockett Club (founded in 1887) used this work as a basis and developed a precise mathematical scoring system in 1949. This system was published in 1952 and remains unchanged and valid for evaluating North American big game trophies to this day, according to the Boone and Crockett Club (B&C, 2021).

The evaluation system developed by the Boone and Crockett Club has had a significant influence and has been recognized and adopted in several new evaluation methodologies within the CIC system. This is due to the prestige and expertise in trophy evaluation and the precise standards they have established. Over time, the CIC has collaborated with various hunting organizations and clubs from around the world, including the Boone and Crockett Club, to develop and harmonize trophy evaluation methods. This exchange of knowledge and experience has led to continuous improvement in trophy evaluation methodologies, ensuring a common and unified framework in terms of standards and evaluation criteria (International Council for Game and Wildlife Conservation, 2012; Spătaru et al., 2021).

1.3.2.5 National game trophy evaluation methodology

The national methodology for the evaluation of hunting trophies in Romania is currently regulated by Order No. 418 dated June 2, 2005, issued by the Ministry of Agriculture, Forestry, and Rural Development, and it was published in the Official Gazette No. 548 on June 28, 2005. This order approved the methodology for the evaluation of hunting trophies in accordance with the International Council for Game and Wildlife Conservation (CIC) standards.

It is important to note that after the issuance of this order, no updates with the most recent adjustments to the CIC methodology beyond 2005 have been made (Spătaru et al., 2021).

1.3.3 Red deer (*Cervus elaphus* L.) methods of trophy measurement

Herbert Nadler, the director of the Budapest Zoo and Botanical Garden, a zoologist, and a hunting journalist, developed and described the first formula for evaluating red deer (*Cervus elaphus*) trophies in 1925. This evaluation method was followed by the "Carpathian Formula."

Both methods were used at the first hunting exhibition organized in Romania in Bucharest, in May-June 1935. This event provided a valuable opportunity to showcase hunting trophies and promote the passion for hunting in Romania. However, with the emergence and development of the CIC method, both the Nadler and Carpathian formulas were no longer used. The scoring by the Nadler method is currently mentioned in an isolated and secondary manner, primarily at exhibitions organized in Hungary. (Spătaru et al., 2021).

In addition to the evaluation formulas for red deer associated with the CIC, Rowland Ward, and SCI methodologies, there is also the Douglas Score (DS) system. The scoring system was developed by Norman Douglas in 1949 and was officially adopted in 1958 by the New Zealand Deerstalkers Association Incorporated. The final form of the DS methodology was published in 1959. This method emphasizes symmetry and is specifically used in New Zealand, Australia, and Papua New Guinea (NZDAI, 2012; Spătaru et al., 2021).

Today, the systems for evaluating deer trophies at the international level are generally classified into three main types: CIC (Hromas et al., 2008), SCI (https://safariclub.org/wp-content/uploads/2020/05/SCIMeasuring-Manual-Sept-2019.pdf), and Rowland Ward (https://rowlandward.org/wpcontent/uploads/2021/01/Measuring-Handbook.pdf).

At the national level, the evaluation of deer trophies is carried out based on Order no. 418 from 02/06/2005 "for the approval of the methodology for evaluating hunting trophies, in accordance with the International Council for Game and Wildlife Conservation methodology" (Annex 4).

Figure 4. *Former world record 261.25 CIC - Vrancea, 1980 (left) and the actual national record 264.01 CIC - Mureș - 2003 (right). Photo: Spătaru Cezar Georgian*

1.4 Hunting trophy exhibitions; importance, history, evolution

1.4.1 The importance of hunting trophy exhibitions

Hunting exhibition events, which focus on presenting hunting trophies based on their origin and location, can be classified as local, regional, national, and international (Șelaru, 2006). Therefore, based on the presented material, hunting exhibitions generate objective deductions regarding the progress or decline of species, both at the local, regional, and national levels, becoming a guiding factor in determining conservation and hunting activities (Pop, 1982).

Local and regional hunting exhibitions are primarily oriented towards educating and training interested parties, staff, and hunters (Șelaru, 2006). This is achieved through the frequency of these activities, as well as the large volume and diversity of the presented material. The educational-instructive role lies in the exhibition of trophies with negative characteristics, represented by selection specimens exhibiting malformations or deviations from normality, as well as trophies taken too early or too late. The aim is to improve the practical and effective approach to hunting activities. The main target audience from a game management perspective includes hunters and personnel involved in identification, monitoring, selection, and harvesting activities. The local, zonal, or regional origin of the trophies leads to specific conclusions about the seasonal characteristics and quality of local populations and the positive or negative direction of past and future hunting actions (Comșia, 1961).

National hunting exhibitions target a more diverse audience, including both hunters and personnel involved in hunting activities, as well as non-hunters. These events aim to promote the overall image of hunting, hunting culture, and the results of game management (Șelaru, 2006). Within national exhibitions, besides the diverse material and top trophies presented as achievements, the staging of historical evolution, elements of art and literature, as well as the beneficial and harmonious implications of hunting culture in close relation to other related fields, converge towards an essential reactualization of this activity in the present. The long-term effects are represented by an increase in hunting culture among enthusiasts and education, promotion, and increased acceptance among the general public, which is becoming more sensitive and progressively removed from the reality and needs of the natural environment.

International exhibitions are events that promote hunting culture through a joint and extensive effort of a considerable number of participating nations. Each country aims to exhibit and promote top achievements as well as national characteristics in the tradition of hunting activities. The promotion of national achievements through the points obtained by applying the evaluation methodology, both as records and as the number of trophies, generates permanent competitiveness between nations. The derived beneficial effects - national prestige, hunting tourism, and social and cultural implications - positively drive the maintenance and improvement of game management measures to support and enhance the quality of game populations and hunting culture as a whole.

World title exhibitions, as the name suggests, represent large-scale and comprehensive international hunting exhibitions that go beyond Europe's borders. These events feature exotic material from all over the world and aim to gather the participation of numerous nations. They highlight and emphasize the importance and role of hunting in society and extensively present national traditions, related activities, history, art, and literature in various branches of international hunting culture. Their structure is often combined with other related fields of activity, featuring demonstrations, competitions, championships, shooting, taxidermy, fairs, commercial activities, as well as thematic presentations, conferences, and meetings of professional organizations.

The catalogs issued during hunting exhibitions record the data of these events. By presenting the program and components of the exhibition, recording the morphometric elements of the participating trophies in the catalogs becomes a valuable database and evidence of the real history regarding the evolution of game quality and game management. Each exhibition thus contributes to enriching the national hunting heritage.

1.4.2 Romania in the context of National and International Hunting Exhibitions

The evolution of hunting events in the form of trophy exhibitions was marked historically by the first international hunting exhibition in Vienna from May 7 to October 16, 1910 - "Erste Internationale Jagdausstellung Wien 1910" (Ristic, 2009). Even from this initial large-scale event with over 2.7 million visitors and 22,000 exhibits, the territory of present-day Romania maintained its position and results among the top rankings worldwide for the main game species of interest. Although Romania did not officially participate in this exhibition, record trophies of chamois (*Rupicapra rupicapra*) from Transylvania as Austro-Hungary were notable. Subsequently, with the introduction of the Nadler evaluation formula in 1925 and the establishment of the CIC, Romania was among the 11 participating countries in the International Exhibition in Leipzig from May to September 1930, which was annexed to the International Fur Fair - IPA - "Internationale Pelzfach-Ausstellung, Internationale Jagd-Ausstellung." At this exhibition, Romania achieved international records for roe deer (*Capreolus capreolus*), wild boar (*Sus scrofa*), and red deer (*Cervus elaphus*) with a trophy known as "Kosch" from the Calimani Mountains, scoring 219.32 points according to the Nadler system, and it marked the country's first official international representation (Comșia, 1961), earning 36 medals (7 gold, 15 silver, and 14 bronze).

The National Hunting Exhibition in Bucharest, held from May 9 to June 9, 1935, represents Romania's first initiative of this kind, where the Nadler and Carpathian formulas were used for the evaluation of red deer (*Cervus elaphus*) trophies.

The International Hunting Exhibition - Internationale Jagdausstellung - held in Berlin from November 2 to November 21, 1937, surpassed all previous events in terms of the number and quality of exhibited trophies, with a total of 25,000 trophies displayed (Romania's pavilion featuring 760 pieces), and 29 countries participating. The event also promoted elements of hunting culture, art, and tradition. At this exhibition, Romania achieved the title of world record for the chamois (*Rupicapra rupicapra*) and brown bear (*Ursus arctos*) trophies, as well as the vice-world record for the roe deer (*Capreolus capreolus*) and red deer (*Cervus elaphus*) with the "Kosch" trophy from the Călimani Mountains, evaluated at 230.1 CIC points. Romania excelled in the number of medals obtained, totaling 354 (112 gold, 122 silver, 120 bronze), reflecting the value and quality of Romanian game (Neacșu et al., 1982). For the red deer (*Cervus elaphus*) species, the evaluation method used by the commission was the improved version of the Nadler formula, as established in Prague in May 1937 (Comșia, 1961).

At the International Hunting Exhibition - Mostra Mercato Internazionale della Caccia - held in Florence from October 24 to November 8, 1964, 15 countries participated, including Romania, which secured the first place in trophies for the chamois (*Rupicapra rupicapra*), wild boar (*Sus scrofa*), and brown bear (*Ursus arctos*). Romania also ranked second in terms of the number of medals won, totaling 71; 52 gold, 17 silver, and 2 bronze (Cotta et al., 2001).

In the International Hunting Exhibition - Sajam Lova I Ribolova - held in Novi Sad from September 22 to October 5, 1967, 19 countries participated. Romania once again achieved the second position in the number of medals won, totaling 288, with 276 gold, 11 silver, and 1 bronze. At this exhibition, Romania ranked first in the number of records obtained for the chamois (*Rupicapra rupicapra*), brown bear (*Ursus arctos*), wolf skull (*Canis lupus*), and wildcat skull (*Felis silvestris*) (Cotta et al., 2001).

During the International Hunting Exhibitions - Mostra Internazionale della Caccia e della Pesca - held in Turin from February 24 to March 5, 1972, and March 2 to 12, 1973, 6 and 9 countries participated, respectively. In 1972, Romania won 56 medals; 50 gold and 6 silver, along with records for the Carpathian red deer (*Cervus elaphus*), roe deer (*Capreolus capreolus*), brown bear (*Ursus arctos*) skin and skull, and Eurasian lynx (*Lynx lynx*) skin. In 1973, Romania

won 76 medals; 65 gold, 11 silver, and records for the chamois (*Rupicapra rupicapra*), Eurasian lynx (*Lynx lynx*) skin and skull, wolf (*Canis lupus*) skin and skull, and brown bear (*Ursus arctos*) skull (Cotta et al., 2001).

The International Hunting Exhibition - Celostátní Myslivecká Výstava - held in České Budějovice in 1976, had 6 participating countries, with Romania obtaining records for the chamois (*Rupicapra rupicapra*), brown bear (*Ursus arctos*) skin and skull, wolf (*Canis lupus*) skin, and Eurasian lynx (*Lynx lynx*) skin, totaling 619 medals; 525 gold, 75 silver, and 19 bronze (Cotta et al., 2001).

At Chassexpo Méditerranée - Marseille, from May 27 to June 6, 1977, with the participation of 6 countries, Romania was awarded 255 medals; 249 gold and 6 silver, obtaining records for the chamois (*Rupicapra rupicapra*), roe deer (*Capreolus capreolus*), brown bear (*Ursus arctos*) skull, wolf (*Canis lupus*) skull, Eurasian lynx (*Lynx lynx*) skin, and vicerecord for brown bear (*Ursus arctos*) skin (Neacșu et al., 1982).

The first and only international event of its kind organized in Romania was the International Hunting Exhibition - București, held from October 5 to 14, 1978, with a total of 2019 medals won; 1071 gold, 657 silver, and 291 bronze (Cotta et al., 2001).

At the Celoštátna poľovnícka výstava - Nitra, held from August 23 to September 7, 1980, Romania obtained new records for the wild boar (*Sus scrofa*) and wolf (*Canis lupus*) skin (Șelaru, 2006).

During the Jagd und Fischereiausstellung - Nürnberg, held from May 23 to June 1, 1986, Romania obtained 468 medals; 333 gold, 98 silver, and 32 bronze.

The Vadászati Világkiállítás - Budapest, held from August 27 to September 30, 1971, and Plovdiv, held from June 14 to July 12, 1981, are the most emblematic World Exhibitions. The Budapest Exhibition brought Romania a total of 505 medals, including 499 gold, 5 silver, and 1 bronze. Out of the 24 participating countries, Romania obtained records for the chamois (*Rupicapra rupicapra*), brown bear (*Ursus arctos*) skin, and Eurasian lynx (*Lynx lynx*) skin (Cotta et al., 2001). The Plovdiv Exhibition, with the participation of over 60 countries and a total of over 11,000 trophies, marked Romania's achievement of the world record for red deer (*Cervus elaphus*) with a trophy harvested in 1980 in Soveja, Vrancea, evaluated at 261.25 CIC.

In 2021, the Budapest 1971 Exhibition celebrated its anniversary with the most comprehensive event of the 21st century to date, the World Exhibition "One With Nature - World of Hunting and Nature Exhibition," held in Budapest from September 25 to October 14, 2021. In the context of the 21st century, the event focused on various themes related to hunting, forestry, and fishing, with an emphasis on the long-term sustainability of nature in general. The goal of the program series was to increase awareness about the importance of protecting the environment, the concept and meaning of sustainability, responsible use of natural resources, and the need for proper management of hunting, fishing, and forestry.

After 1990, Romania's participation in international hunting exhibitions with trophy evaluation gradually shifted to organizing national or regional exhibitions. Two main events can be highlighted: the National Hunting Exhibition in Bucharest, held from September 15 to 21, 1997, and in Pitești, held on September 20, 2003. Currently, trophy exhibitions in Romania are mostly organized on a regional initiative, and some of them have already become a tradition with several successive editions. Among the most recent ones, we can mention Expo-Venatoria - Timișoara 2018, Expo-Moldavia - Bacău 2022, and H-Hunting Prize - Sibiu 2022.

CHAPTER 2. AIM AND RESEARCH OBJECTIVES

2.1 Research aim.

The activity of trophy evaluation, apparently a traditional and aesthetic matter, produces both specific effects related to this activity, such as national and international exhibitions and rankings, as well as effects with cultural, social, and economic implications. Over time, the evaluation formulas for red deer (*Cervus elaphus* L.) trophies have been concretized through the objective selection of measurable or appreciable elements, which can be analyzed, quantified, and ranked. The proposed purpose of this work is to provide a clear perspective regarding the architecture, peculiarities, the relationship between measurable parameters, performances, and characteristics of red deer trophies in Romania, both historical and current. Additionally, an analysis of the composition and specificities of evaluation methods and parameters within the CIC, Rowland Ward, Safari Club International methods, along with complementary information about the Nadler and Carpatină methods, as a common basis of development, is also necessary (Spătaru et al., 2021).

2.2 Research objectives.

To achieve the proposed purpose, the following objectives have been established:

1. Determine the composition, specificities, and contribution of evaluation parameters in the scoring formula for red deer (*Cervus elaphus* L.) trophies within the evaluation methodologies.
2. Determine the performances of red deer trophies (Cervus elaphus L.) from the upper class of CIC medal-worthy trophies in Romania, in the context of national and international hunting exhibitions.
3. Determine the peculiarities and the ratio between measurable parameters in red deer (*Cervus elaphus* L.) trophies from the upper class of CIC medal-worthy trophies in Romania, categorized by regions.
4. Determine the peculiarities and the ratio between measurable parameters in red deer (*Cervus elaphus* L.) trophies by applying the CIC and Rowland Ward evaluation formulas and their correlation with other determined parameters.

CHAPTER 3. RESEARCH MATERIALS AND METHODS

3.1 The research material and method for determining the composition, particularities and contribution of the evaluation parameters in the score calculation formula, from the evaluation methodologies

To achieve objective 1, which is to determine the composition, specificities, and contribution of evaluation parameters within the scoring formulas for red deer (*Cervus elaphus* L.) trophies, the methodologies of CIC, Rowland Ward, Safari Club International (SCI) were consulted, and information regarding the Nadler and Carpatină methods was identified as a common starting point. However, detailed references regarding the Carpatină method, including its establishment and application instructions, were problematic to obtain. Therefore, the analysis in the paper is limited to the composition based on information available in the literature.

Consultation and publication of information from the CIC methodology required a special approval from the issuing authority, as the current methodology is accessible only to certified evaluators. On the other hand, the current methodologies of SCI and Rowland Ward allow public access.

In the process of trophy evaluation and the scoring formula for red deer trophies, the following elements expressed parametrically are considered relevant:

- main beams (lengths, spread, circumferences);
- tines (brow tine - lengths, bay tine - presence and lengths, tray tine - lengths, crown - number of tines and lengths, total number of tines - presence and lengths);
- coronets (circumferences);
- entire trophy or skull plate (weight);
- appreciable elements (color, pearling, tip of tines, symmetry);

The classification of components in the evaluation sheet, with specificities for each methodology, includes three major categories:

- measurable parameters (lengths, weight);
- appreciable parameters, as additions (color, pearling, condition of tine tips);

A separate category represents penalizations brought to the trophy, also under the appreciable character, related to irregularities and asymmetry.

The final score is the sum of the values obtained through the scoring formula for each parameter within the categories, from which the penalty values are subtracted if applicable (Spătaru et al., 2021).

3.2 The research material and method for determining the performance of red deer (*Cervus elaphus* L.) trophies, from the upper class of CIC medalable trophies in Romania, in the context of national and international hunting exhibitions.

To achieve objective 2, which is to determine the national, historical, and current performances of red deer (*Cervus elaphus* L.) trophies from the top class of CIC-medalable trophies in Romania, trophies with scores over 210 CIC points were selected from national and international hunting exhibitions.

3.2.1 Data selection

For data selection and analysis, catalogs from all national and international exhibitions in which Romania participated were consulted. The resulting dataset includes a total of 361 trophies harvested between 1908 and 2022, from the following exhibitions:

- 38 trophies from the international exhibition in Berlin 1937;
- 10 trophies from the international exhibition in Florence 1964;

- 36 trophies from the international exhibition in Novi Sad 1967;
- 34 trophies from the world exhibition in Budapest 1971;
- 8 trophies from the international exhibition in Turin 1972;
- 6 trophies from the international exhibition in Turin 1973;
- 25 trophies from the international exhibition in České Budějovice 1976;
- 3 trophies from the international exhibition in Marseille 1977;
- 63 trophies from the international exhibition in Bucharest 1978;
- 8 trophies from the international exhibition in Nitra 1980;
- 13 trophies from the world exhibition in Plovdiv 1981;
- 11 trophies from the international exhibition in Brno 1985;
- 9 trophies from the international exhibition in Nuremberg 1986;
- 36 trophies from the national exhibition in Bucharest 1997;
- 29 trophies from the national exhibition in Bucharest 2003;
- 6 trophies from the Expo-Hunting Moldavia Bacău 2019 exhibition;
- 7 trophies from the Expo-Hunting Moldavia Bacău 2022 exhibition;
- 17 trophies from the H-Hunting Prize Sibiu 2022 trophy exhibition.

Three trophies from individual evaluations were also added to the analyzed dataset.

3.2.2 Elements selected for analysis

The selected elements for analysis within the dataset are as follows:
- the exhibition where the trophy was homologated;
- the CIC score of the trophy;
- the county where the trophy was harvested;
- the year of harvest.

The parameters selected for the analysis of records within the CIC evaluation formula are as follows:
- average length of the main beam - LP;
- average circumference of the coronet - CR;
- average circumference of the beam - C1;
- average circumference of the beam - C2;
- total number of tines - NRR;
- weight - GR.

3.2.3 Research method

For the determination of national performances, the first step was to identify and gather data from all red deer (*Cervus elaphus* L.) trophies from the catalogs of national and international hunting exhibitions. To calibrate the data regarding performance relevance, trophies with scores exceeding 210 CIC points were selected. The assessment of performances was carried out by identifying traditional areas based on the recorded results, such as the number of trophies. A general graphical representation was pursued, along with a breakdown based on time intervals, considering the available data, exhibition homologation, county of origin, and year of harvesting. The achieved performances were also analyzed in terms of records by comparing the average scores and parameters over time units.

3.3 The research material and method for determining the particularities and the ratio between measurable parameters, in red deer (Cervus elaphus L.) trophies from the upper class of CIC medalable trophies in Romania, by region.

Objective 3 aims to determine the characteristics and the relationship between measurable parameters in the case of red deer (*Cervus elaphus* L.) trophies from the top class of CIC medalable trophies in Romania, both historical and recent, by regions.

3.3.1 Data selection

The analysis and data selection were carried out by consulting the catalogs of all national and international exhibitions in which Romania participated. However, only a portion of these exhibitions recorded each measurable/appreciable parameter of the trophies in their catalogs. To calibrate the data and ensure the relevance of the measurable parameters' performance, trophies with scores over 210 CIC points were selected. This resulted in a total of 217 data sets:

- 28 trophies from the Novi Sad 1967 international exhibition;
- 34 trophies from the Budapest 1971 international exhibition;
- 25 trophies from the České Budějovice 1976 international exhibition;
- 8 trophies from the Nitra 1980 international exhibition;
- 13 trophies from the Plovdiv 1981 international exhibition;
- 11 trophies from the Brno 1985 international exhibition;
- 36 trophies from the Bucharest 1997 national exhibition;
- 29 trophies from the Bucharest 2003 national exhibition;
- 6 trophies from the Expo-Hunting Moldavia Bacău 2019 exhibition;
- 7 trophies from the Expo-Hunting Moldavia Bacău 2022 exhibition;
- 17 trophies from the H-Hunting Prize Sibiu 2022 trophy exhibition;
- 3 trophies from individual evaluations.

The trophies originated from 29 counties and were collected between 1919 and 2022.

3.3.2 Component elements and selected for analysis expressed parametrically, within the CIC evaluation formula

Although the formula for calculating scores within the CIC method has undergone changes over time, leading to different results for the same trophies, the morphometric elements remain the most objective and consistent database. Thus, from the content of the CIC evaluation method for the red deer trophy, the following measurable parameters were selected for analysis:

- length of the main beam;
- length of the brow tine;
- length of the tray tine;
- circumference of the coronets;
- circumference of the beams
- total number of tines;
- trophy weight;
- greatest spread;
- length of the main beam;
- bay tine;
- crown;
- total score

These selected parameters will be used for further analysis and evaluation of red deer trophies using the CIC method.

Table 2. *Explicitation of the parameters selected for analysis – Objective 3*

Nr. Crt.	Acronyms for the selected parameters	Explicitation of the selected parameters for analysis	The precision of the unit of measurement
1	LP	Left-right average for main beam length	0.05 cm
2	RO	Left-right average for brow tine length	0.05 cm
3	RM	Left-right average for tray tine length	0.05 cm
4	CR	Left-right average for coronets circumference	0.05 cm
5	CP1	Left-right average for the smallest circumference identified between the bay tine, or where it is missing, the brow tine, and the tray tine	0.05 cm
6	CP2	Left-right average for the smallest circumference identified between the tray tine and the crown	0.05 cm
7	NRR	Total number of tines	.
8	GR	Net weight of the trophy*	0.01 kg
9	DS	Maximum interior spread of the trophy	0.1 cm
10	RG	Presence of the bay tine**	.
11	CRN	Crown***	.
12	PCT	Total score expressed in CIC points****	.

* Net weight is obtained by subtracting 0.7 kg from the combined weight of the antlers and the upper jawbone.
** The presence of the bay tine is expressed in points awarded for its presence and length - Score = 0-2.
*** The crown is expressed in points awarded based on the number and length of the tines; Score = 0-10.
**** The final score is calculated by summing up the values obtained for each parameter in their respective categories, and subtracting the value of any penalties where applicable; the trophy's performance is recorded through awards, namely medals: Bronze Medal (170-189.99 CIC points), Silver Medal (190-209.99 CIC points), Gold Medal (> 210 CIC points).

3.3.3 Research method.

The applied statistical analysis on the dataset pertains to elements related to the trophy's architecture and focuses on its descriptive analytical relationships, correlation analysis, and its components. Under the first category, descriptive statistical analysis includes the following statistical indices: arithmetic mean, standard deviation, standard error of the means, and coefficient of variation. The relationship between the measured elements of the trophy is expressed through correlation analysis, simple correlation analysis, and multiple correlation analysis.

Based on their location and the geographical unit, the trophy data has been selected and grouped into the following three samples:

- Group 1: The mountainous region of the Eastern Carpathians, comprising 167 trophies;
- Group 2: The mountainous region of the Southern Carpathians, comprising 26 trophies;
- Group 3: The extracarpathian region, comprising 13 trophies.

3.4 The research material and method for determining the particularities and the ratio between measurable parameters of red deer (*Cervus elaphus* L.) trophies, by applying the CIC, Rowland Ward evaluation formula and their ratio with other determined parameters.

Objective 4 aims to determine the specific characteristics and the relationship between measurable parameters in the trophies of red deer (*Cervus elaphus* L.) from Romania, by applying the evaluation formulas of CIC and Rowland Ward, as well as in relation to other additional parameters identified in the evaluation form.

3.4.1 Data selection

To achieve the objective, a sample of 44 red deer trophies (*Cervus elaphus* L.) from Romania was measured according to the CIC and Rowland Ward methods. These trophies belong to private collections of hunters, originating from 16 counties, and were harvested between 2007 and 2021. To calibrate the data concerning the relevance of the measurable parameters' performance, trophies from the medaling class, i.e., those with over 170 CIC points, were selected.

3.4.2 Component elements and selected for analysis expressed parametrically, from the CIC evaluation formula, Rowland Ward and other determined parametersa

From the contents of the CIC and Rowland Ward evaluation methods for the red deer trophy (*Cervus elaphus* L.), the following measurable parameters have been selected for analysis:

- length of the main beams;
- length of the brow tines;
- length of the bay tines;
- length of the tray tines;
- circumference of the coronets;
- circumference of the main beams;
- total number of tines;
- trophy weight;
- inside widest spread of the trophy;
- crown.

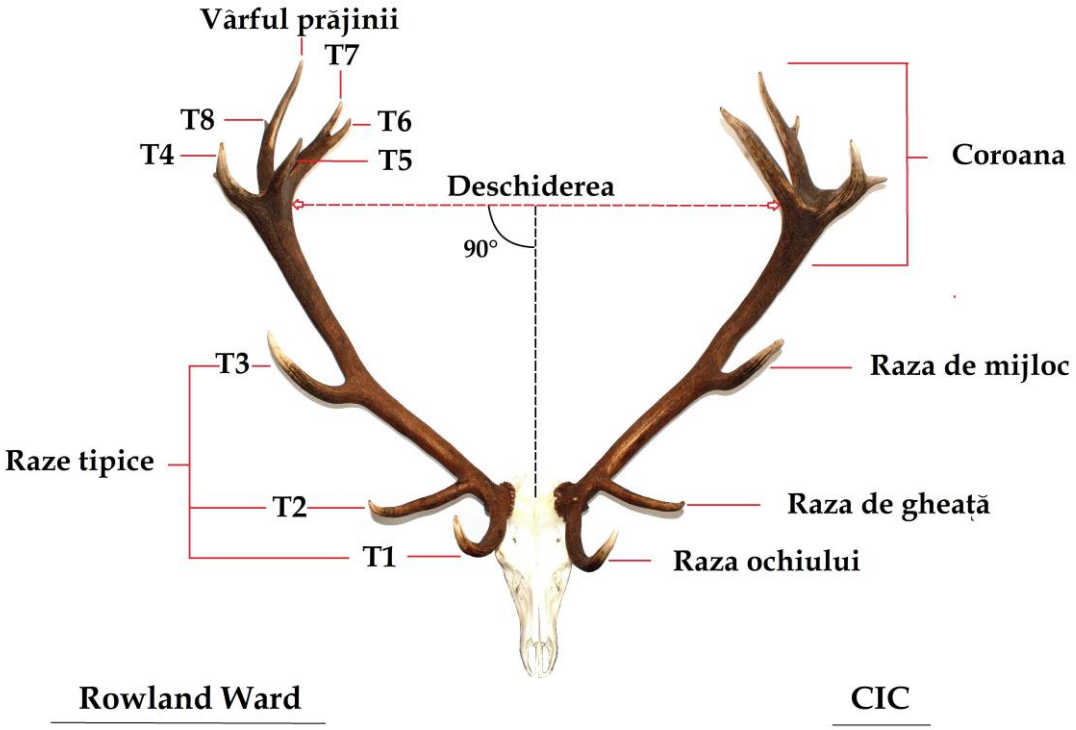


Figure 5. *The way parameters are organized according to the CIC and Rowland Ward method (original)*

Additionally to the evaluation methods of CIC and Rowland Ward for red deer (*Cervus elaphus* L.) trophies, the following parameters were added to the analysis:

- determined age;
- frontal beam diameter;
- maximum length of the skull;
- maximum width of the skull;
- greatest spread;
- tip to tip spread.

Tabel 3. *Explicitation of the parameters selected for analysis – Objective 4*

Nr. Crt.	Acronyms for the selected parameters	Explicitation of the selected parameters for analysis	The precision of the unit of measurement
1	LP	Left-right average for main beam length	0.05 cm
2	RO	Left-right average for brow tine length	0.05 cm
3	RG	Left-right average for bay tine length	0.05 cm
4	RM	Left-right average for tray tine length	0.05 cm
5	CR	Left-right average for coronets circumference	0.05 cm
6	C1	Left-right average for the smallest circumference identified between the bay tine, or where it is missing, the brow tine, and the tray tine	0.05 cm
7	C2	Left-right average for the smallest circumference identified between the tray tine and the crown	0.05 cm
8	NTR	Total number of tines	.
9	GR	Net weight of the trophy *	0.01 kg
10	DS	Maximum interior spread of the trophy	0.1 cm
11	CRN	Crown**	.
12	VS	Determined age	0.5 years
13	DCF	Left-right average for the frontal beam diameter	0.01 cm
14	LNC	maximum length of the skull	0.01 cm
15	LTC	maximum width of the skull	0.01 cm
16	DSM	greatest spread of the antlers	0.1 cm
17	DSm	smallest tip to tip spread of the antlers	0.1 cm

* Net weight is obtained by subtracting 0.7 kg from the combined weight of the antlers and the upper jawbone.
** The crown is expressed in points awarded based on the number and length of the tines; Score = 0-10.

3.4.3 Research method.

A percentage comparison was performed between the CIC and Rowland Ward evaluation methods for the total score, each parameter, and categories of parameters. The statistical analysis applied to the dataset focuses on elements related to the trophy's architecture and includes descriptive analytical relationships, correlation analysis, and its components. In the first category, the descriptive statistical analysis involves the following statistical indices: arithmetic mean, standard deviation, standard error of means, and coefficient of variation. The relationship between the measured elements of the trophy is expressed through correlation analysis, simple correlation analysis, and multiple correlation analysis.

The determination of additional parameters was carried out based on complementary measurements from the CIC evaluation form, supplemented with the frontal beam diameter and the determined age (Fig. 6).

Age determination was conducted by analyzing the layers of secondary dental cement, which are deposited continuously around the tooth root as the animal ages. These cementation layers correspond to seasons, appearing dark and thin during winter when trophic resources are scarce and thick during spring and summer when resources are more abundant (Lieberman et al., 1992). This results in a visible pattern under the microscope, with Pm1/Pm2 from the upper jaw being selected and extracted for age determination (Fig. 7).

Figure 6. *Additional parameters measurements(original)*

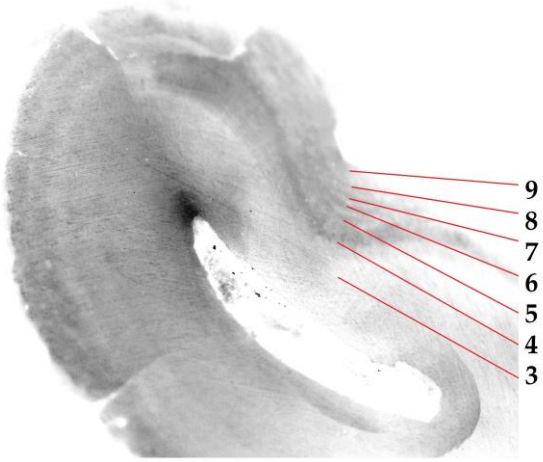


Figure 7. *Example of age determination - 9 years (original)*

CHAPTER 4. RESULTS OF THE RESEARCH AND DISCUSSIONS

4.1 The composition, particularities and contribution of the evaluation parameters in the score calculation formula, from the evaluation methodologies.

Over time, the evaluation formulas for red deer trophies have evolved through the objective selection of measurable or appreciable elements. The hierarchical organization of these elements is determined by different perspectives regarding the importance assigned to certain parameters, depending on each methodology. To calculate the score, coefficients are used to recognize and promote the importance of these parameters. The measurements and evaluation formulas for each element of the red deer trophy are applied following the instructions specified in the manual of each methodology (Spătaru et al., 2021).

Although the units of measurement differ, the Rowland Ward and SCI evaluation formulas use the Anglo-American (imperial) system and the CIC uses the metric system. However, these methodologies reciprocally accept conversions. The current use of the Nadler and Carpatină methods is now very limited and isolated, with very limited evaluation instructions. As a result, these methods can become problematic or even irrelevant in the face of a more complex and comprehensive approach.

One advantage of the Rowland Ward method compared to the SCI method lies in the organization of the evaluation form (typical/atypical points are treated differently). This can provide useful information for a possible more detailed classification of trophies into typical/atypical categories (Spătaru et al., 2021).

4.1.1 Measurements and assessments

For the measurable elements, a metric ruler is used, measured in centimeters with a precision of 0.1 cm, and the weight is determined by weighing with a precision of 0.01 kg. Conversion of values from the imperial system to the metric system is done by multiplying by 2.54, and vice versa for the reverse conversion, with the clarification that the value resulting from counting the points remains constant (CIC Handbook for the Evaluation and Measurement of Hunting Trophies, 2019). The repetition of measurements by different evaluators of these parameters should not result in significant differences in values and, consequently, in the final score.

Regarding the appreciable elements, the CIC method has evolved and improved over time, providing well-exemplified photographic value scales, thus limiting the apparent subjectivity in appreciation. We can, therefore, state that the evaluated score is as objective as possible from the perspective of measurements and, implicitly, appreciations; the methodology specifies that after the trophy is homologated, it is not reevaluated except in exceptional situations (CIC Handbook for the Evaluation and Measurement of Hunting Trophies, 2019; Spătaru et al., 2021).

The Rowland Ward and SCI methods, which are quite similar, for evaluating red deer trophies, only consider measurable parameters, namely lengths. Weight is not taken into account in the score calculation formula, but it is mentioned only as additional information (Table 5). While the CIC and Nadler methods consider all categories of parameters, the Carpatină method does not include penalties (Table 4, 6). The final score is composed of the sum of all values, subtracting penalties. Only the CIC, Nadler, and Carpatină methodologies use coefficients in the calculation formula (Spătaru et al., 2021).

Table 4. *Description of the score calculation formula according to the measurable parameters for the Nadler, Carpathian and CIC method for the red deer (Cervus elaphus L.) trophy*

Nr. crt.	Measurable parameters	Method - calculation/coefficient/score		
		CIC	Nadler	Carpatină
1	Beam length	Mean length of left-right (with a precision of 0.1 cm) x 0.5 = Score	Average of left-right lengths (precision 0.1 cm) x 0.5 = Score.	Average length of left-right measurements (precision 0.1 cm) x 0.5 = Score.
2	Brow tine length	Mean length of left-right (with a precision of 0.1 cm) x 0.25 = Score	Average of left-right lengths (precision 0.1 cm) x 0.25 = Score.	Average length of left-right measurements (precision 0.1 cm) x 0.25 = Score.
3	Tray tine length	Mean length of left-right (with a precision of 0.1 cm) multiplied by 0.25 = Score.	.	.
4	Coronets circumference	Mean circumference of left-right (with a precision of 0.1 cm) multiplied by 1 = Score.	Average of left-right circumferences (precision 0.1 cm) x 1 = Score.	Average circumference of left-right measurements (precision 0.1 cm) x 1 = Score.
5	Beam circumference 1	Sum of circumferences of left-right (with a precision of 0.1 cm) multiplied by 1 = Score.	Sum of left-right circumferences (precision 0.1 cm) x 1 = Score.	Sum of circumferences of left-right measurements (precision 0.1 cm) x 1 = Score.
6	Beam circumference 2	Sum of circumferences of left-right (with a precision of 0.1 cm) multiplied by 1 = Score.	Sum of left-right circumferences (precision 0.1 cm) x 1 = Score.	The sum of circumferences of left-right measurements (precision 0.1 cm) x 1 = Score.
7	Number of tines	Total sum of the number of antler points = Score.	Total sum of the number of rays = Score.	The sum of 1-4 points for each present antler tine (>30 cm = 4; 20-30 cm = 3; 10-20 cm = 2; 1-10 cm = 1) = Score.
8	Trophy weight	Weight (precision 0.01 kg) - (0.7 kg/0.5 kg) x 2 = Score.	Weight (precision 0.01 kg) - (0.5 kg) x 2 = Score.	.
9	Inside spread	Widest length x 100 / average length of beams = Percentage; Score = 0-3 (<60% = 0; 60-69.9% = 1; 70-79.9% = 2; >80% = 3).	Widest length x 100 / Average length of beams = %; Score = 0-3 (<60% = 0; 60-70% = 1; 70-80% = 2; >80% = 3).	OWidest length x 100 / mean length of beams = %; Score = 0/1/4 (<80% = 0; 80-90% = 1; >90% = 4)
10	Bay tine	Depending on the presence and length; Score = 0-2 (2.0-0.0 cm = 0/0.5; 10.1-15.0 = 0.5/1; >15 = 1/2).	.	.
11	Crown	Depending on the total number of points and lengths; Score = 0-10 (precision 0.5).	.	.
	TOTAL	Sum of cumulative scores (precision 0.01).		

Table 6. *Description of the score calculation formula according to the apreciable parameters for the CIC, Nadler and the Carpathian method for the red deer (Cervus elaphus L.) trophy*

Nr. crt.	Appreciable parameters	Method - calculation/coefficient/score		
		CIC	Nadler	Carpatină
1	Color	Score = 0-2 (precision 0,5)	Score = 0/1/2	Score = 0/1/2
2	Perling	Score = 0-2 (precision 0,5)	Score = 0/1/2	Score = 0/1/2
3	Tine tips	Score = 0-2 (precision 0,5)	Score = 0/1	Score = 0/1
4	Crown	.	Score = 0/1/2/4	Score = 0/1/2/3/6
5	Penalties	Score = 0-3 (precision 0,5)	Score = 1/2/3	.

Table 5. *Description of the score calculation formula according to the measurable parameters for the SCI and Rowland Ward method for the red deer (Cervus elaphus L.) trophy*

Nr. crt.	Measurable parameters	Method - calculation/coefficient/score
		SCI - Rowland Ward
1	Beam length	Sum of the left-right lengths (precision 0.1 cm) = Score
2	Brow tine length	Sum of the left-right lengths (precision 0.1 cm) = Score
3	Bay tine length	Sum of the left-right lengths (precision 0.1 cm) = Score
4	Tray tine length	Sum of the left-right lengths (precision 0.1 cm) = Score
5	Coronets circumference	Sum of the left-right circumferences (precision 0.1 cm) = Score
6	Beam circumference 1	Sum of the left-right circumferences (precision 0.1 cm) = Score
7	Beam circumference 2	Sum of the left-right circumferences (precision 0.1 cm) = Score
8	Number of tines	Sum of the lengths of all present left-right antlers (precision 0.1 cm) = Score
9	Inside spread	Interior opening length = Score
	TOTAL	Sum of cumulative scores (precision 0.01)

4.1.2 Peculiarities in measurement, the determination of measurable elements, coefficients and the formula for calculating scores

The first differentiation in measuring trophies is represented by the system in which the measurements are taken: the Anglo-American system for SCI and Rowland Ward, and the metric system for CIC. Conversion between CIC and Rowland Ward is accepted, including at the level of score bars for validating trophies in specific publication registers. The practical method of determination and measurement of morphometric elements is carried out with specific particularities depending on the applied method (Spătaru et al., 2021).

The measurement and determination of the tines

The determination of the tines in the CIC method recognizes any valid projection on the main beam, with a minimum height of 2.5 cm, whose height is greater than its base. Due to the conversion between the imperial-metric systems, the SCI and Rowland Ward methods also acknowledge the same criteria, with the particularity that the length of the tine must be a minimum of 1 inch (2.5 cm).

The length of the brow tine, bay tine, and tray tine, which are categorized as typical tines, are measured differently in the CIC method. For the length of the brow tine, the CIC method specifies that the measurement is taken on the lower side of the tine, from the upper edge of the coronets to the tip. In cases where the brow tine has a higher starting point, the bisecting angle method is applied, and the measurement is taken on the lower side, similar to the middle tine. The middle tine is measured on the lower side, using the bisecting angle method from the point where the angle between the axis of the tine and the main beam is halved, up to the tip. The CIC method also mentions that it is possible to measure the middle tine with the starting point on the upper side if it is more advantageous (Spătaru et al., 2021).

The bay tine is measured on the lower side, from the intersection between the baseline formed by the main beam and the tine to the tip. With the exception of the "brow tine," which can be measured according to the C.I.C. evaluation formula, the Rowland Ward method indicates measuring all tines on the longest side, mostly on the exterior (in case a tine curves in the opposite direction, the measurement is taken on the interior side), from the intersection between the baseline formed by the main beam and the tine to the tip.

The SCI (Safari Club International) method describes measuring the typical tines (brow tine, bay tine, tray tine) mostly on the exterior side, from the intersection between the baseline formed by the main beam and the tine to the tip, with priority given to the longest length. In this

method, tines that curve outward can also be measured on the upper side if it results in a longer value. However, an exception to this measurement method may apply to the eye tine, which should be measured on its longest surface starting from the exterior part.

In the case of broken tines, all methods allow for their measurement if possible and, if applicable, their recognition for determining the total number of tines. Unlike the CIC method, the Rowland Ward and SCI methods also measure the length of secondary tines, both with the main beam as their baseline and the additional typical tines from the lower half of the main beam. Among the typical tines, the Nadler method only measures the brow tine.

The measurement of the crown

The crown consists of all the tines that are located above the tray tine and represents the upper half of the antlers. To be considered valid, the tines must adhere to the general principles of measurement. For all the analyzed methods, the measurement of the tines in the crown is conducted from the intersection between the baseline formed by the main beam (or base tine) and the tine, up to its tip.

The Rowland Ward and SCI methods prescribe a specific order for the measurements: main beam, parent tine, and additional tines. On the other hand, the CIC method allows for a combined order of measurements, taking into account the most advantageous categorization based on the resulting lengths. While the CIC formula aims to measure all the tines in the crown, the Rowland Ward and SCI methods exclude the measurement of the tine identified as the termination of the main beam; this being a major difference between the methods.

The measurement of the weight

According to the CIC method for determining the weight, weighing of trophies must be carried out at least 30 days after the date of the trophy's harvest. This time interval is necessary to allow the natural drying process of the trophy to be, in principle, completed. Similarly, the Rowland Ward methodology also requires a minimum period of 30 days from the date of the trophy's harvest for the evaluation, and this rule applies to all species of game, as mutually agreed (Spătaru et al., 2021).

4.1.3 Calculation Formula of the Score

The resulting score of each parameter, depending on the calculation formula and coefficients, is divided into 2 categories:

- variable score: Regardless of the coefficient and calculation formula of the measured parameters (e.g., average x 0.5/0.25, sum of left-right values, measured value x 2, etc., Table 4), it is directly proportional to the magnitude of the measured value.
- limited score: Regardless of whether the parameters are measured, calculated, or estimated, they fall within a fixed interval (e.g., 0-3, 0-2, 0-10, etc., Table 4).

The main difference between the evaluation methods in the accumulation of scores lies in the importance given to each parameter, the calculation formula, and the applied coefficient.

Rowland Ward and SCI methods accumulate the value of each parameter, whether expressed by length or circumference.

The CIC method favors certain measurable elements with approximate values, and the percentages of these parameters in relation to the final score as appreciated by Bán (1986) fall within the following intervals (Spătaru et al., 2021):

- 20-25% for prong lengths;
- 15-16% for lower prong circumferences;
- 14-15% for upper prong circumferences;

- 8-12% for weight;
- 8-12% for the crown;
- 10% for rosette circumferences;
- 6% for middle tine lengths;
- 5% for eye tine lengths;
- 1% for bez tine lengths;
- 1% for spread length.

Astfel, ordinea parametrilor promovați prin formula de calcul a metodei CIC este următoarea: lungimea prăjinilor; circumferința (rozetelor și prăjinilor); greutatea și numărul total de raze; coroana, lungimea razelor ochiului și de mijloc; celelalte elemente măsurabile și apreciabile (Spătaru et al., 2021).

Este important de menționat că în cazul trofeelor mari, conform baremului de medaliere, există un procent redus al ponderii elementelor cu punctaj limitat, reprezentate prin adaosuri și penalizări (Tab. 7).

Thus, the order of parameters promoted by the calculation formula of the CIC method is as follows: beam lengths; circumference (of coronets and beams); weight and total number of tines; crown, lengths of brow and tray tines; and other measurable and appreciable elements (Spătaru et al., 2021).

It is important to mention that in the case of large trophies, according to the medal scoring system, there is a reduced percentage of limited score elements, represented by additions and deductions (Tab. 7).

Table 7. *Percentage rates of add-ons and penalties for medalable trophies*

Medal	Intervals by category
Bronze medal (170-189,99 pct. CIC)	Additions: 10.59% to 9.47% of the total score Penalties: 1.76% to 1.57% of the total score.
Silver medal (190 - 209.99 pct. CIC)	Additions: 9.47% to 8.57% of the total score. Penalties: 1.57% to 1.42% of the total score.
Gold medal (> 210 pct. CIC)	Additions: Less than 8.57% of the total score. Penalties: Less than 1.42% of the total score.

According to the Carpathian method for calculating the score for antler tines (excluding the brow tine, which has a calculation coefficient of 0.25), a limited score is assigned based on the length category. This score varies between 1 and 4 points, as shown in Table 4.

4.1.4 Scoring formula

The performance of trophies is directly proportional to the number of points. The maximum appreciation of trophy quality is rewarded through various forms. CIC recognizes the value of trophies that exceed a certain score limit by awarding medals, according to the following intervals: bronze medal for trophies with 170 - 189.99 CIC points, silver medal for trophies with 190 - 209.99 CIC points, and gold medal for trophies that accumulate over 210 CIC points. The highest homologated score is recognized as a world record. Although any trophy can be evaluated (including those from game reserves), the awarding of medals is only given to trophies that have been harvested, or those that result from accidental or natural mortalities in the wild, and are homologated through evaluation by a certified commission (Spătaru et al., 2021).

Within the Rowland Ward methodology, the main recognition is represented by the publication of the volumes "Records of Big Game," which appear periodically at intervals of 4-5 years. To be included in these volumes, trophies must meet certain minimum acceptance scores, and they need to be evaluated by certified evaluators. It is important to mention that the evaluation is done according to the Rowland Ward methodology, which also recognizes the CIC

methodology; the minimum score for red deer (*Cervus elaphus* L.) species being set at 225 points. Other forms of recognition outside the publication in specific volumes include the awarding of plaques or certificates for trophies featured in publications, as well as a distinct certificate for the world record and the top 10 trophies in the ranking (Spătaru et al., 2021).

Safari Club International (SCI) offers the most diverse range of awards, starting from the registration in the "SCI - Record Book of Animals" and awards with simple plaques, medallions, or for the top 10-20 trophies in the ranking, as well as major awards for the top 3 or top 7 trophies in different geographic regions of the world. There are also awards for alternative methods of harvesting and awards for hunting in specific areas like "Ibex of the world," "Sheep of the world," "Oxen of the world," etc. All forms of awards are exclusively given to members of the organization and are based on the records in the publications "SCI – Record Books of Big Game Animals" (Spătaru et al., 2021).

4.2 Determining the performance of red deer (Cervus elaphus L.) trophies, from the upper class of CIC medalable trophies in Romania, in the context of national and international hunting exhibitions

For the determination of national performances, the first step was to identify and gather data on all red deer (*Cervus elaphus* L.) trophies with a score of over 210 CIC points from the catalogs of national and international hunting exhibitions where they were homologated. This resulted in a dataset from 31 counties (Fig. 8), comprising 361 trophies according to the exhibitions (Fig. 9), with a collection period spanning from 1908 to 2022. To this dataset, data for 3 trophies evaluated outside the exhibitions were added, with collection years in 2003, 2011, and 2015.

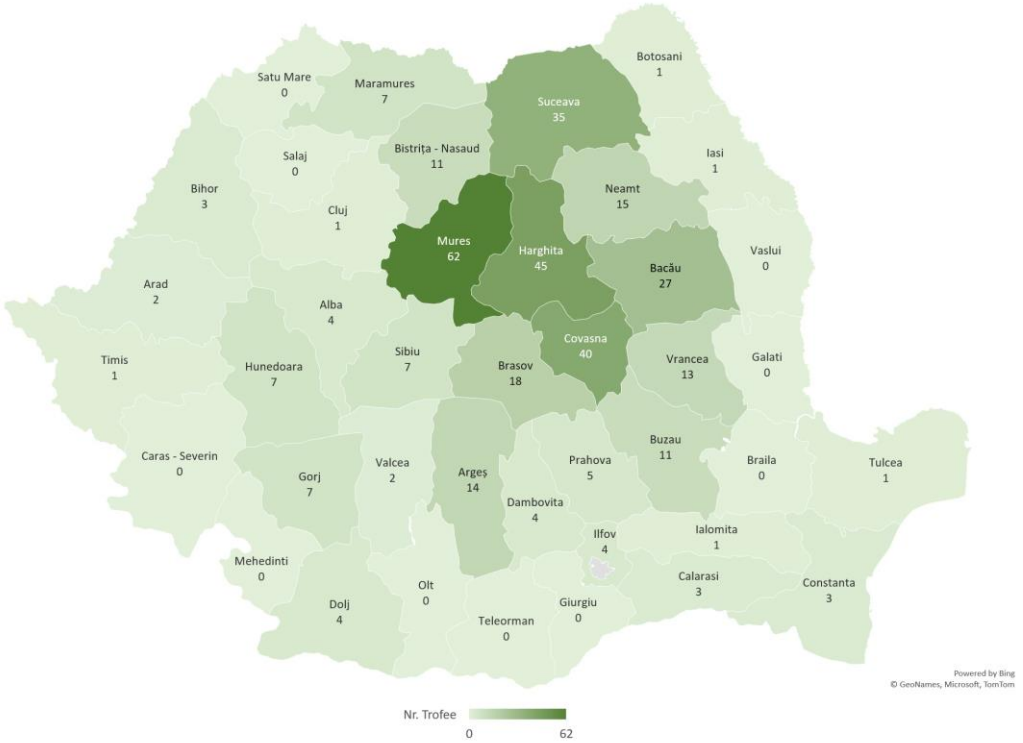
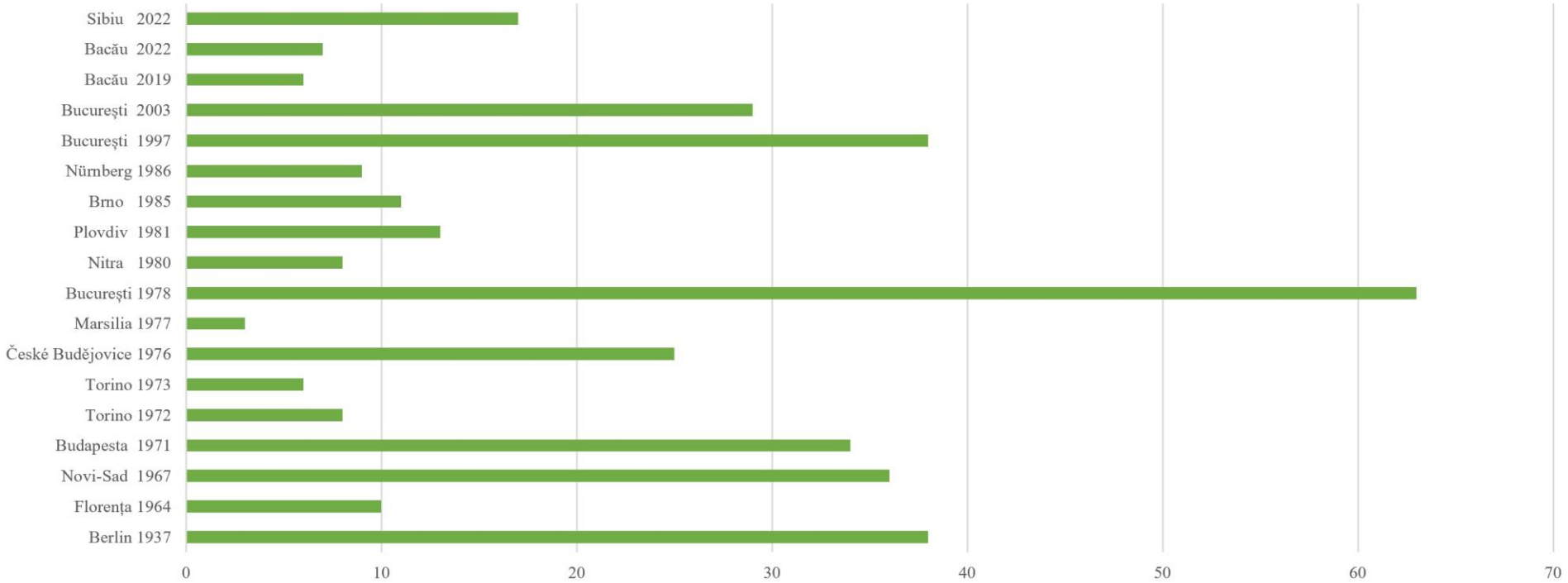


Figure 8. *Map of counties in relation to the number of trophies that scored over 210 CIC*



	Berlin 1937	Florența 1964	Novi-Sad 1967	Budapesta 1971	Torino 1972	Torino 1973	České Budějovice 1976	Marsilia 1977	București 1978	Nitra 1980	Plovdiv 1981	Brno 1985	Nürnberg 1986	București 1997	București 2003	Bacău 2019	Bacău 2022	Sibiu 2022
Series1	38	10	36	34	8	6	25	3	63	8	13	11	9	38	29	6	7	17

Figure 9. *Exhibitions and number of red deer trophies (Cervus elaphus L.) that scored over 210 CIC from Romania*

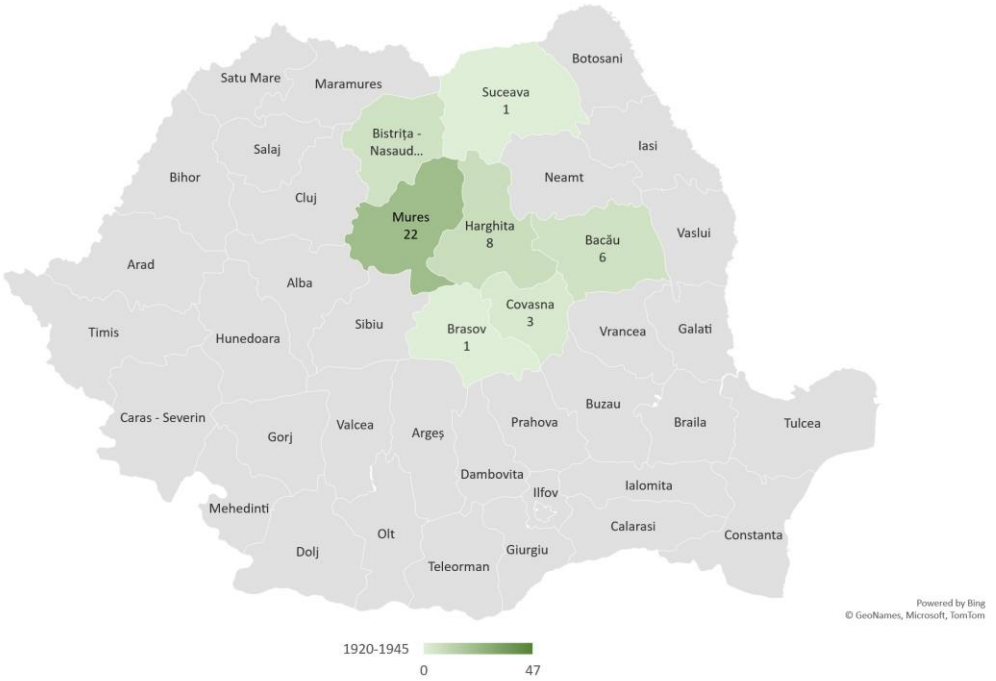


Figure 10. *Map of counties in relation to the number of trophies ≥ 210 CIC, harvested in the period 1920-1945*

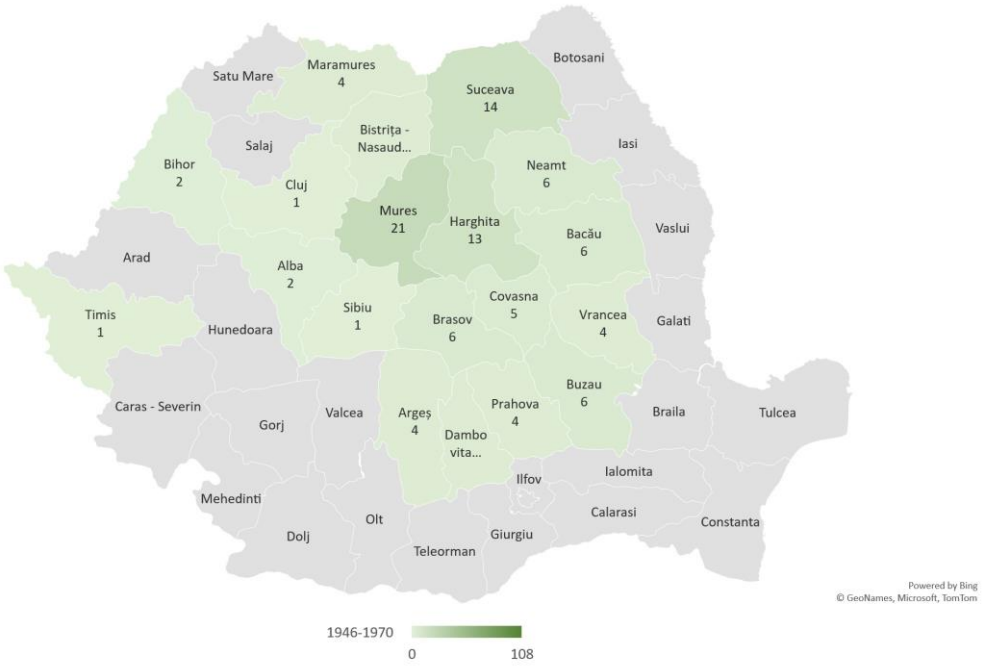


Figure 11. *Map of counties in relation to the number of trophies ≥ 210 CIC, harvested in the period 1946-1970*

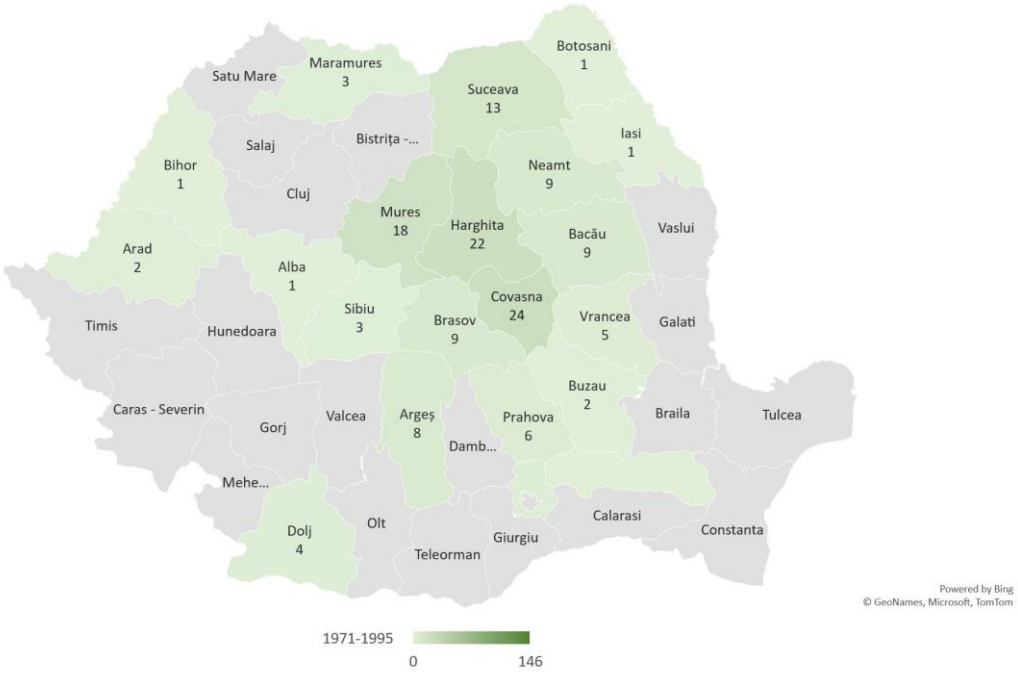


Figure 12. *Map of counties in relation to the number of trophies ≥ 210 CIC, harvested in the period 1971-1995*

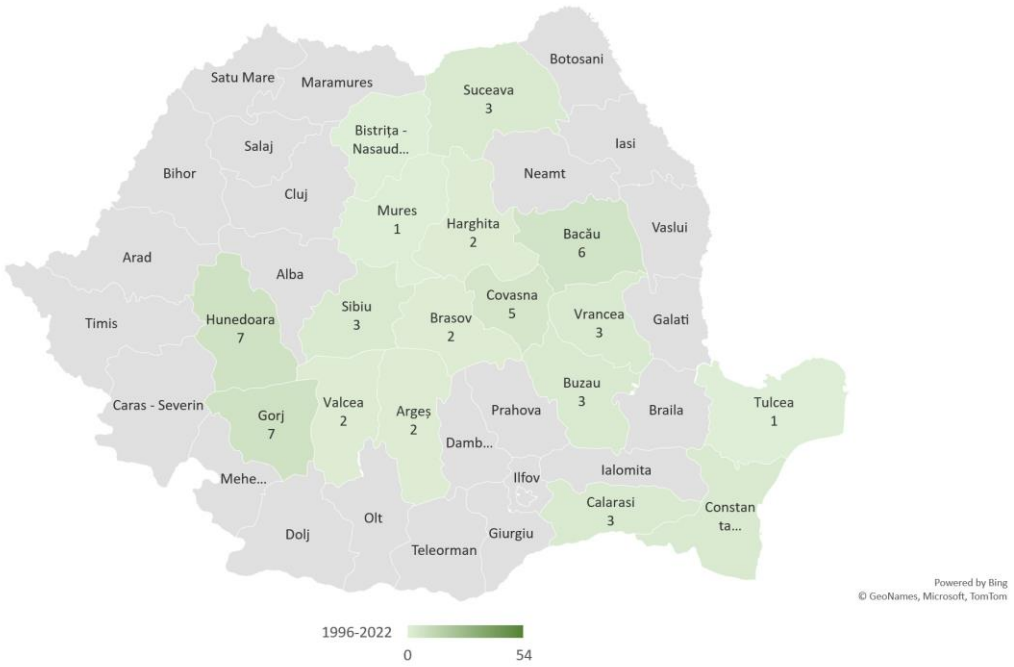


Figure 13. *Map of counties in relation to the number of trophies ≥ 210 CIC, harvested in the period 1995-2022*

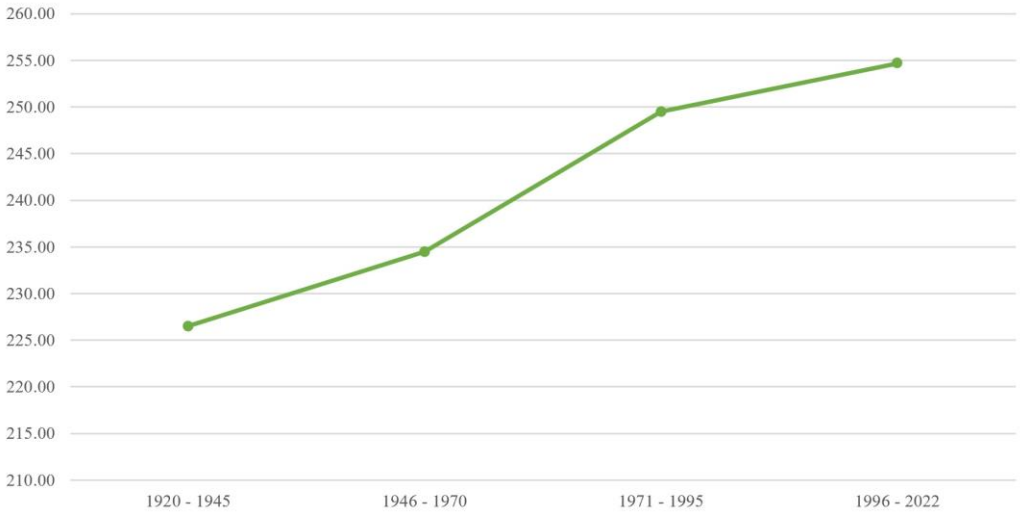


Figure 14. *Average score of records for the interval 1920-2022*

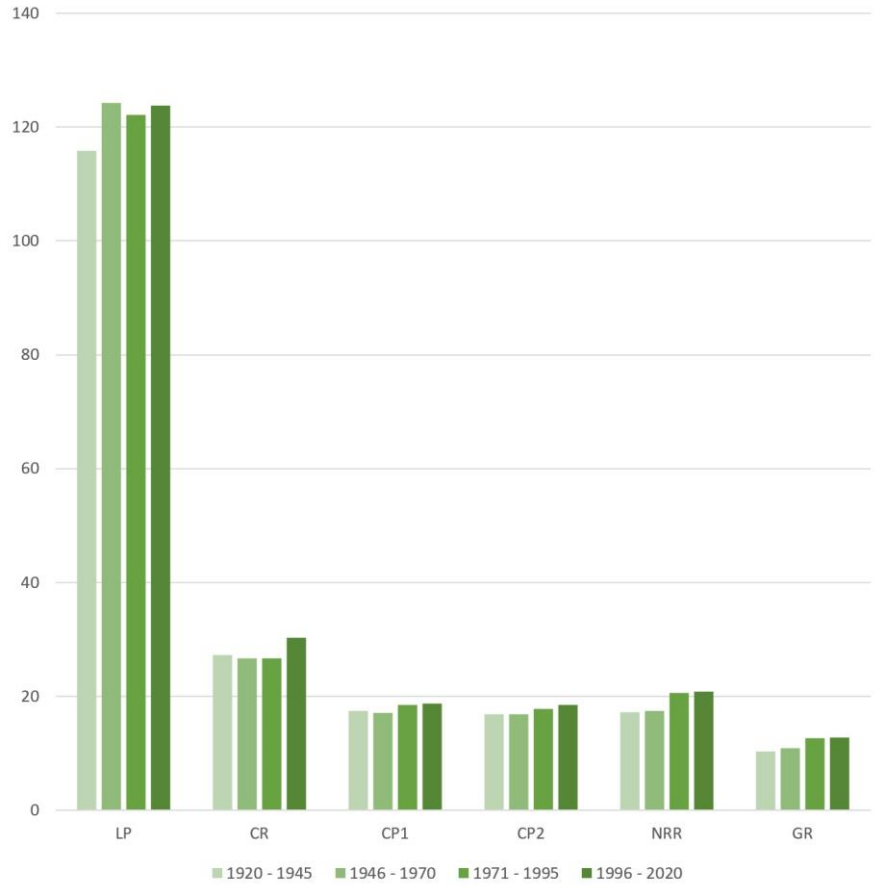


Figure 14. *Average score of records for the interval 1920-2022*

The achieved performances were analyzed from the perspective of the evolution of records over time by selecting the top 5 trophies, their average scores, and parameters over the same time intervals. The determination of performances was carried out by identifying traditional areas based on historical records, specifically the number of trophies per county. A general graphical representation was made (Fig. 8) as well as separate representations for different time intervals: 1920-1945, 1946-1970, 1971-1995, 1996-2022 (Fig. 10, 11, 12, 13).

According to the analysis, the following counties are considered traditional in terms of the performances achieved in red deer trophies in Romania: Mureș, Harghita, Covasna, Suceava, Bacău, Brașov, Neamț, Argeș, Vrancea, Bistrița, and Buzău. Figures 10, 11, 12, 13 also show the expansion of the red deer population and, consequently, the increase in their performances at the national level, with the number of counties growing from 7 for the 1920-1945 interval to 17 for the 1995-2022 interval.

For a better understanding of the evolution, the average scores and main evaluation parameters of the top 5 trophies for each time interval were graphically represented (Fig. 14, 15). It can be observed that there is an upward trend in scores, from 226.49 for the 1920-1945 interval to 254.70 for the 1996-2022 interval. There is also an increase in the main parameters, specifically weight and, consequently, circumferences, while the average length of the tines and the total number of tines remain relatively constant (Fig. 15).

4.3 Determining the particularities and the ratio between measurable parameters, in red deer (*Cervus elaphus* L.) trophies, from the upper class of CIC medalable trophies in Romania, by region.

For the analysis and data selection, the catalogs of all national and international hunting exhibitions attended by Romania were consulted. However, only a portion of these exhibitions recorded each measurable/appreciable parameter of the trophies in their catalogs. The data of trophies with over 210 CIC points, harvested between 1919 and 2022, from 29 counties were selected. Based on their location and relief unit, the 217 datasets were grouped into 3 samples: Group 1 - Eastern Carpathians - 167 trophies; Group 2 - Southern Carpathians - 26 trophies; Group 3 - Extracarpathian region - 13 trophies. Using descriptive statistics, the data were processed, obtaining the main statistical indicators, such as mean (m), standard deviation (sd.), standard error of the mean (Std. err. of media), and coefficient of variation (CV%) (Tab. 8, 9, 10).

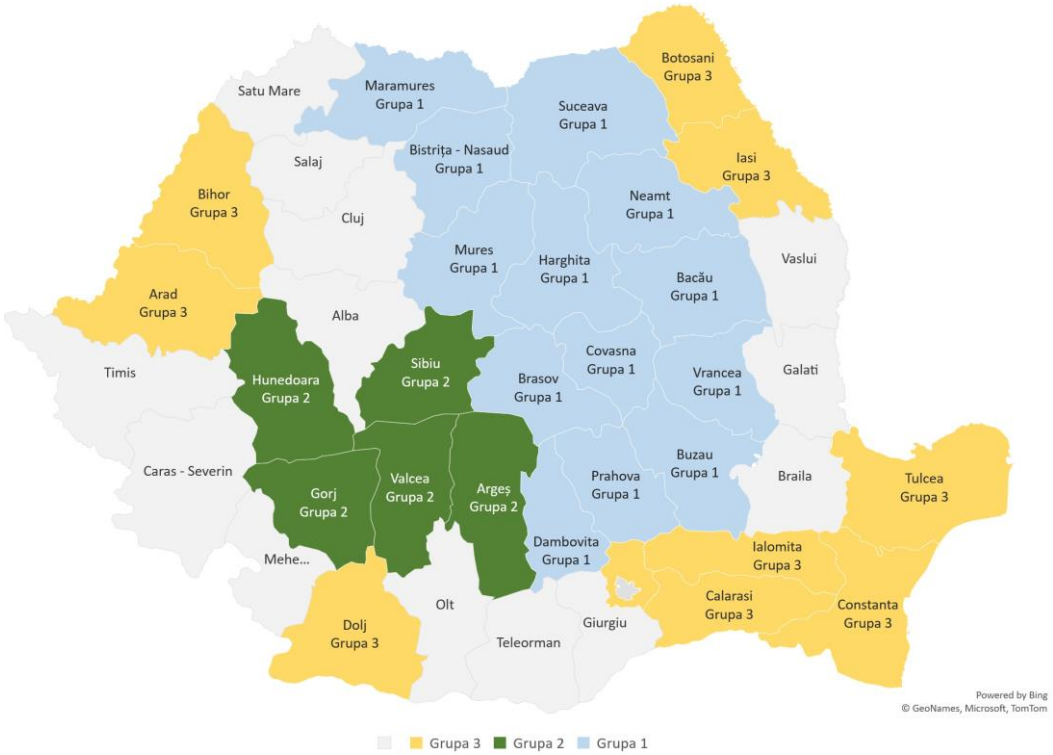


Figure 15. *Map of selected groups by county*

Tabel 8. *Descriptive statistics of variables for Group 1 – Oriental Carpathians*

Variabile	Valid N	Media m	Minimum	Maximum	Abaterea standard sd.	Coeficientul de variație (CV%)	Eroarea standard a mediilor
LP	167	117,4047	93,7500	133,0000	7,30594	6,22287	0,565351
RO	167	41,6133	24,7000	67,4000	6,50180	15,62433	0,503125
RM	167	40,4066	17,3500	73,2000	7,36548	18,22842	0,569958
CR	167	26,3835	22,6000	33,1500	1,92132	7,28229	0,148677
CP1	167	16,4820	14,4000	20,8500	1,13790	6,90391	0,088054
CP2	167	16,1952	13,8500	21,5000	1,26113	7,78708	0,097589
NRR	167	16,2395	11,0000	25,0000	2,80105	17,24837	0,216752
GR	167	9,6259	7,1500	15,1100	1,39597	14,50218	0,108023
DS	149	91,1709	68,5000	123,5000	11,64587	12,77367	0,954067
RG	167	1,3051	0,0000	2,0000	0,79431	60,86221	0,061465
CRN	167	7,3159	2,0000	10,0000	1,99249	27,23524	0,154184
PCT	167	222,2596	210,1000	264,0075	10,68456	4,80725	0,826796

Tabel 9. *Descriptive statistics of variables for Group 2 – Meridional Carpathians*

Variabile	Valid N	Media m	Minimum	Maximum	Abaterea standard sd.	Coeficientul de variație (%)	Eroarea standard a mediilor
LP	26,0	115,273	103,300	136,100	6,7363	5,8438	1,32110
RO	26,0	39,337	8,050	51,750	8,7449	22,2310	1,71501
RM	26,0	39,098	27,700	54,450	7,4211	18,9807	1,45539
CR	26,0	27,063	23,050	30,000	1,7797	6,5760	0,34903
CP1	26,0	16,492	14,800	18,900	0,9993	6,0590	0,19597
CP2	26,0	15,825	13,850	18,200	0,9694	6,1255	0,19011
NRR	26,0	14,654	10,000	20,000	2,7121	18,5076	0,53188
GR	26,0	9,471	7,760	12,100	1,1810	12,4700	0,23162
DS	17,0	91,782	72,500	109,500	11,8887	12,9532	2,88344
RG	26,0	1,288	0,000	2,000	0,7832	60,7886	0,15361
CRN	26,0	7,288	3,000	10,000	2,1734	29,8191	0,42623
PCT	26,0	217,854	210,350	226,370	4,9058	2,2519	0,96211

Table 10. *Descriptive statistics of variables for Group 3 – Extracarpathian region*

Variabile	Valid N	Media m	Minimum	Maximum	Abaterea standard sd.	Coeficientul de variație (%)	Eroarea standard a mediilor
LP	13	110,8615	101,8000	123,5000	7,427711	6,69999	2,060077
RO	13	38,7846	25,6500	42,9500	4,861086	12,53354	1,348223
RM	13	41,2346	32,0000	50,5000	6,221146	15,08719	1,725436
CR	13	28,6308	25,5000	32,8000	1,940096	6,77626	0,538086
CP1	13	16,9269	15,0000	18,3500	1,083323	6,40000	0,300460
CP2	13	16,1038	13,9000	19,0000	1,388264	8,62070	0,385035
NRR	13	16,4615	12,0000	20,0000	2,025479	12,30431	0,561767
GR	13	10,3869	8,3600	11,8700	0,978488	9,42039	0,271384
DS	11	78,1000	64,6000	99,0000	8,586035	10,99364	2,588787
RG	13	1,5769	0,0000	2,0000	0,759555	48,16687	0,210663
CRN	13	8,3846	5,0000	10,0000	1,474136	17,58144	0,408852
PCT	13	224,4962	213,7700	238,3000	7,244229	3,22688	2,009188

Synthetically, in tables 8, 9, and 10, the analysis elements of the trophy are presented. It can be observed that the coefficient of variation values for certain elements are high, indicating a large amplitude of variation. The analysis of the coefficients of variation between groups highlighted several particularities among the groups. The parameter LP (length of the main beams) shows a wide variation for the extracarpathian group and a smaller variation for the Southern Carpathians group. The brow tine (RO) exhibits a very large variation compared to the

tray tine (RM) for the Southern Carpathians group; RM for the extracarpathian region records the smallest variation. The Southern Carpathians group shows the smallest variation for circumferences, specifically for the circumference of the coronets (CR) and the circumferences of the beams (CP1, CP2). The total number of tines (NRR) exhibits the highest variations in the mountain groups, 1 and 2. The element weight (GR) shows the highest variation for the Eastern Carpathians group, followed by the Southern Carpathians group, and then the extracarpathian group. The widest spread (DS), bay tine (RG), and crown (CRN) have significantly higher and similar variations for the mountain groups and lower variations for the extracarpathian group. The total score (PCT) has a higher variation for the Eastern Carpathians group, followed by the extracarpathian group, and finally the Southern Carpathians group. The most significant differences between groups are highlighted for the elements of brow tine (RO), total number of points (NRR), weight (GR), crown (CRN), and total score (PCT).

Table 11. *Analysis of variance (ANOVA)*

Analiza de varianță, α =0,05, α =0,01, α =0,001								
Variabila	**Suma pătratelor SS**	**Media pătratelor MS**	**df**	**Suma pătratelor reziduale SS err.**	**Media pătratelor reziduale MS err.**	**Grade de libertate reziduale df err.**	**Statistica Fisher F**	**Valoarea critică p**
LP	578,90	289,449	2	10657,0	52,498	203	5,51355	0,00466**
RO	194,09	97,044	2	9212,8	45,383	203	2,13833	0,12050
RM	50,80	25,402	2	10846,8	53,432	203	0,47541	0,62232
CR	67,00	33,498	2	737,1	3,631	203	9,22508	0,00015***
CP1	2,40	1,199	2	254,0	1,251	203	0,95832	0,38526
CP2	3,10	1,552	2	310,6	1,530	203	1,01435	0,36447
NRR	58,88	29,439	2	1535,5	7,564	203	3,89189	0,02195*
GR	7,99	3,994	2	369,8	1,822	203	2,19214	0,11431
DS	1785,16	892,582	2	23071,4	132,594	174	6,73169	0,00153**
RG	0,92	0,461	2	127,0	0,626	203	0,73620	0,48020
CRN	14,02	7,012	2	803,2	3,957	203	1,77236	0,17255
PCT	534,24	267,118	2	20182,0	99,419	203	2,68680	0,07052

Note: * - significant, ** - distinctly significant, *** - highly significant.

To highlight the differences between the analyzed samples, a variance analysis was used (Tab. 11). It can be observed that the parameter beam length (LP) and spread (DS) show distinctly significant correlations for all three analyzed groups. A highly significant difference can be observed for the parameter coronet circumference (CR), suggesting that active development is influenced by the specific environmental conditions of each group.

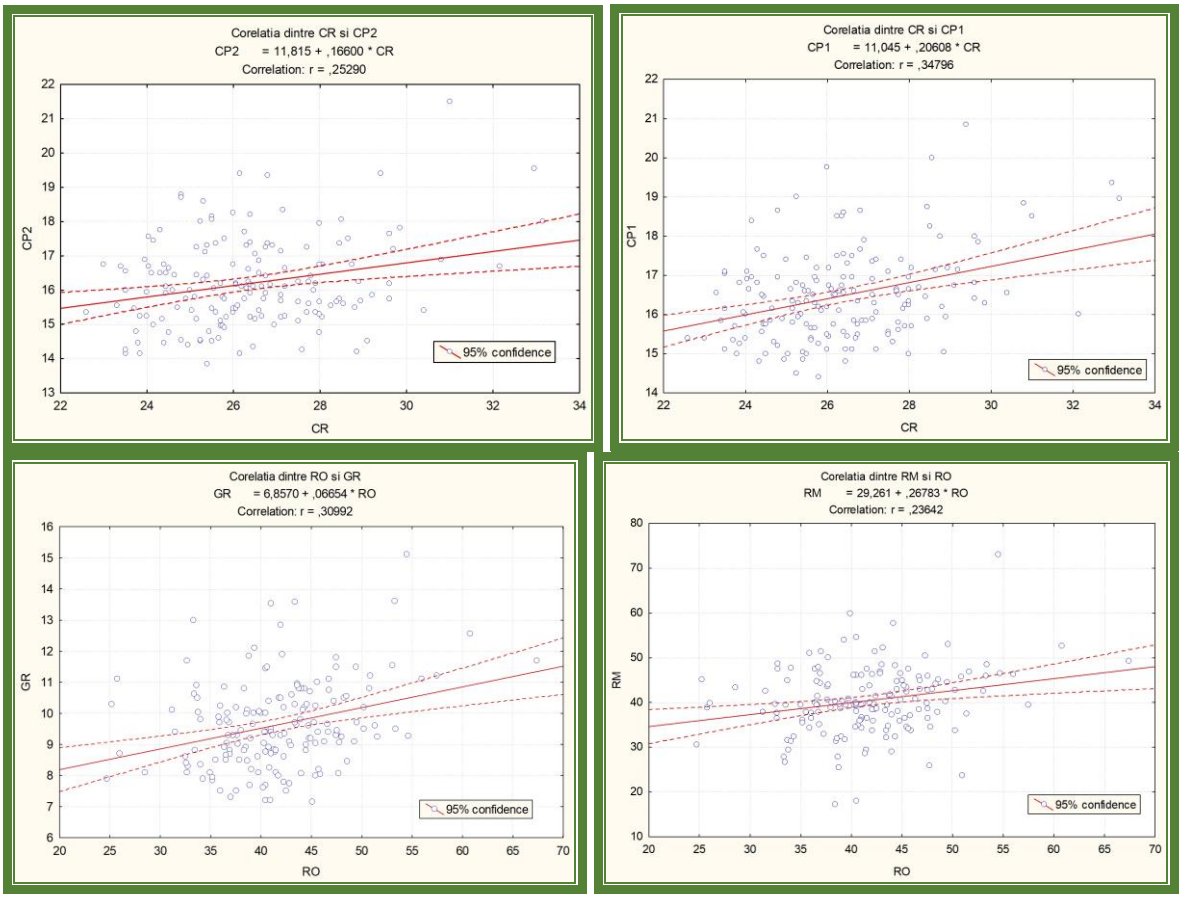
Table 12. *Correlation matrix for trophy elements Group 1 - Eastern Carpathians*

Var.	LP	RO	RM	CR	CP1	CP2	NRR	GR	DS	RG	CRN	PCT
LP		0,13	-0,03	0,18*	0,21**	0,07	-0,30^{ooo}	0,34***	0,26**	-0,11	-0,32^{ooo}	0,35***
RO			0,28***	0,06	0,11	0,11	0,03	0,29***	0,12	-0,01	0,11	0,41***
RM				-0,17^{o}	0,14	-0,11	0,30***	0,24	-0,14	0,09	0,22**	0,33***
CR					0,37***	0,29***	0,07	0,50***	0,05	-0,10	0,05	0,49***
CP1						0,54***	0,12	0,47***	-0,12	-0,18^{oo}	-0,02	0,61***
CP2							0,15	0,47***	-0,03	-0,13	0,08	0,57***
NRR								0,28***	-0,09	0,09	0,74***	0,50***
GR									0,16	0,02	0,20	0,84***
DS										-0,06	-0,07	0,09
RG											-0,03	-0,01
CRN												0,39***
PCT												

Note: * - significant, ** - distinctly significant, *** highly significant; For inverse correlations: ^{o} - significant, ^{oo} distinctly significant, ^{ooo} - highly significant.

For Group 1, the Eastern Carpathians, the correlation analysis highlighted a significant number of positive correlations, highly significant correlations, and very significant correlations (Tab. 12). A highly significant correlation is observed between the total score and most of the parameters, except for the spread (DS) and the bay tine (RG), which have a low weight in the total score calculation. The correlation with the circumference of the coronet (CR) and the first circumference of the beam (CP1) suggests a normal architectural relationship based on a volumetric ratio. The highly significant negative correlation between the length of the main beam (LP) and the total number of tines (NRR), as well as LP and crown (CRN), suggests a balanced relationship for the diverse format of trophies in this group. The very significant correlation between the length of the main beam (LP) and the weight (GR) indicates that Group 1 records the heaviest trophies. The brow tine (RO) showed a highly significant correlation with the tray tine (RM), as these elements are closely related, with the middle radius being the first of the two typical tines that enter the regression. This is justified by the highly significant correlation of the brow tine (RO) with the weight (GR). The highly significant correlation between the circumference of the coronets (CR), the first circumferences of the main beam (CP1) and the second one (CP2), and their correlation with the weight (GR), highlights the volumetric relationship with the weight. This relationship is also supported by the highly significant correlation between weight (GR) - total number of points (NRR) and weight (GR) - crown (CRN).

An aspect highlighted by the distinct inverse correlation between the first circumference of main beam (CP1) and the bay tine (RG) is the infrequent occurrence of the bay tine in trophies from this group.



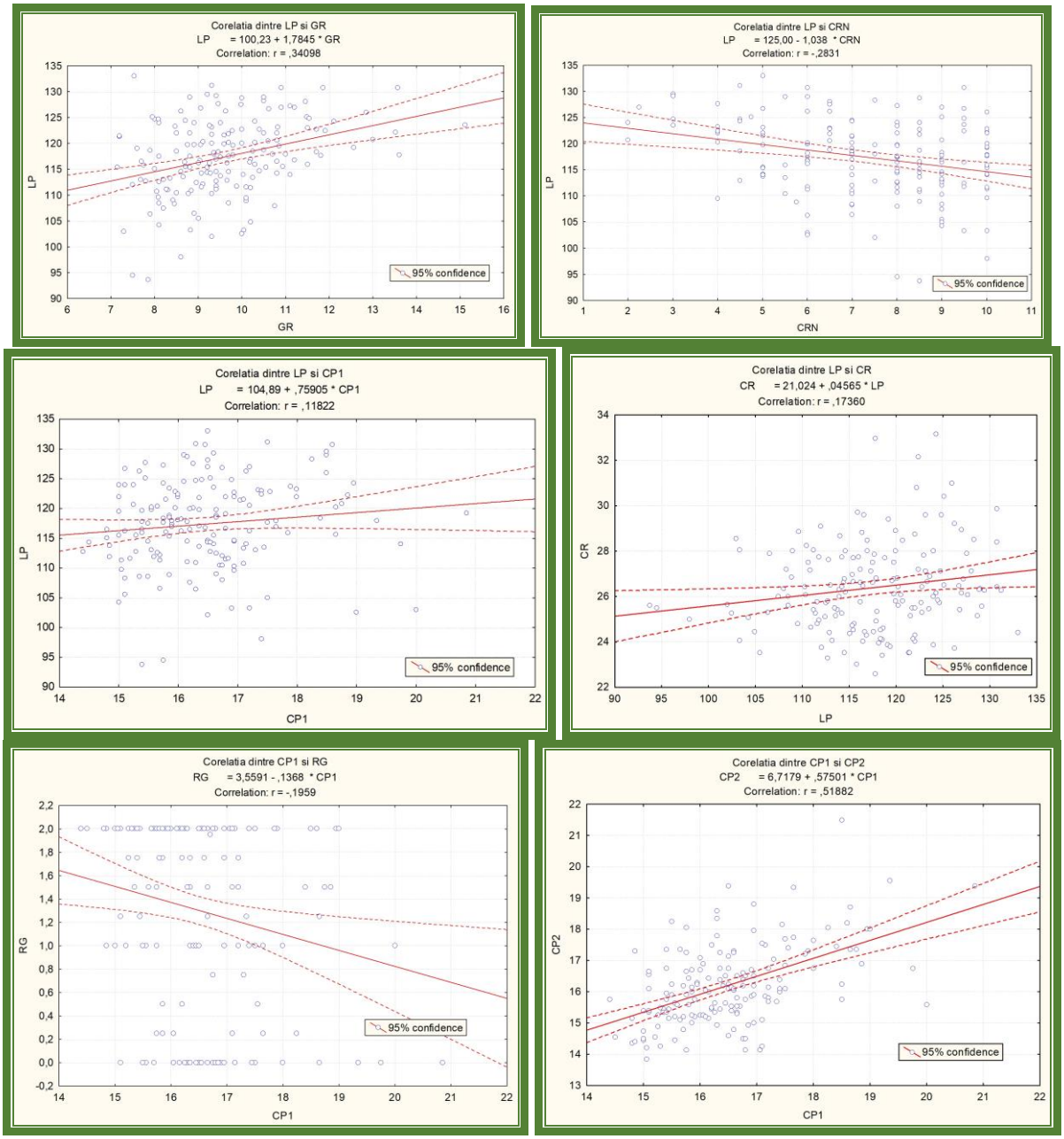


Figure 16. *Scatterplot between elements of Group 1 – Eastern Carpathians*

Table 13. *Correlation matrix for trophy elements Group 2 - Southern Carpathians*

Var.	LP	RO	RM	CR	CP1	CP2	NRR	GR	DS	RG	CRN	PCT
LP		0,33	-0,03	-0,08	-0,23	-0,20	-0,44	0,29	0,39	-0,09	-0,42	0,19
RO			0,46	-0,07	-0,37	-0,21	0,06	-0,04	0,27	-0,04	-0,07	0,25
RM				-0,21	-0,36	-0,14	0,01	0,02	0,55*	0,28	-0,15	0,27
CR					0,35	0,19	0,02	0,26	-0,22	0,26	-0,21	0,49*
CP1						0,66**	-0,13	0,11	-0,40	-0,28	-0,07	0,17
CP2							-0,30	-0,20	-0,40	-0,29	-0,32	0,04
NRR								-0,08	-0,21	0,53*	0,83**	0,34
GR									0,10	0,27	0,10	0,48
DS										0,14	-0,35	0,11
RG											0,32	0,60*
CRN												0,13
PCT												

Note: * - significant, ** - distinctly significant, *** highly significant; For inverse correlations: ^{o} - significant, ^{oo} distinctly significant, ^{ooo} - highly significant.

Similarly to Group 1, for Group 2 - the Southern Carpathians, distinct significant correlations are observed between the first circumferences of the main beam (CP1) and the second one (CP2). A significant correlation is found between the bay tine (RG) and the total number of points (NRR). This can be justified by the predominant occurrence frequency of the bay tine and the relatively low total number of points in trophies from this group (Tab. 13).

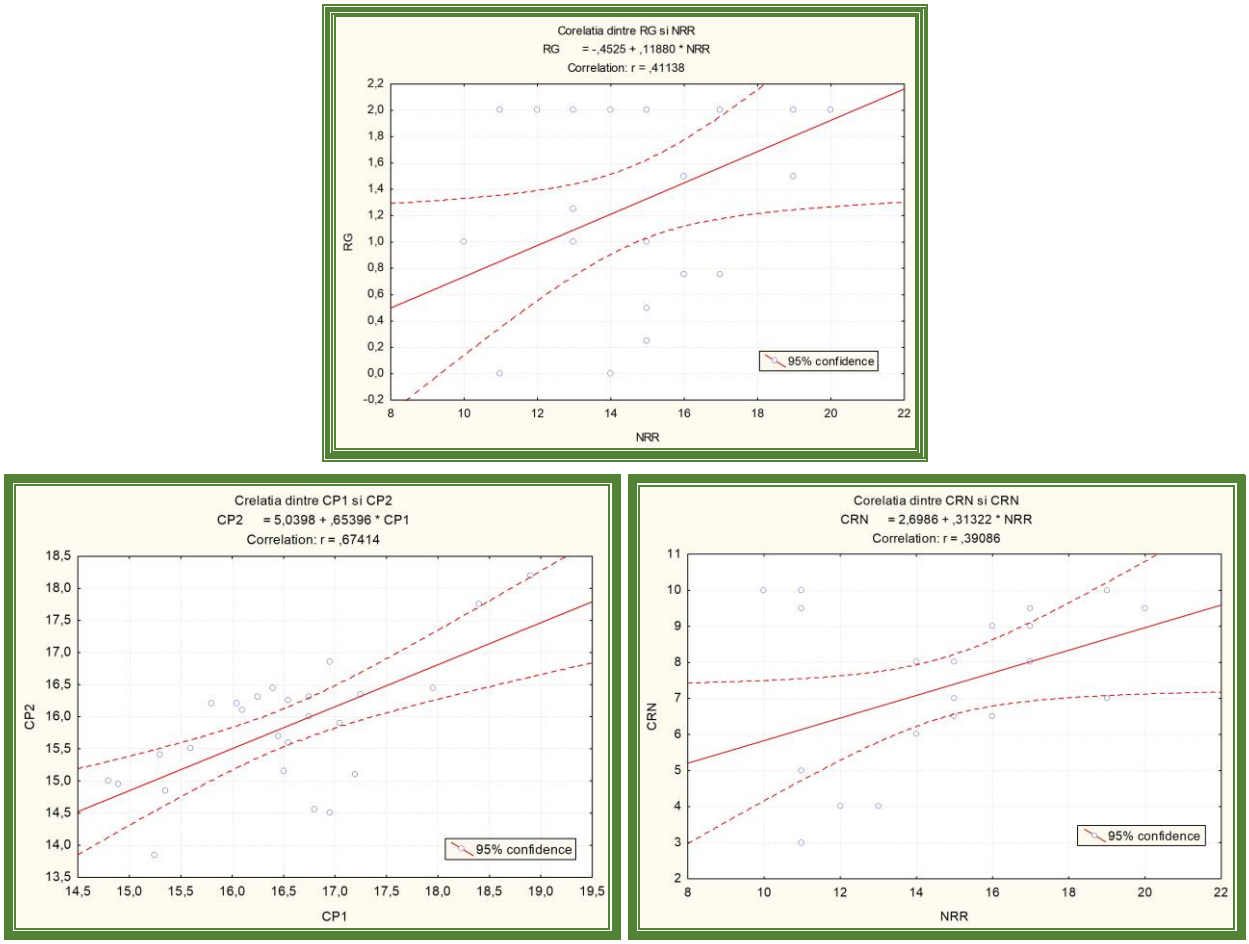


Figure 117. *Scatterplot between elements of Group 2 – Southern Carpathians*

Table 14. *Correlation matrix for trophy elements Group 3 – Extracarpathian region*

Var.	LP	RO	RM	CR	CP1	CP2	NRR	GR	DS	RG	CRN	PCT
LP		-0,68 ^{o}	0,07	0,39	-0,18	-0,50	-0,09	0,16	0,63*	-0,01	0,12	0,28
RO			0,27	-0,57	0,15	0,16	-0,05	-0,25	-0,33	0,04	-0,33	-0,29
RM				-0,29	-0,25	-0,56	0,49	0,11	-0,44	0,33	0,25	0,14
CR					-0,21	-0,16	0,03	0,38	0,22	0,43	0,40	0,33
CP1						0,71*	-0,13	0,52	-0,18	0,34	-0,17	0,55
CP2							-0,29	0,16	-0,24	-0,07	-0,13	0,18
NRR								0,15	-0,45	0,34	0,82**	0,45
GR									-0,24	0,80**	0,27	0,83**
DS										-0,36	-0,26	-0,17
RG											0,33	0,69*
CRN												0,59
PCT												

Note: * - significant, ** - distinctly significant, *** highly significant; For inverse correlations: ^{o} - significant, ^{oo} distinctly significant, ^{ooo} - highly significant.

For the extracarpathian region, Group 3, a significant negative correlation is observed between the length of the main beam (LP) and the brow tine (RO). This could indicate a particular characteristic of the brow tine in these areas where the seasonal conditions are highly productive in terms of food, which may justify major differences in trophy architecture elements. This argumentation is further supported by the distinct significant correlation between the number of tines (NRR) and the crown (CRN), as well as the weight (GR) with the bay tine (RG) (Tab. 14).

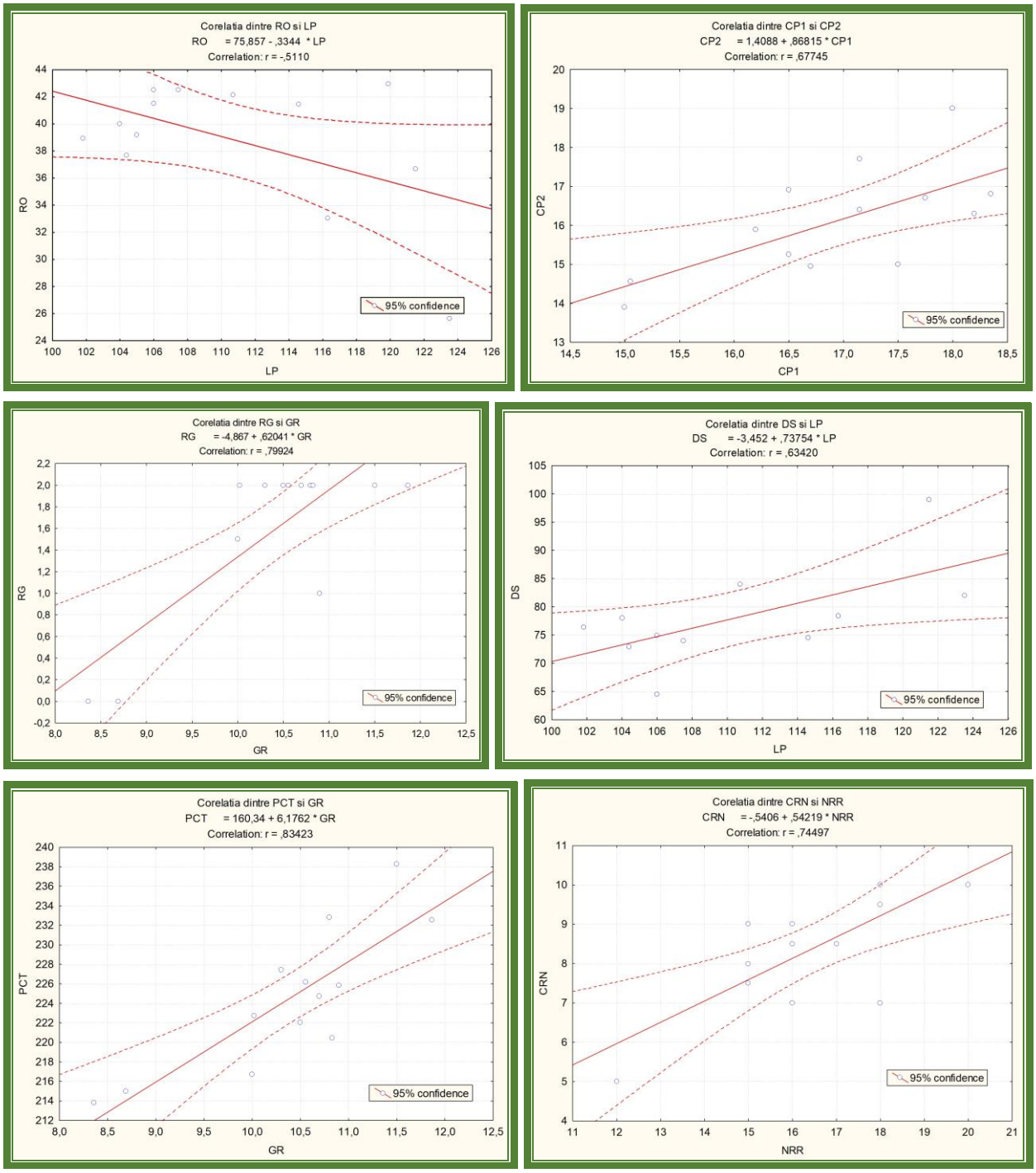


Figure 18. *Scatterplot between elements of Group 3 – Extracarpathian region*

4.4 Determining the particularities and the ratio between measurable parameters in red deer (*Cervus elaphus* L.) trophies, by applying the CIC, Rowland Ward evaluation formula and their ratio with other determined parameters.

To achieve the objective, a sample of 44 red deer (*Cervus elaphus* L.) trophies from Romania was measured according to both the CIC and Rowland Ward methods. The trophies were selected from the medalable class, specifically those with over 170 CIC points, originating from 16 counties, and were harvested between 2007 and 2021.

4.4.1 Results on the CIC and Rowland Ward evaluation method

By comparing the two methods, the first difference lies in the classification of species and subspecies of Cervidae. The Rowland Ward method covers all species and subspecies of deer and elk, both Asian and European, including all European red deer subspecies, those from Asia Minor (Turkey), the Caucasus Mountains, and all of Asia. It also includes introduced deer from the South Pacific and South America.

On the other hand, the CIC method categorizes and sets score intervals for medals for nine subspecies of deer as follows:

- Swedish red deer (*Cervus elaphus elaphus*): 160-169.99, 170-179.99, ≥180
- Norwegian red deer (*Cervus elaphus atlanticus*): 160-169.99, 170-179.99, ≥180
- Central European red deer (*Cervus elaphus hippelaphus*):170-189.99, 190-209.99, ≥210
- Carpathian red deer (*Cervus elaphus montanus*): 170-189.99, 190-209.99, ≥210
- Scottish red deer (*Cervus elaphus scoticus*): 160-169.99, 170-179.99, ≥180
- Spanish/Iberian red deer (*Cervus elaphus hispanicus*): 160-169.99, 170-179.99, ≥180
- Corsican red deer (*Cervus elaphus corsicanus*): 160-169.99, 170-179.99, ≥180
- North African red deer (*Cervus elaphus barbarus*):160-169.99,170-179.99, ≥180
- Red deer (introduced) (*Cervus elaphus hippelaphus*): 170-189.99, 190-209.99, ≥210

According to the CIC method, Romania is home to two subspecies of red deer: the Central European red deer (*Cervus elaphus hippelaphus*) and the Carpathian red deer (*Cervus elaphus montanus*), based on their geographic location.

Table 15. *Percentage ratio of evaluation parameters to total score for the CIC and Rowland Ward method*

Measurable parameters	Average CIC	Average RW	Intervals CIC		Intervals RW	
			Minimum	Maximum	Minimum	Maximum
Main beam length	26.34%	28.77%	22.12%	30.46%	22.57%	36.95%
Brow tine	4.55%	9.77%	2.76%	5.98%	5.50%	14.28%
Bay tine	0.65%	4.80%	0.00%	1.11%	0.00%	10.76%
Tray tine	4.37%	9.43%	2.03%	5.50%	4.43%	12.10%
Coronet circumference	12.75%	6.96%	10.61%	14.88%	5.79%	8.65%
Main beam circumference 1	15.05%	4.11%	13.79%	17.41%	3.78%	4.41%
Main beam circumference 2	14.44%	3.95%	12.62%	17.44%	3.21%	5.30%
Inside greatest spread	0.90%	10.86%	0.00%	1.67%	7.93%	15.18%
Weight	8.21%	-	6.35%	10.55%	-	-
Total number of tines	7.07%	-	5.08%	9.53%	-	-
Crown	3.40%	21.36%*	1.85%	4.67%	9.02%*	31.49%*
Color	0.76%	-	0.44%	0.91%	-	-
Perling	0.75%	-	0.24%	1.06%	-	-
Tine tips	0.81%	-	0.28%	1.06%	-	-

* The crown includes adjacent points to the typical antler points (RO, RG, RM).

Regarding the weights assigned to each category, the interpretation was done through a percentage comparison between the CIC and Rowland Ward evaluation methods for total scores,

parameters, and categories of parameters (Tab. 15, 16). By applying the evaluation methods to the analyzed sample, although the calculation formulas differ, a proportional relationship between the mean total scores of CIC and Rowland Ward can be observed (Fig. 21, 22).

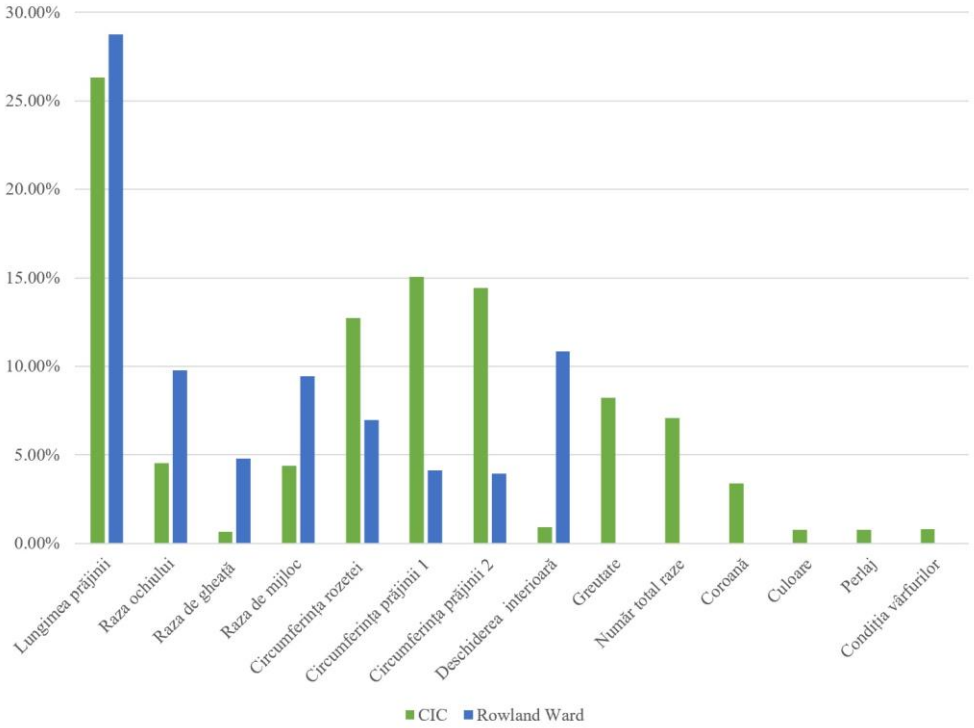


Figure 19. *Percentage ratio of evaluation parameters to total score for CIC and Rowland Ward*

Table 16. *Percentage ratio of evaluation parameters to total score for CIC and Rowland Ward*

Parametri măsurabili	Media CIC	MediaRW	Interval CIC		Interval RW	
			Minim	Maxim	Minim	Maxim
Typical tines	9.56%	23.99%	5.10%	11.27%	12.18%	31.22%
Circumferences	42.24%	15.03%	39.37%	46.53%	12.79%	18.43%
Crown	3.40%	21.36%	1.85%	4.67%	9.02%	31.49%

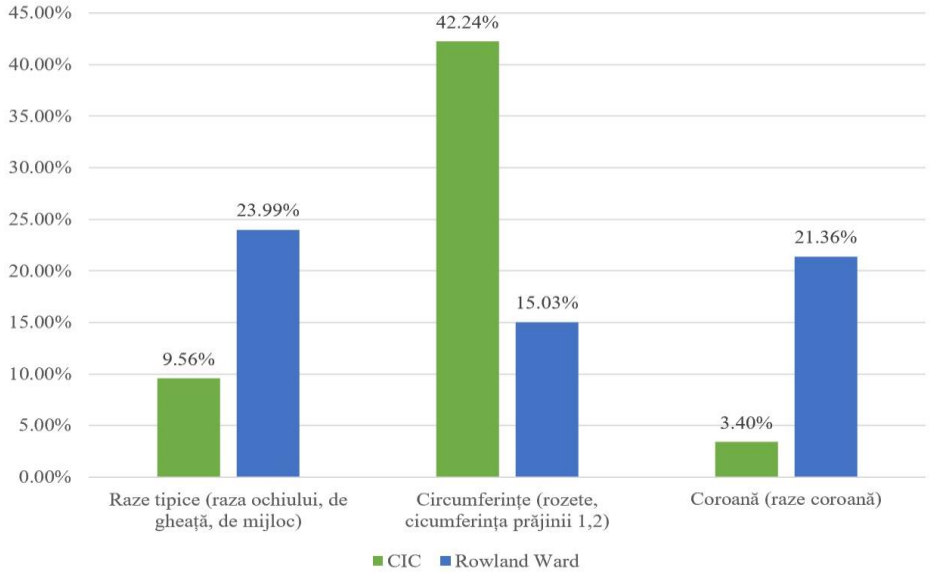


Figure 20. *The ratio between categories of measurable parameters and the total score for the CIC and Rowland method*

In relation to the additional parameter determined - age, a graphical representation of the mean final scores in CIC and Rowland Ward has been made. It can be observed that the peak in both CIC and Rowland Ward scores of the trophies is reached around the age of 11.5 years, progressively accumulating similar values at 9.5 and 10.5 years, and slightly decreasing for the age of 12.5 years (Fig. 21, 22).

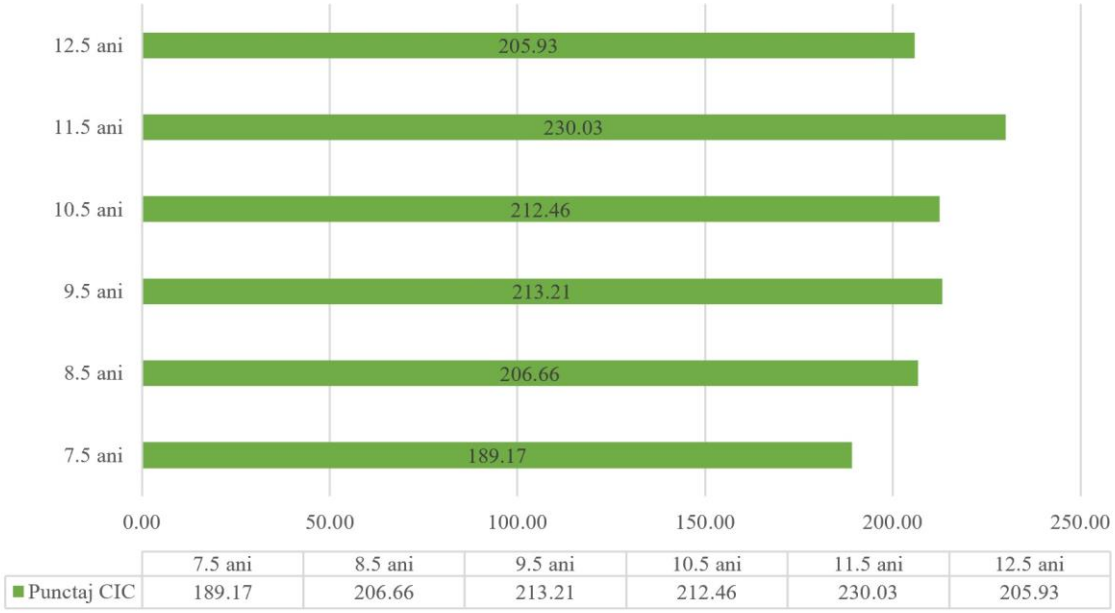


Figure 21. *Average CIC scores in relation to the determined age*

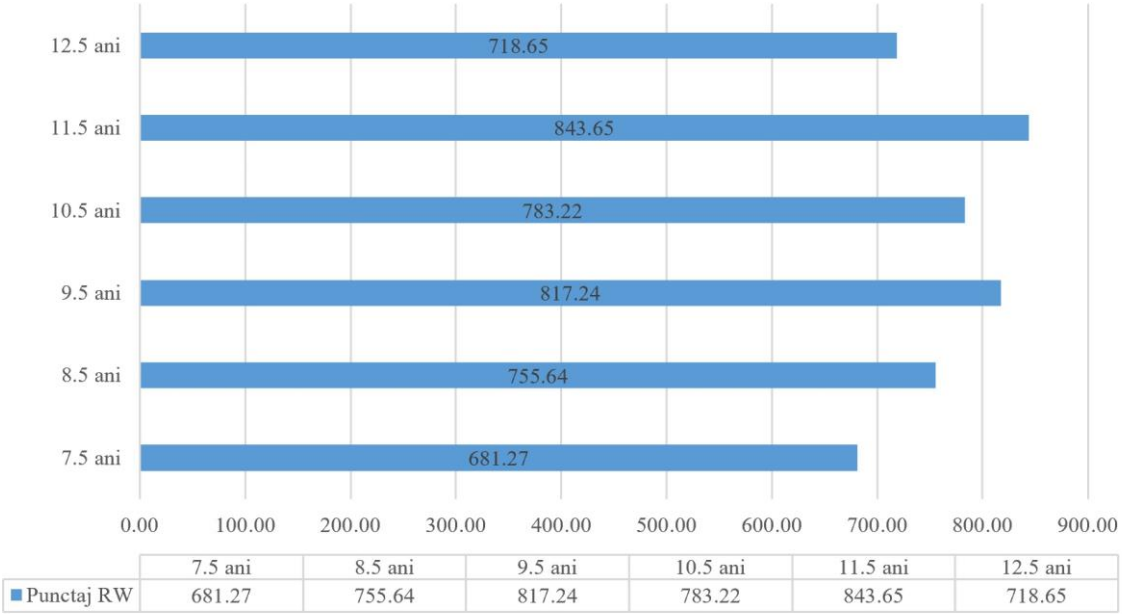


Figure 22. *Average Rowland Ward scores in relation to the determined age*

4.4.2 Results regarding the analysis of the measurable parameters within the CIC and Rowland Ward method in relation to other determined parameters.

Considering that the sample of 44 trophies was evaluated using both methods, it is important to mention that the measurement mode for the brow, bay, and tray tines differs. While insignificant differences of 1.42% for the brow tine and 0.94% for the tray tines were observed, for the analysis, the average values from CIC measurements were used for the brow and the average values from Rowland Ward measurements were used for the bay tine (Fig. 23).

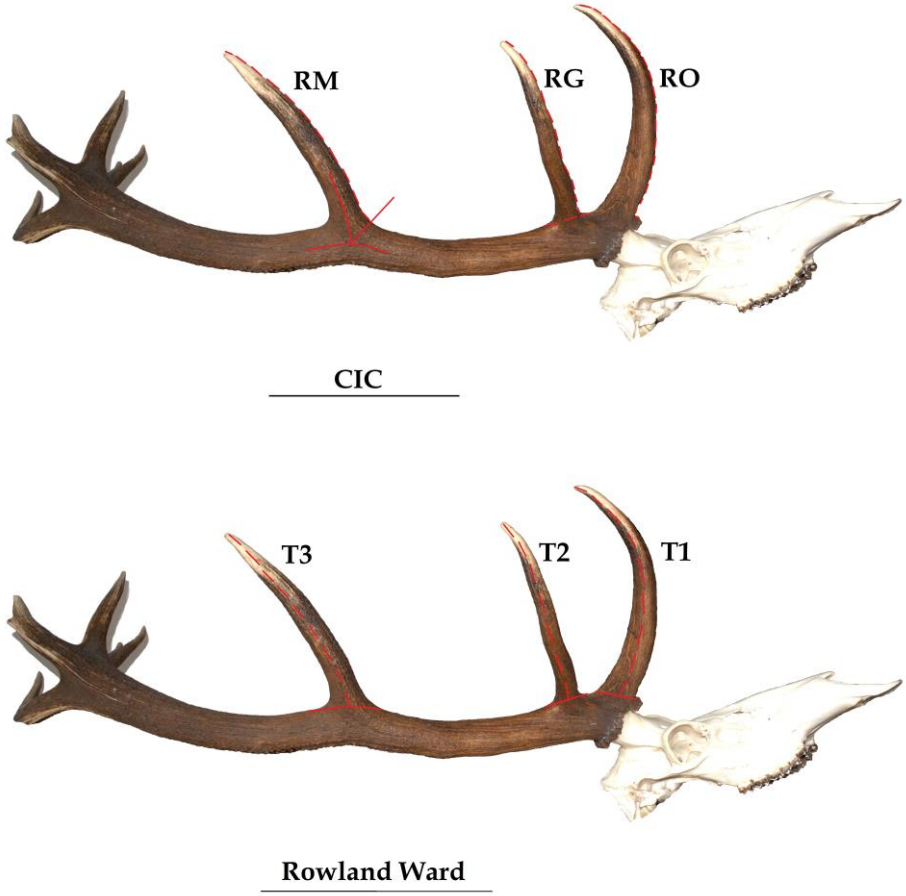


Figure 23. *Measurements of the typical tines according to CIC and Rowland Ward method (original)*

Using descriptive techniques, the trophy data was processed to obtain the main statistical indicators, namely the mean (m), standard deviation (sd.), standard error of the mean (Std. err. of media), and coefficient of variation (CV%) (Tab. 17).

It can be observed that the highest variation (67.39%) is recorded for the bay tine (RG), which is justified by its occasional presence. In descending order, medium variations were recorded for the minimum trophy spread (DSm) with 32.98% and for the crown (CRN) with 28.80%, elements that differ significantly based on the trophy's conformation. Small and similar variations were recorded for the circumferences of coronets and main beam (CR, C1, C2). The smallest variations were recorded for the minimum and maximum length of the skull (LNC, LTC).

Table 17. *Descriptive statistics of variables*

Variabile	Valid N	Media (m)	Minimum	Maximum	Abaterea standard (sd.)	Coeficientul de variație (CV%)	Eroarea standard a mediilor
LP	44	110,2443	88,95000	125,1500	8,46760	7,68076	1,276539
RO	44	38,1841	22,25000	54,6500	7,11362	18,62980	1,072418
RG	44	19,1648	0,00000	48,7500	12,91562	67,39250	1,947103
RM	44	36,7500	17,35000	47,0000	7,74775	21,08230	1,168017
CR	44	26,6966	22,65000	32,9500	2,24132	8,39554	0,337892
C1	44	15,7625	12,60000	19,3500	1,31220	8,32484	0,197822
C2	44	15,1284	12,80000	19,5500	1,39706	9,23471	0,210615
NTR	44	14,8636	11,00000	20,0000	2,62892	17,68690	0,396324
GR	44	8,6732	5,71000	13,6000	1,67172	19,27463	0,252022
DS	44	83,1659	54,00000	116,0000	13,19180	15,86203	1,988739
CRN	44	7,1932	4,00000	10,0000	2,07201	28,80514	0,312367
VS	44	9,3636	7,50000	13,5000	1,42797	15,25022	0,215275
DCF	44	54,2959	46,73500	61,2500	4,02276	7,40896	0,606454
LNC	44	47,8523	43,00000	50,8000	1,84681	3,85939	0,278416
LTC	44	18,9580	17,40000	20,2000	0,64555	3,40518	0,097321
DSM	44	108,9705	55,00000	150,0000	16,61757	15,24961	2,505192
DSm	44	57,8500	14,00000	101,5000	19,08413	32,98899	2,877041

To highlight the differences between the analyzed parameters, a dispersion analysis was used. Through the analysis of trophy elements, a significant number of positive correlations, distinct significant correlations, and very significant correlations were identified (Tab. 18, Fig. 24). The very significant correlation between the length of the main beam (LP) and the weight (GR) and the front circumference of the main beams (DCF), as well as between the circumference of the coronets (CR) and the circumferences of the main beams (C1, C2), supports a normal architectural relationship based on a proportional volumetric ratio. This relationship is further supported by the very significant correlation between the supplementary parameter, the front circumference of the main beams (DCF), and the circumference of the coronets (CR) and the circumferences of the main beams (C1, C2).

The relationship between volume and weight is highlighted by the very significant correlation between weight (GR) and the crown (CRN), the total number of tines (NRR), and the front circumference of the main beams (DCF). A distinct significant correlation is evident between age (VS) and the maximum width of the skull (LTC), as well as between the maximum length of the skull (LNC) and weight (GR).

Table 18. *Correlation matrix for trophy elements*

Variabila	LP	RO	RG	RM	CR	C1	C2	NTR	GR	DS	CRN	VS	DCF	LNC	LTC	DSM	DSm
LP		0,32*	-0,00	0,12	0,45**	0,36*	0,40**	0,17	0,65***	0,28	0,27	0,34*	0,52***	0,34*	0,49*	0,32	-0,07
RO			0,09	0,48**	0,38*	0,30*	0,30*	0,19	0,42**	0,29	0,11	0,25	0,28	0,02	0,17	0,26	0,12
RG				0,26	0,16	0,16	-0,02	0,44**	0,24	0,32*	0,30*	-0,12	0,07	-0,22	-0,02	0,46**	0,28
RM					0,28	0,40**	0,17	0,27	0,45**	0,08	0,19	0,08	0,26	-0,06	-0,02	0,21	0,01
CR						0,53***	0,55***	0,34*	0,75***	0,10	0,29	0,36*	0,61***	0,21	0,30*	0,30*	-0,03
C1							0,80***	0,38*	0,76***	-0,15	0,36*	0,26	0,46**	0,26	0,06	0,10	-0,33
C2								0,31*	0,72***	-0,12	0,34*	0,40**	0,61***	0,29	0,17	0,15	-0,28
NTR									0,47**	0,08	0,92***	0,17	0,35*	-0,02	0,00	0,37*	-0,05
GR										0,12	0,50***	0,36*	0,69***	0,40**	0,24	0,36*	-0,15
DS											0,07	0,15	0,29	0,06	0,28	0,80***	0,81***
CRN												0,30*	0,43**	0,08	0,06	0,37*	-0,07
VS													0,34*	0,29	0,45**	0,18	-0,03
DCF														0,34*	0,45**	0,49**	0,16
LNC															0,36*	0,12	-0,17
LTC																0,30*	0,03
DSM																	0,68***
DSm																	

Note: * - significant, ** - distinctly significant, *** highly significant; For inverse correlations: ^{o} - significant, ^{oo} distinctly significant, ^{ooo} - highly significant.

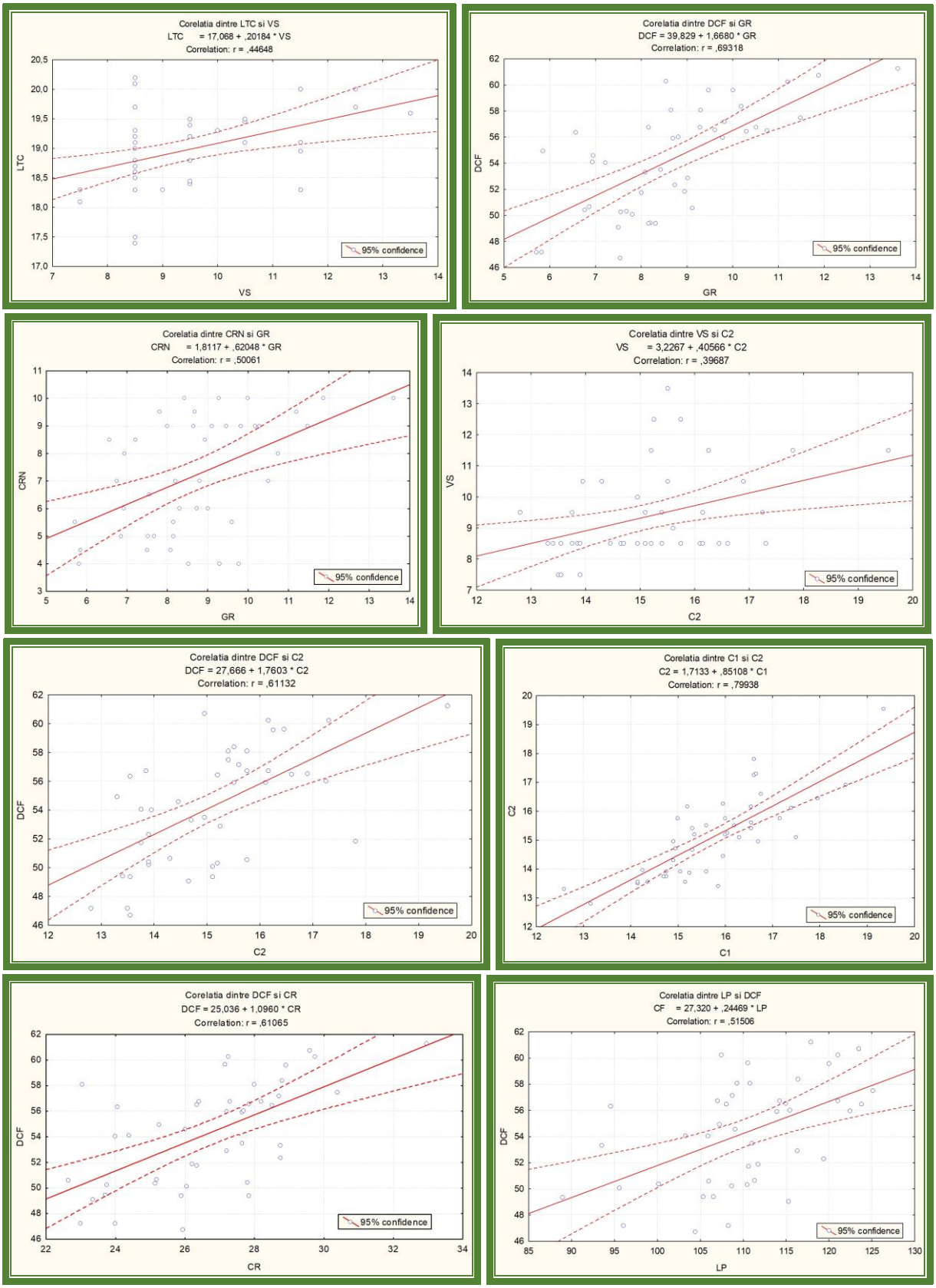


Figure 24. *Scatterplot between trophy elements*

CHAPTER 5. GENERAL CONCLUSIONS AND ORIGINAL CONTRIBUTIONS

5.1 Final conclusions.

5.1.1 Conclusions regarding the composition, particularities and contribution of the evaluation parameters in the score calculation formula, from the evaluation methodologies.

The main limitations of the evaluation formulas can be pinpointed by the absence or limitation of certain measurable elements. The Carpathian method offers limited scoring for the lengths of the brow and tray tines (except for the brow tine) and does not include deductions or additions. The Nadler method does not measure the bay and tray tines, and for the crown, the limited score is given based on an appreciation rather than measurement (Spătaru et al., 2021).

Although the CIC method is much more elaborate, several measurements are missing or limited. The presence of any other atypical tines in the lower half of the main beam is not recorded through measurement (and scored through measurement), thus becoming almost irrelevant for the final score. The calculation of the score awarded to the crown is limited in terms of value. These aspects, while tolerable and sufficient for scoring trophies up to the medal threshold, become limited and problematic for ranking larger trophies (over 210 CIC points). Essentially, the differentiation between trophies that exceed the maximum crown score cannot be determined for these measurable parameters; the final ranking (in terms of points) can only be done through the influence of other parameters, which have variable scores (Spătaru et al., 2021).

Compared to the CIC method, which is widely used in Europe, the Rowland Ward and SCI methods offer a different contemporary perspective of evaluation. The score obtained through the Rowland Ward and SCI methods is composed entirely of measurable parameters. In these methods, the main beams and the maximum inner spread are measured, as well as all relevant points and circumferences (coronets, tines), and the final score is obtained by adding up these values. Due to this overall approach in calculating the component elements of the trophy, these methodologies do not differentiate between a trophy with short tines and a larger number of short points versus a trophy with longer tines and a smaller number of longer points. A significant difference in measuring the points in the crown is that the Rowland Ward and SCI methods do not measure the point identified as the tip of the tine. In the CIC method, this point is measured twice; once as part of the total length of the main beam and again as a component tine in the crown. The evaluation form in the CIC method also includes several supplementary measurable and determinable elements, which are more numerous compared to the Rowland Ward and SCI methods. These additional information provided in the CIC evaluation form, along with other measurable elements (such as front circumference of the main beams) or those that can be determined (such as age), can provide important data for establishing correlations between different parameters (objective 3) (Spătaru et al., 2021).

5.1.2 Conclusions regarding the performance determination of red deer (*Cervus elaphus* L.) trophies, from the upper class of CIC medalable trophies in Romania, in the context of national and international hunting exhibitions.

According to the graph in Figure 9, it can be hypothesized that in the context of international exhibitions from the beginning of trophy exposure and evaluation phenomenon, i.e., the period 1937-1964, the limited number of Romanian trophies can be justified by difficulties in collaboration, infrastructure, and transportation, political conditions, and national initiative in

this regard, as well as the number and accessibility of hunters for this species, and even the national population of the species.

The large number of deer trophies presented during the period 1967-1985 indicates the growing importance of this phenomenon, including national efforts to improve species management measures, expanding populations and distribution, repopulation initiatives, competitive engagement between countries, and national initiatives in related activities.

After 1990, international events gradually disappear, being replaced by national or regional ones. Even at an official national level, the interest of Romania diminishes, and currently, trophy exhibitions are mainly organized privately. The large number of valuable trophies displayed at recent exhibitions also reflects the high interest of the hunting public in trophy evaluations and the current status of the species' performance at the national level.

Current and historical data, together with specific information related to location, can contribute to drawing conclusions regarding the typology expressed through trophy conformation in different geographical areas (Objective 3), as well as providing relevant information about the results of population management activities over time.

Promoting a consistent and universally accepted method of trophy evaluation, which includes certain generally accepted parameters, has significant economic implications in the hunting field. This method allows for establishing appropriate pricing in hunting activities, considering the quality and value of trophies. Moreover, detailed analysis has led to the improvement of direct in-field evaluation methods, facilitating the assessment of game quality.

According to the analysis results, the following counties can be considered traditional in terms of trophy performance in Romania: Mureș, Harghita, Covasna, Suceava, Bacău, Brașov, Neamț, Argeș, Vrancea, Bistrița, Buzău. Figures 10, 11, 12, 13 also illustrate the expansion of the deer population and, consequently, their improved performance at the national level, with the number of counties increasing from 7 in the period 1920-1945 to 30 in the period 1971-2022.

Regarding the evolution of records, an ascending trend in scores can be observed, from 226.49 for the period 1920-1945 to 254.70 for the period 1996-2022, with an increase in key parameters such as weight and associated circumferences, while the average length of antlers and total number of points remain relatively constant (Figure 15). The national ranking for the most powerful trophies also corresponds to the determined traditional areas: Mureș, Covasna, Vrancea, Bacău, Argeș, Harghita, Suceava.

5.1.3 Conclusions regarding the determination of the particularities and the ratio between measurable parameters, in red deer trophies (*Cervus elaphus* L.), from the upper class of CIC medalable trophies in Romania, by region

Recording the morphometric elements of trophies in exhibition catalogs represents a valuable database and, through their analysis, provides real historical evidence of the evolution of game quality and game management.

Based on the analyzed data, several conclusions have been formulated regarding the selected regions. Overall, Group 1, the Eastern Carpathians, registers the highest variation for coronets circumference, first main beam circumference, weight, bay tine, total score, being the most diverse group in terms of significant variations, which can be attributed to the larger number of trophies. Historically, this group also has the most extended collection period, ranging from 1919 to 2022, making it the main and traditional area regarding the top performances of this species in Romania.

Group 2, the Southern Carpathians, shows the highest variation in brow tine, tray tine, total number of tines, spread, crown, and the lowest variation in coronets circumferences, first and second main beam circumferences, and total score. Historically, the trophy performances,

particularly those scoring over 210 CIC points, from this area date back to the period 1958-2021, but the representation of trophies from this region is relatively low in the exhibitions of hunting.

Group 3, the extracarpathian area, exhibits the highest variation in main beam length, second main beam circumference, and the lowest variation in brow tine, tray tine, total number of points, weight, spread, bay tine and crown. This group has the least representation in terms of trophies scoring over 210 CIC points, with the most recent history of performance for this species dating from 1966 to 2019, and it is also the most dispersed origin of trophies at the national level. According to the coefficient of variation, the most significant differences between groups are highlighted in the elements of brow tine, total number of tines, weight, crown, and total score, suggesting the formation of specific trophy architecture characteristics based on the analyzed groups and the seasonal conditions.

5.1.4 Conclusions regarding the determination of the particularities and the ratio between measurable parameters in red deer (*Cervus elaphus* L.) trophies, by applying the CIC, Rowland Ward evaluation formula and their ratio with other determined parameters

By applying and interpreting the evaluation methods to the analyzed sample, a first clarification for the current CIC formula is that in Romania, depending on the geographical location, it considers two subspecies of red deer, namely the Central European red deer (*Cervus elaphus hippelaphus*) and the Carpathian red deer (*Cervus elaphus montanus*).

In relation to the additional parameter determined - age, a proportional relationship between CIC and Rowland Ward scores was observed. The peak score for trophies is reached around the age of 11.5 years, with a progressive increase and similar values at 9.5 and 10.5 years, followed by a slight decrease at the age of 12.5 years. It can be concluded that the age of 12.5 years marks the beginning of the regressive period.

Regarding the different measurement methods for the brow tine and tray tine applied to the analyzed sample, no significant differences were recorded: 1.42% for the brow tine and 0.94% for the tray tine.

For the analyzed sample, a series of highly significant correlations between parameters that express a normal architectural relationship based on a proportional volumetric ratio were identified. Additionally, distinct and highly significant correlations were found between the determined supplementary parameters. Age showed a significant correlation with the front cylinder diameter and maximum skull width, while trophy weight exhibited a highly significant correlation with the front cylinder diameter and a distinct significant correlation with the maximum skull length.

5.2 Original contributions.

- Determinarea componenței, particularităților și aportului parametrilor de evaluare în formula de calcul a punctajului pentru metodele de evaluare CIC, Rowland Ward, Safari Club International și completări privind metodele Nadler și Carpatină ca și bază comună, a trofeului de cerb comun;
- Determinarea performanțelor naționale, pentru trofeele de cerb comun, din clasa superioară a trofeelor medaliabile CIC din România, în contextul expozițiilor naționale și internaționale de vânătoare;
- Determinarea zonelor tradiționale din punctul de vedere al performanțelor obținute la trofeele de cerb comun;
- Detereminarea evoluției recordurilor, din punctul de vedere al punctajului și al principalilor parametri de evaluare CIC pentru trofeele de cerb comun;

- Determinarea particularităților și a raportului dintre parametri măsurabili, la trofeele de cerb comun, din clasa superioară a trofeelor medaliabile CIC din România, atât istorice cât și recente pe regiuni;
- Dterminarea raportului dintre parametrii de evaluare prin aplicarea formulei de evaluare CIC și Rowland Ward la trofeele de cerb comun;
- Determinarea particularităților și a raportului dintre parametri măsurabili la trofeele de cerb comun din România, prin aplicarea formulei de evaluare CIC, Rowland Ward și raportul acestora cu alți parametri determinați.

5.3 Dissemination of results.

Publications (BDI):

1. **Spătaru C.G.**, Sîrbu G.E., Codrean L.C., Ionescu O. (2022). Red deer (*Cervus elaphus* L.) trophies from Romania. Proceedings "Forest and sustainable development" 11th Edition, Brașov, Romania – forthcoming.
2. **Spătaru C.G.**, Sîrbu G.E., Cazacu R. (2022). Contribuții ale speciilor: cerb comun (*Cervus elaphus* L.), căprior (*Capreolus capreolus* L.) și mistreț (*Sus scrofa* L.) la serviciile ecosistemice din România. Revista de Silvicultură și Cinegetică, Anul XXVI/nr.51. pp.103-110.
http://progresulsilvic.ro/wp-content/uploads/2022.51-WEB.pdf
3. **Spătaru C.G**., Sîrbu G.E., Ionescu O. (2021). Considerații privind particularitățile și evoluția formulelor de evaluare pentru trofeul de cerb comun (*Cervus elaphus* L.). Revista de Silvicultură și Cinegetică, Anul XXVI/nr.48; pp. 40-48.
http://progresulsilvic.ro/wp-content/uploads/2021.48-WEB.pdf
4. Sîrbu G.E., Dieter C. S., **Spătaru C.G.**, Codrean C.L. (2022). Elemente morfo-anatomice de analiză comparată privind arhitectura cranială și trofeul cerbului comun (*Cervus elaphus* L.), din Carpaţii de Curbură și Masivul Făgăraș. Revista de Silvicultură și Cinegetică, Anul XXVII/nr.50. pp. 21-27.
http://progresulsilvic.ro/wp-content/uploads/RSC_nr_50_2022.pdf
5. Sîrbu G., Simon D., Sîrbu A., **Spătaru C.G.**, Ionescu O. (2020). Antler size and form in relationship with cranial architecture in red deer (*Cervus elaphus* L.). A case study in the Curvature. Proceedings "Forest and sustainable development" 9th Edition, Brasov, Romania. pp. 95-113.
https://silvic.unitbv.ro/images/conferinte/fsd2020/Proceedings_FSD_2021_-_tot_volumul.pdf
6. Sîrbu G.E., Simon D., **Spătaru C.G.**, Sîrbu A., (2020). Studiu craniometric asupra populației de cerb (*Cervus elaphus* L.) din Carpații de Curbură. Determinarea vârstei utilizând modelarea elementelor craniene. Revista de Silvicultură și Cinegetică, Anul XXV/nr.46. pp.85-93.
http://progresulsilvic.ro/wp-content/uploads/RSC_46_2020.pdf

Other publications (books):

1. **Spătaru C.G.**, Băluţ D., Codrean C.L., Hadăr O.C., Ionescu O., Jurj R.R., Mirea I., Titianu A.V., Unici R.G. (2023). Expoziția de vânătoare Hunting Exhibition H – Hunting Prize-Sibiu 2022, Catalogul Trofeelor Trophies Catalogue. ISBN 978-973-0-38236-5.
2. **Spătaru C.G.**, Băluţ D., Codrean C.L., Ionescu O., Jurj R.R., Mirea I., Titianu A.V., Unici R.G. (2023). Expoziția de trofee Trophy Exhibition Expo-Moldavia - Bacău 2022, Catalogul Trofeelor Trophies Catalogue – forthcoming.

REFERENCES

1. Abramović A. (2008). Trofejna struktura krupne divljači na području zapadne Hrvatske. Diplomski rad. Sveučilište u Zagrebu, Šumarski fakultet. 35 pp.
2. Almășan H, Ilie E, Scărlătescu G M (1977). Date somatometrice la cerbul comun (*Cervus elaphus hippelaphus* Erxl.) din România. Analele ICAS, 35, 17-28.
3. Anon. (1985). Celostátní výstava myslivosti s mezinárodní účastúí pod zaštitou CIC. BrnoVýstaviště˘, 401 pp.
4. Anon. (1981). Katalog of Hunting Trophies, Plovdiv 1981 - 1. Sofia, 328 pp.
5. Anon. (1980). Celostátní výstava myslivosti s mezinárodní účastúí pod zaštitou CIC. NitraVýstaviště˘, 346 pp.
6. Anon. (1976). Katalog - Celostátní myslivecka výstava mezinárodní účastí. České Budějovice, 261 pp.
7. Anon. (1971). Vadászati Világkiállítás. Trófea katalógus. Globus Nyomda, Budapest, 527 pp.
8. Anon. (1967). Međunarodna izložba lova i sajam lova i ribolova, 22.9. - 5.10. 1967. NIP. Novi Sad.
9. Anon. (1954). Die Straße der Nationen (Hale P). 35-170 p. Iz: Anon., 1954: Internationale Ausstellung Jagd und Sportfischerei, Düsseldorf 16. bis 31. Oktober 1954.
10. Anon. (1937). Amtlicher Führer und Katalog zur Internationalen Jagdausstellung Berlin 1937, Ausstellungshallen am Funkturm, 3. bis 21. November. Reichsbund Deutsche Jägerschaft, Berlin, 460 pp.
11. Anon. (1935). Expoziția națională de vânătoare. Catalog. Ed. Cartea Românească.
12. Azorit C., Analla M., Carrasco R., Calvo J. A., Munosz-Cobo J. (2002). Teeth eruption patern in red deer (*Cervus elaphus hispanicus*) in southern Spain. Anales de Biologia 24: 107-114.
13. Bán I., Fatalin Gy., Fodor T., Szidnai L. (1986). Élőhely és trófeavizsgálat számítógéppel. Akadémia Kiadó Budapest. p. 207.
14. Baker K. H., Hoelzel A.R. (2013). Fluctuating asymmetry in populations of British roe deer (*Capreolus capreolus*) following historical bottlenecks and founder events. Mammalian Biology, 78(5), 387-391.
15. Bertouille S.B., De Crombrugghe S.A. (1995). Body mass and lower mandible development of the female red deer as indices of habitat quality in the ardennes. Acta Theriol. 40(2), 145–162.
16. Bodea M. (1966). Recoltarea și valorificarea vânatului.
17. Bokor J., Bokor Á., Nagy J., Horn P., Nagy I. (2013). Summary of comments on analysis of Hungarian red deer trophies by means of principal component analysis in two different counties. Journal of Central European Agriculture, 14(1), 452-466.
18. B&C Score (2021). B&C Net Score and B&C Gross Score. https://www. boone-crockett.org/policies-bc-big-game-records-program
19. Boone & Crockett (2021). How to Score North American Big Game, 5th Edition boone-crockett.org
20. Botezat E. (1903). Gestaltung und Klassifikation der Geweihe des edelhirsches, nebst einem Anhange über die Stärke der Karpathenhirsche und die zwei Rassen derselben. Gegenbaurs Morphol. Jahrb. 32: 104-158 (Issue 32 from 1904 but 32(1) was already published in 1903).

21. Botezat E. (1922). Die varietaeten des edelhirsches im gebiete der oestlichen Waldkarpaten Von Rumanien. Zoologisches institut der universitat Cernauti. Bukarest, 1922. pp.72.
22. Botezat E. (1933). Coarne enorme si cerbul din regiunea Carpatilor. Extras din revista "Carpații". Cluj, 1933. No. 11, 12.
23. Botezat E. (1938). Priviri asupra chestiunii trofeelor. "Carpatii", 10/1938. Bucuresti.
24. Bradvarovic J. (1997). Morfometrijske i morfoloske, karakteristike parogova jelena sa podrucja Deliblatske pescare. Specialisticki rad. Bioloski fakultet Beograd. 1997.g. pp. 125.
25. Bradvarovic J. (1999). Lovna Osnova Lovista Deliblatska pescara. JP Srbijasume, SG Banat Pancevo.
26. Bradvarović J. (2009). Lovna Osnova Lovista Deliblatska pescara. JP Vojvodinasume, SG Banat Pancevo.
27. Bradvarovic J., Savic R. I., Milosevic-Zlatanović S. (1994). Taksonomski i ekoloski status jelena (*Cervus elaphus* L) na podrucju Deliblatske pescare. "Deliblatski pesak", bornik radova V1, 483 - 488, Beograd.
28. Bradvarovic J., Dordevic-Milosevic S. (2011). Neeticki hacini dobijanja trofeja (Lovni doping). Simpozij um, Zagubica. Mai 2011.g. pp. 372-379.
29. Bradvarovic J., Kunovac D., Prentovic R. (2005). Turisticki znaca repro-centara love divljaci. Turizam, br.9/2005. pp. 173-174.
30. Bradvarovic J., Pelkic C. (2004). Sest decenija gajenja jelena (*Cervus elaphus* L.) na Deliblatskoj pescari. Zbornik radova sa Simpozijuma: 185 godina SRP "Deliblatska pescara'", Pancevo, pp. 381-394.
31. Bradvarovic J., Prentovic R. (2006). Lovni turizam Vojvodine i potenci alna opasnost od avijarne influence. br. 10/2006 pp. 212-214.
32. Bradvarovic J., Prentovic R. (2007). Rika jelena kao turisticka atraktivnost Turizam, br.11/2007. pp. 247-250. PMF Novi Sad.
33. Bradvarovic J., Prentovic R. (2008). Etiologija ugrozavanja divljaci kao limitirajuci faktor lovnog turizma Vojvodine. Turizam, br. 1/2008. pp. 194-1197. PMF Novi Sad.
34. Bradvarovic J., Kolic B., Vasic M. (1990). Utica nekih Klimatskih cinilaca na pojavu, ponasanje i gasenje sumskog pozara na Deliblatskom pesku 1990.godine. VIII Jugoslovenski simpozi) o zastiti bilja. Opatija, 3-6.XII 1990.g. pp. 372 -373.
35. Bradvarovic J., Milenkovic M., Vasic M. (1990). Prilog poznavanju nekih vaznijih cinilaca koji povecavaju opasnost od sumskog pozara. VIII Jugoslovenski simpozij o zastiti bilja. Opatija, 3-6.XII 1990.g. pp. 373.
36. Bradvarovic J., Prentovic R. (2011). Introduction and reintroduction of the red deer (*Cervus elaphus* L.) in Danube-Carpathian Basin. Sloveski prosvet z medjunarodno udelezbo o upravljanju z divjadi - jelenjad, Velenje, 12. november 2011, ERICO, Institut za ekoloske raziskave doo Velenje, Slovenia, strana 90-98.
37. Bradvarovic J., Prentovic R. (2011). Red Deer Motive of Huting Tourism in Romania, Cotemporari Trends in Tourism and Hospitality, 2011, Universy of Novi Sad, Faculty of Science, Department of Geography, Tourusm and Hotel Menagemant, strana 185-187. Novi Sad.
38. Bradvarovic J., (2017). Jeleni (*Cervus elaphus* L., 1758) Dunskovo – Karpatskog Basena – Udruzejne za zastitu Dunava i Save Republike Srbije.
39. Brown W. A. B. (1991). The dentition of red deer (*Cervus elaphus)*: a scoring scheme to assess age from wear of the permanent molariform teeth, J. Zool. Lond. 224, pp. 519-536.

40. Buetzler W., cit. Gosow H. (1976). Ekologija divljaci. Frajburg. Brdska knjiga, Salcburg. Pp 418.
41. Butzler W. (1986). Rotwild, BLV Wildbiologie, 52-64. 2. Aufl. Munchen, Salzburg.
42. Burbaitė L., Csányi S. (2010). Red deer population and harvest changes in Europe. Acta Zoologica Lituanica, 20(4), 179-188.
43. Cegielski M, Calkosinski I, Dziegiel P, Gebarowski T et al. (2006). Search for stem cells in the growing antler stag (*Cervus elaphus*). Bulletin - Veterinary Institute in Pulawy, 50(2), 247-521.
44. CIC (1952). Formules pour l'appréciation des trophées. Secrétariat Général du Conseil International de la Chasse. 15, Rue de Téhéran
45. CIC (2019). Handbook for the Evaluation and Measurement of Hunting Trophies. CIC – Division of Applied Sciences. ted.cic-wildlife.org
46. Clutton-Brock J. (2002). Mammals. Dorling Kindersley Handbooks, London.
47. Comșia A. M. (1960). Biologia şi principiile culturii vînatului. Editura Academiei R.P.R., București.
48. Cotta V., Almășan H. (1963). Răspândirea și densitatea efectivelor de cerb și elemente pentru cunoașterea calității trofeelor. Ed. AgroSilvică, București.
49. Cotta V., Bodea M (1969). Vânatul României. Ed. Agrosilvică.
50. Cotta V., Bodea M., Micu I (2001). Vânatul și vânătoarea în România, Ed. Ceres. București, România.
51. Cotta M., Oroian G.M., Oroian M. (2016). The assessment of deer (*Cervus elaphus*) trophies. Bulletin UASVM Animal Science and Biotechnologies 73(1):1-7.
52. Dolan J.M. (1988.). A deer of many lands - A guide to the subspecies of the red deer *Cervus elaphus* L. Zoonooz LXII 10.4 -34.
53. Drechsler H. (1992). Über die Zusammenhänge zwischen verschiedenen Körper- und
54. Geweihmerkmalen der Rothirsche und dem Alter. Z. Jagdwiss. 38(2): 101–106.
55. Drechsler H. (1992). Über die Wirksamkeit des Wahlabschusses nach Geweihmerkmalen bei Rothirschen. Z. Jagdwiss. 38(3): 195–201.
56. Drechsler H. (1980). Über die Geweihbildung bei Rothirschen im „Rotwildring Harz" in den Jahren 1959–1978. Zeitschrift Für Jagdwissenschaft, 26(4), 207–219. doi:10.1007/bf02241635.
57. Geist V. (1998). Deer of the World: Their Evolution, Behavior and Ecology. I ed. Stackpole Books, Mechanicsburg, Pennsylvania, p. 170.
58. Goicea N., Dănilă N. (2012). Aspects regarding the red deer trophy size (*Cervus elaphus* L.) in the beech–fir tree mixture areas in comparison with those in the spruce-fir tree areas. Integrated Management of Environmental Resources, 95-101.
59. Goss R. J. (1969). Photoperiodic controlof antler cycles in deer. II. Alterations in amplitude. J. Exp. Zool. 171: 223-234.
60. Goss R. J. (1980). Photoperiodic controlof antler cycles in deer. V. Reversed seasons. J. Exp. Zool. 221: 101-105.
61. Goss R. J. (1983). Deer antlers: regeneration, function and evolution. Academic Press, NewYork, 336 pp.
62. Harvey P.H., Bradbury J. W. (1991). Sexual Selection. - In: Krebs, J.R. & Davies, N.B. (Eds.); Behavioural Ecology: an evolutionary approach. Blackwell Scientific, Oxford, Pp. 203-233.
63. Hell P., (1983). Rast parožia jeleňa obyčajného (*Cervus elaphus* L.) v Chráneney poľovnej oblasti Poľana. Folia venatoria 13: 35-50.

64. Hell P., Cimbal D., (1974). K otazke vekovej kulminacie srnčich parožkov. Folia venatoria (Polovnicky zborník, Myslivecký sbornik) 4: 15-24.
65. Hromas J., Bakoš A. (1994). Výška nasazení opěráku jelena evropského (*Cervus elaphus* L.) v České a Slovenské Republice. Folia venatoria 24: 143-145.
66. International Council for Game and Wildlife Conservation, (2012). The game-trophies of the world. International Formula for the Measurement and Evaluation of Trophies. www.cic-wildlife.org/ uploads/media/red_book.pdf
67. Ionescu O. et al. (2020). Serviciile oferite de ecosistemele populate cu speciile de faună de interes cinegetic și conservativ. Faza IX Stabilirea valorii monetare a serviciilor ecosistemice oferite de către speciile cerb, căprior, mistreț. Raport PN 19070602.
68. Isakovic I. (1968). Morfologija jelenjih parogova severnog Podunavlja/Belja. Magistarski rad. Brograd. pp. 172.
69. Isakovic I. (1969). Morfologija jelenjih parogova Belja. "Jelen" Bilten br. 8. Posebno izdanje operativno naucnog institute "dr llija Duric"- Beograd. Pp. 5-60.
70. Kawtikwar P. S., Bhagwat D. A., Sakarkar D. M. (2010). Deer antlers-traditional use and future perspectives. Indian Journal of traditional Knolwledge, Vol. 9 (2), pp. 245-251.
71. Janiszewski P., Gugołek A., Hanzal V., Bółkowski D. (2011). Variability of the carcass weight of the red deer (*Cervus elaphus* L.) in Poland. Polish Journal of Natural Science, 26(2), 99-110.
72. Janiszewski P., Kolasa S (2006). Zoometric characteristics of red deer (*Cervus elaphus* L.) stags from Northern Poland. Baltic Forestry, 12(1), 122-127.
73. Lieberman, D. E., & Meadow, R. H. (1992). The biology of cementum increments (with an archaeological application). Mammal Review, 22(2), 57–77. doi:10.1111/j.1365-2907.1992.tb00120.x.
74. Lovari S., Herrero J., Conroy J., Maran T., Giannatos G. et al. (2008). *Cervus elaphus.* IUCN 2009, IUCN Red List of Threatened Species.
75. Markov G. (2014). Morphometric variations in the skull of the red deer (*Cervus elaphus* L.) in Bulgaria. Acta Zoologica Bulgarica, 66(4), 453-460.
76. Marman Ž. (1994). Trofejna struktura populacije jelena običnog (*Cervus elaphus* L.) i njena ovisnost o izboru odstrela. Magistarski specijalistički rad obranjen na Šumarskom fakultetu Sveučilišta u Zagrebu; Zagreb; 41 pp.
77. Mason F., Fotschki B., Di Rosso A., Korzekwa A. (2019). Influence of Farming Conditions on the Rumen of Red Deer (*Cervus elaphus*). Animals: an open access journal from MDPI, 9(9), 601. https://doi. org/10.3390/ani9090601.
78. Meister W. (1956). Changes in biological structure of the long bones of white-tailed deer during the growth of antlers. Anatomical Record 124: 709-721.
79. Merino M. L., Milne N, Vizcaíno S F (2005). A cranial morphometric study of deer (Mammalia, Cervidae) from Argentina using threedimensional landmarks. Acta Theriologica, 50(1), 91-108.
80. Milanov Z. (2015). Impact of environmental factors on the size of red deer (*Cervus elaphus* L.) antlers. Forestry Ideas, 21(2), 329-334.
81. Monteith K.L., Long R.A., Bleich V.C., Heffelfinger J.R., Krausman P.R., Bowyer R.T. (2013). Effects of harvest, culture, and climate on trends in size of horn-like structures in trophy ungulates. Wildlife Monographs, 183(1), 1-28.
82. Mystowska E. (1966). Morphological variability of the skull and body weight of the red deer. Acta Theriologica, Bialoweza, XI, 5, 129-194.

83. Muir P.D., Sykes A.R., Barrell G. K. (1987). Calcium metabolism in red deer (*Cervus elaphus*) offered herbages during antlerogenesis: kinetic and stable balance studies. Journal of Agriculture Science 109: 357-364.
84. Munkačević V. (1964). Morfološke osobine rogova beljskih jelena. Jelen - bilten lovnošumskog gazdinstva Beograd, posebno izdanje Operativno-naučnog centra - Bilje; 1: 33-65.
85. Neacșu A., Popescu C., Nicolau C. (1982). Vânatul cu trofee. Ed. Ceres.
86. Negruțiu A. (1983). Vânătoare și salmonicultură. E.D.P. București.
87. Ordin 418/2005 pentru aprobarea metodologiei de evaluare a trofeelor de vânat, în conformitate cu metodologia Consiliului Internațional de Vânătoare și Protecție a Vânatului. Monitorul Oficial nr. 548.
88. Parfianovics M., Kairisa D. (2015). Analysis of captive-bred red deer (*Cervus elaphus*) antlers' assessment. In Zinātniski praktiskā konference: Līdzsvarota lauksaimniecība, Jelgava (Latvia), 19–20 Feb 2015. Latvijas Lauksaimniecības universitāte.
89. Pélabon C., van Breukelen L. (1998). Asymmetry in antler size in roe deer (Capreolus capreolus): an index of individual and population conditions. Oecologia, 116, 1-8.
90. Pop I. (1982). Prefață în Neacșu A., Popescu C., Nicolau C.: Vânatul cu trofee. Ed. Ceres.
91. Pop I. (1944). Aprecierea trofeelor de cerb. Revista Carpații, 1, Cluj.
92. Ristić Z. (2009). Ocenjivanje lovačkih trofeja, Biblioteka Matice srpske, Novi Sad.
93. Rubio-Paramio M.A., Montalvo-Gil J.M., Ramírez-Garrido J.A., MartínezSalmerón D., Azorit C. (2016). An interactive photogrammetric method for assessing deer antler quality using a parametric Computer-Aided Design system (Interactive Photogrammetric Measure Method). Biosystems Engineering, 150, 54-68.
94. SCI (2019). SCI - Safari Club International Record Book. https:// safariclub.org/wp-content/uploads/2020/05/SCI-Measuring-ManualSept-2019.pdf
95. Schwabland J., Barnhart L.I. (2019). Complex Antler Measuring. Supplement contributed by Paz G, Aguilar G. Revised September 2019. Official Measurer's Manual.
96. Sîrbu G.E., Dieter C. S., Spătaru C.G., Codrean C.L. (2022). Elemente morfo-anatomice de analiză comparată privind arhitectura cranială și trofeul cerbului comun (*Cervus elaphus* L.), din Carpaţii de Curbură și Masivul Făgăraș. Revista de Silvicultură și Cinegetică, Anul XXVII/nr.50.
97. Sîrbu G.E., Simon D., Sîrbu A., Spătaru C., Ionescu O. (2020). Antler size and form in relationship with cranial architecture in red deer (*Cervus elaphus* L.). A case study in the Curvature. Proceedings "Forest and sustainable development" 9th Edition, Brasov, Romania. 95-113.
98. Sîrbu G.E., Simon D., Spătaru C.G., Sîrbu A., (2020). Studiu craniometric asupra populației de cerb (*Cervus elaphus* L.) din Carpații de Curbură. Determinarea vârstei utilizând modelarea elementelor craniene. Revista de Silvicultură și Cinegetică, Anul XXV/nr.46. pp.85-93.
99. Šmehýl P., Hlavatý J., Slamečka J. (2018). Evaluation of European red deer (*Cervus elaphus hippelaphus*) antlers traits in district of Čadca. Animal Science and Biotechnologies, 51(2), 70-75.
100. Șelaru N., (1997). Catalogul trofeelor de vânat. Expoziția națională de vânătoare București 15-21 septembrie 1997. Ed. Vânătorul și Pescarul.
101. Șelaru N. (2000). Trofee de vânat. Ed. Ared.
102. Șelaru N. (2003). Catalogul trofeelor de vânat. Expoziția națională de vânătoare Pitești 20 septembrie 2003. Ed. Cynegis.
103. Șelaru N. (2006). Trofee de vânat european. Ed. Cynegis.

104. Spătaru C.G., Băluț D., Codrean C.L., Hadăr O.C., Ionescu O., Jurj R.R., Mirea I., Titianu A.V., Unici R.G. (2023). Expoziția de vânătoare Hunting Exhibition H – Hunting Prize-Sibiu 2022, Catalogul Trofeelor Trophies Catalogue.ISBN 978-973-0-38236-5.
105. Spătaru C.G., Băluț D., Codrean C.L., Ionescu O., Jurj R.R., Mirea I., Titianu A.V., Unici R.G. (2023). Expoziția de trofee Hunting Exhibition Expo-Moldavia - Bacău 2022, Catalogul Trofeelor Trophies Catalogue – în publicare.
106. Spătaru C.G., Sîrbu G.E., Codrean L.C., Ionescu O. (2022). Red deer (*Cervus elaphus* L.) trophies from Romania. Proceedings "Forest and sustainable development" 11th Edition, Brașov, Romania – în publicare.
107. Spătaru C.G., Sîrbu G.E., Cazacu R. (2022). Contribuții ale speciilor: cerb comun (*Cervus elaphus* L.), căprior (*Capreolus capreolus* L.) și mistreț (*Sus scrofa* L.) la serviciile ecosistemice din România. Revista de Silvicultură și Cinegetică, Anul XXVI/nr.51. pp.103-110.
108. Spătaru C.G., Sîrbu G.E., Ionescu O. (2021). Considerații privind particularitățile și evoluția formulelor de evaluare pentru trofeul de cerb comun (*Cervus elaphus* L.). Revista de Silvicultură și Cinegetică, Anul XXVI/nr.48; pp. 40-48.
109. Stubbe, Ch., 1967: Variationsbreite, Variabilität und Beziehungen zwischen einigen Körper- und Gehörnmaßen beim Rehwild. Z. Jagdwiss. 13: 53-62.
110. Tot Z., Degmečić D., Pintur K., Florijančić T., Ozimec S., Bošković I. (2013). Analyses of trophy values of red deer (*Cervus elaphus* L.) antlers from the Baranja Region (Eastern Croatia). In International symposium on hunting "Modern aspects of sustainable management of game population", 79-83.
111. Tucak Z. (1997). Morphometrical characteristics of red deer (*Cervus elaphus* L.) from the Donau region in Baranja. Zeitschrift für Jagdwissenschaft 43, 141–153.
112. Volokh A. (2015). Investigation of Red Deer (*Cervus elaphus*) antlers in the Ukrainian Steppe and results. Beitrage zur Jagd- und Wildforschung, 40, 145-164.
113. Wagenknecht, E. (1981) Rotwild. Neudamn: J. Neumann.
114. Wagenknecht, E. (1996) Bewirtschaftung unserer Schalenwildbestande. Edit. VEB Deutscher landwirtschaftsverlag, Berlin.
115. Wagenknecht, E. (1996) Der Rothirsch *Cervus elaphus*. Die Neue Brehm-Bucherei Band 129.
116. Whitehead G.K. (1993). The Whitehead encyclopedia of red deer. Swan Hill Press, Shrewsbury.
117. Witting O. (1960). Economia Vânatului. Ed. Agrosilvică.
118. NZDA (2012). Douglas score. New Zealand Deerstalkers Association Incorporated. https://www.deerstalkers.org.nz/resources/animals/ trophy-scoring-douglas-score/
119. Statistix 13.1 Software.
120. https://onewithnature2021.org/en/about-one-with-nature
121. https://www.iucnredlist.org/species/55997072/142404453
122. https://rowlandward.org/measurements/
123. https://safariclub.org/sci-measuring-program-resources/