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# CONTRIBUTIONS TO THE STUDY OF THE CARPINO-FAGETUM PAUCĂ 1941 ASSOCIATION IN THE NORTHERN PART OF THE SEMENIC MOUNTAINS (SOUTHWESTERN ROMANIA)

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**Abstract.** In the present study, a phytosociological and floristic analysis is conducted on the *Carpino-Fagetum* Paucă 1941 association, identified in the northern part of the Semenic Mountains in southwestern Romania. The research aims to perform a floristic, phytocenological, ecological, conservative, and economic study of the Banat beech and hornbeam forests identified in the northern part of the Semenic Mountains. The phytocoenoses of these forests have been analyzed in terms of physiognomy, floristic composition, life form spectrum, floristic elements, and the influence of ecological indicators: soil moisture, temperature and soil chemical reaction. The conclusions synthesize the research results, highlighting the necessity for thorough investigations of natural forest ecosystems. The analysis carried out for the *Carpino-Fagetum* Paucă 1941 association demonstrates its stability both in terms of economic equilibrium and dynamic equilibrium. Regarding the composition of the *Carpino-Fagetum* Paucă 1941 association, the conducted research highlights relevant results regarding the biodiversity of the Semenic Mountains compared to the Codru-Moma Mountains, according to Păşcuţ's 2012 study.

**Keywords:** association; phytocoenoses; relevés; life forms; floristic elements; ecological indicators.

## INTRODUCTION

The Semenic Mountains are located in the southwestern part of the country, well individualized, marking the core of the orogeny. They are crossed by the parallel 45° and the peaks range between 45°00' and 45°23' north latitude and 21°58' and 22°18' east longitude, covering an area of 1180 km2, representing 0.4% of the country's surface (Grigore, 1981).

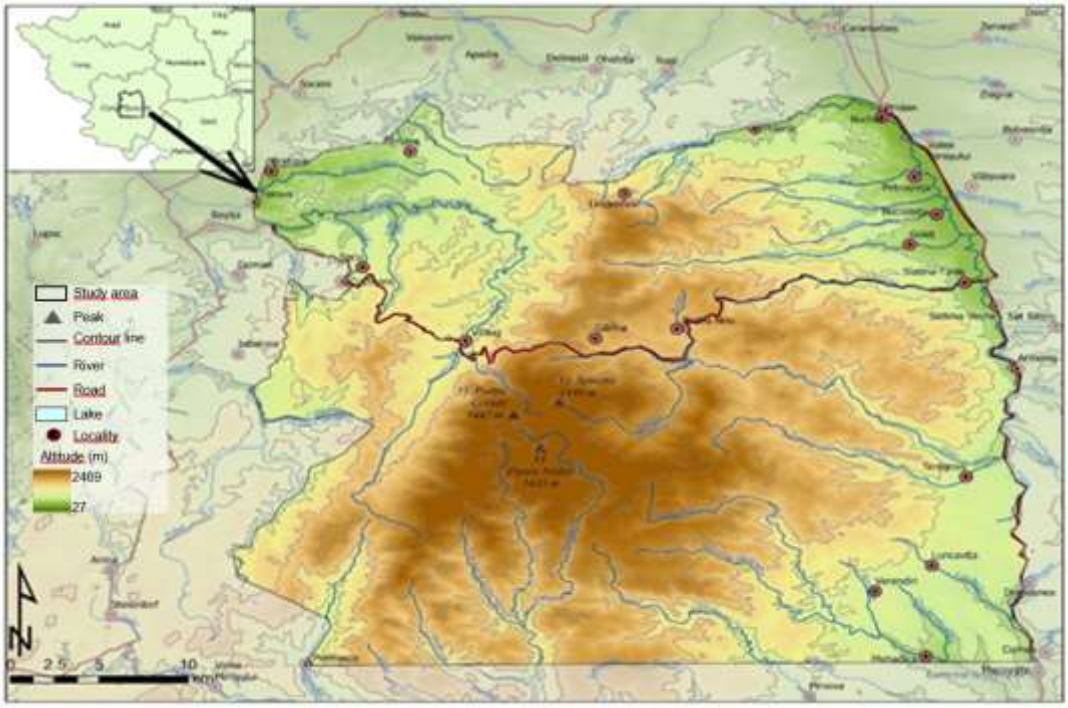


**Fig. 1.** Geographic Location and Delimitation of the Northern Part of Semenic Mountains (taken from Stereo 70 cartographic projection).

The Semenic Mountains are situated within the Caraș-Severin county, which has a total area of 8514 km2. The research area covered 980 km2 (Figure 1), including the territories of the production units within the Reșița and Văliug Forestry Districts (Management UP III; IV; V; VI; VII, 2012). From a geological point of view, these mountains consist of crystalline metamorphic rocks, mainly schists and paragneisses, with occasional intercalations of quartzites. In the basins of the Secu and Râul Alb valleys, the mountain

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foundation is composed of crystalline schists, with Paleozoic and Mesozoic sedimentary deposits arranged above them, the oldest represented by conglomerates and sandstones. Depressions and the main valleys are predominantly characterized by sedimentary formations, including marls, clays and alluvium (gravel and sand) (Grigore, 1981).

The most frequently encountered altitude within the researched forested areas ranges from 320 to 660 meters. The exposition is largely determined by the flow direction of the main rivers (Bârzava, Secu, Alb, Timiș, Stârnic, Groposu, Pietrosu, Bârzăvița) (Grigore, 1981).

Within the studied territory, relevés were described in the northern part of the Semenic Mountains within the boundaries of the two forestry districts, where the phytocoenoses of the Carpino-Fagetum Paucă 1941 association were identified.

The majority of the studied territory falls within the temperate continental climatic zone with Mediterranean influences. The thermal regime is fairly constant and monthly precipitation throughout the year does not fall below 300 mm, reaching its peak in early summer. The variations in the monthly average air temperature and the annual temperature amplitude give the studied territory the character of a continental climate with predominantly Mediterranean influences. The number of favorable days for forest crops is 210-250 days per year (Grigore, 1981).

The average annual temperature for the Semenic Mountains ranges from 8°C to 4°C, indicating a relatively balanced thermal equilibrium and a pronounced moisture regime of the climate. The highest average monthly temperature is in July at 16°C, while the lowest average monthly temperature is in January at -6°C. During the vegetation season, the average temperature ranges from 7°C to 8°C (Grigore, 1981).

Precipitation in the Semenic Mountains is abundant, with an uneven distribution throughout the year. There is a minimum in January and February and a maximum during the months of May and June (Grigore, 1981).

Within the atmospheric precipitation, an important role is played by snowfall, which results in a significant snow cover with a long presence during the cold season. The first day of snowfall occurs in early November and the last day is at the end of April (Grigore, 1981).

The most important winds predominantly blow from the south, southwest, west (Austru and Foehn) and southeast sector (Coșava) (Grigore, 1981).

The *Carpino-Fagetum* Paucă 1941 association (Figure 2), spread throughout the Romanian Carpathians, represents the first description and cenotaxonomic classification of beech and hornbeam forests in the country, carried out by Paucă in 1941 in a study conducted in the Codru-Moma Mountains in the Western Carpathians. The botanist investigated the association, compiling a total of 29 relevés grouped into two sub-associations: aposeridetosum (11 relevés) and filicetosum (18 relevés), (Peia, 1978; Pop et al., 2002; Sanda et al., 2008; Păşcuţ, 2012).

**Fig. 2.** *Carpino-Fagetum* Paucă 1941, below Piatra Alba.



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## MATERIALS AND METHODS

Studies regarding the vegetation in the northern part of Semenic Mountains (in southwestern Romania) were conducted between 2015 and 2022, aiming to establish a relevant floristic inventory for *Carpino-Fagetum* Paucă 1941 association (Puumalainen et al., 2003). In vegetation research, we employed phytosociological research methods developed by Braun-Blanquet (1964). Sampling techniques and quantitative recordings were performed according to the guidelines provided by Borza and Boșcaiu (1965). Plant associations were identified based on characteristic species, without neglecting differential and dominant species (Dihoru et al., 2009).

To achieve a comprehensive identification of associated phytocoenoses, a total of 16 phytosociological relevés were conducted, out of which 9 were included in the synthetic table of the association (Table 1). The remaining 7 relevés were excluded from the table due to similarity in encountered site conditions. For sampling relevés, areas of 1000 square meters were selected, as homogeneously as possible in terms of floristic composition and pedoclimatic conditions, avoiding ecotonal zones (Braun-Blanquet et al., 1928).

Phytosociological records contain data regarding the site characteristics of the habitat where phytocoenoses develop, including information about rock type, soil, altitude, exposure, slope and vegetation cover. During the compilation of records defining each relevé, we also added a quantitative assessment of species participation in terms of abundance and dominance, using the method proposed by Braun-Blanquet et Pavillard (1928). Additionally, we completed information regarding total vegetation cover, applying methods developed by Tüxen (1955) and Ellenberg (1974).

The phytosociological table of the association was structured according to the methodology developed by Braun-Blanquet (1964) and improved by Ellenberg (1974). To classify the association within higher cenotaxonomic units, such as suballiance, alliance, order and class, we considered both traditional ecological-floristic systems developed by Tüxen (1955), Braun-Blanquet (1964), Borza and Boșcaiu (1965), Soó (1980), as well as more recent studies conducted by researchers such as Mucina et al. (1993), Pott (1995), Borhidi (1996), Weber et al. (2000), Sanda (2002), Chifu et al. (2006) and Sanda et al. (2008),. In framing the *Carpino-Fagetum* Paucă 1941 association (analyzed in this study) within higher cenotaxonomic units, we also considered the research conducted by Sanda et al. (2003).

The degree of fidelity of species (K), whose classes are indicated by Roman numerals from I to V, represents the measure to which each species exhibits fidelity to the environment of associated phytocoenoses. For calculating the values of the synthetic phytosociological index, constancy (K), we used the methods proposed by Braun-Blanquet et Pavillard (1928), Rodwell et al. (2002) and Cristea et al. (2004).

In the process of assigning taxonomic nomenclature, we followed the guidance of Ciocârlan (2009) and the plant association was analyzed using the main ecological indices of component species, life forms and floristic elements. The results were presented graphically, in the form of spectra and diagrams, according to Sanda (2003).

## RESULTS AND DISCUSSION

The phytocoenoses of the *Carpino-Fagetum* Paucă 1941 association were identified as clusters at the base of shaded slopes, in the lower montane zone at altitudes ranging from 320-660 m, where they form an extrazonal vegetation. They are also found at higher altitudes, occasionally in sunny areas, in the following zones: Rotundă forest, Văliug crest, Crucea Albă, Cioaca Înaltă, Liscovu Mare valley, Poiana Cozia Mare, Tâlva Golețului, Cehului forest, Soharului valley.

Habitat type: code: R4118 Dacian beech (*Fagus sylvatica*) and hornbeam (*Carpinus betulus*) forests with *Cardamine* (*Dentaria*) *bulbifera*. Correspondences: NATURA 2000: 9110 *Asperulo-Fagetum* beech forest; EMERALD: !41.1 Beech forests; PAL.HAB: 41.1D224 Dacian *Dentaria bulbifera* beech forest.

Types of ecosystems: code: 4116 Beech with *Asperula-Asarum-Stellaria*; code: 4216 Beech with hornbeam and *Asperula-Asarum-Stellaria*; code: 4316 Mixed beech with *Asperula-Asarum-Stellaria* (Doniță et al., 2005). Low conservation value.

Beech forests with hornbeam were encountered in the studied territory, identified from the nemoral zone to the upper part of the massif, ranging from the hilly zone (320 m) to the upper part (660 m). They grow on varied slopes (5-40°), on shaded northern, northeastern and northwestern exposures, as well as on sunny exposures in the lower third of slopes with different inclinations, plateaus, ridges, along shaded and moist valleys. The lithological substrate consists of crystalline schists, limestones, marls, calcareous sandstones and gravel. The soils supporting this association are moderately deep, of the eutricambosol type, skeletal, acid-neutral to slightly acidic, moderately moist with high trophicity in the surface horizon.

In these phytocenoses, the two dominant tree species, European beech (*Fagus sylvatica*) and hornbeam (*Carpinus betulus*), coexist in a codominance relationship during their youth, while at maturity, European beech becomes dominant. In this layer, the following tree species with low frequency are sporadically present: sessile oak (*Quercus petraea*), sycamore maple (*Acer pseudoplatanus*), wild cherry (*Cerasus avium*), common ash (*Fraxinus excelsior*), wych elm (*Ulmus glabra*), and small-leaved lime (*Tilia cordata*).

The tree layer has a consistency index of 0.7-0.9, with European beech (*Fagus sylvatica*) dominating with a medium Abundance-Dominance of 36.39% ADm, and the characteristic species hornbeam (*Carpinus betulus*) with a mediu Abundance-Dominance of 22.78% ADm. Their diameters range from 34-48 cm, with heights of 20-26 m.

The shrub layer is weakly represented and its development varies depending on the tree cover. It has an inverse relationship with the consistency of the tree layer. Some species with higher frequency include hazel (*Corylus avellana*), hawthorn (*Crataegus monogyna*), and elderberry (*Sambucus nigra*).

The herbaceous layer is well-defined, with variable coverage ranging from 35-60%. It includes many species from the mull flora, such as European wild ginger (*Asarum europaeum*), greater stitchwort (*Stellaria holostea*), bulbous bittercress (*Cardamine bulbifera*), and dog's mercury (*Mercurialis perennis*).

The herbaceous layer of Carpino-Fagetum forests has a coverage that includes 127 vascular plant species. It is composed of acidophilic species accompanied by characteristic species from the mull flora of the *Lathyro hallersteinii-Carpinenion* suballiance and the *Symphyto cordati-Fagion* Alliance. The more frequently encountered species include: *Acer pseudoplatanus, Symphytum cordatum, Dactylis glomerata, Cardamine glanduligera, Helleborus purpurascens, Tilia cordata, Arum maculatum* and species from the *Fagetalia sylvaticae* Order, among which: *Galium odoratum, Asarum europaeum, Circaea lutetiana, Rubus hirtus, Allium ursinum, Anemone ranunculoides, Carex sylvatica, Corydalis solida, Pulmonaria officinalis, Salvia glutinosa, Veronica chamaedrys, Carex sylvaticae, Impatiens noli-tangere, Lamium maculatum, Mercurialis perennis, Oxalis acetosella, Polystichum aculeatum*. Species from the *Querco-Fagetea* Class are also present, such as: *Caradamine bulbifera, Carex pilosa, Brachypodium sylvaticum, Galium schultesii, Mycelis muralis, Anemone nemorosa, Glechoma hirsuta, Luzula luzuloides, Acer platanoides, Campanula persicifolia, Deschampsia flexuosa, Geranium robertianum, Geum urbanum, Hedera helix, Melica uniflora, Scilla bifolia, Stellaria nemorum, Viola reichenbachiana, Asplenium scolopendrium* (Table 1).

Alongside the characteristic species of the cenotaxa to which the association belongs, transgressive species from the *Quercetea pubescenti-Petraeae* Class also occur, such as: *Quercus petraea, Melittis melissophyllum, Primula veris, Pteridium aquilinium*, from the *Rhamno-Prunetea* Class: *Sambucus nigra, Corylus avellana, Crataegus monogyna, Acer campestre, Rosa canina*, from the *Epilobietea angustifolii* Class: *Urtica dioica, Galeopsis speciosa, Calamagrostis arundinacea, and from the Vaccinio-Piceetea class: Hypericum macultum, Vaccinium myrtillus, Veratrum album*.

Hornbeam (*Carpinus betulus*) and beech (*Fagus sylvatica*), recognized species in forest ecosystems, have significant economic and bioeconomic importance. They provide high-quality timber extensively used in the furniture, construction and flooring industries. Hornbeam and beech contribute to the development of the forestry sector, generating income and employment opportunities. From a bioeconomic perspective, these species are crucial in conserving biodiversity and maintaining the ecological balance of forest ecosystems. They provide habitats for numerous organisms, contributing to the regeneration and perpetuation of biological diversity. Sustainable management of the resources of these species is essential to ensure long-term economic and ecological benefits and to protect valuable hornbeam and beech species.

**Table 1.**

*Carpino-Fagetum* Paucă 1941

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Life Forms | Floristic Elements | U. | T. | R. | 2n | Nr. relevé | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | K | ADm |
| | | | | | | Altitude (m) | 610 | 320 | 530 | 490 | 400 | 430 | 620 | 660 | 510 | | |
| | | | | | | Exposure | S | NV | E | NV | NE | E | E | S | S | | |
| | | | | | | Tree layer consistency | 0,9 | 0,8 | 0,7 | 0,9 | 0,9 | 0,8 | 0,7 | 0,8 | 0,7 | | |
| | | | | | | Trees height (m) | 24 | 22 | 26 | 26 | 22 | 20 | 24 | 24 | 26 | | |
| | | | | | | Tree diameter (cm) | 40 | 34 | 46 | 48 | 40 | 38 | 48 | 42 | 46 | | |
| | | | | | | Herbaceous layer coverage (%) | 35 | 60 | 40 | 55 | 35 | 50 | 60 | 45 | 55 | | |
| | | | | | | Slope (°) | 32 | 28 | 12 | 6 | 25 | 40 | 25 | 25 | 28 | | |
| | | | | | | Sample area ($m^2$) | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | | |
| MPh | E | 3 | 3 | 3 | P | As. *Carpinus betulus* | 3 | 2 | 3 | 2 | 2 | 1 | 2 | 3 | 2 | V | 22,78 |
| MPh | E | 3 | 3 | 0 | D | As. *Fagus sylvatica* | 3 | 4 | 2 | 3 | 2 | 4 | 3 | 2 | 3 | V | 36,39 |
| | | | | | | ***Lathyro hellersteinii- Carpinenion, Symphyto cordati-Fagion*** | | | | | | | | | | | |
| MPh | Ec | 3,5 | 3 | 3 | P | *Acer pseudoplatanus* | + | 1 | + | - | - | + | + | - | + | IV | 0,83 |
| G | Ec | 3,5 | 3,5 | 4 | P | *Arum maculatum* | - | + | + | + | + | - | + | + | - | IV | 0,33 |
| H-Ch | Eua | 3 | 3 | 0 | D | *Stellaria holostea* | + | + | - | - | + | + | + | - | + | IV | 0,33 |
| H-G | Ec | 2,5 | 3 | 3 | D | *Dactylis glomerata* | + | + | - | + | - | + | - | - | - | III | 0,22 |
| H | Carp | 2,5 | 3 | 4 | P | *Helleborus purpurascens* | + | - | + | + | - | + | - | - | - | III | 0,22 |
| H-G | Carp | 3 | 2 | 3 | D | *Symphytum cordatum* | + | + | - | + | - | - | + | + | - | III | 0,28 |
| MPh | E | 3 | 3 | 3 | D, P | *Cerasus avium* | + | + | - | - | - | - | - | - | - | II | 0,11 |
| G | End | 4 | 2,5 | 4 | P | *Cardamine glanduligera* | + | - | - | - | - | + | - | - | - | II | 0,11 |
| MPh | E | 3 | 3 | 3 | D | *Tilia cordata* | - | - | + | + | - | - | 1 | - | - | II | 0,67 |
| H | E | 2,5 | 3 | 3 | P | *Festuca heterophylla* | - | - | - | - | - | - | - | + | - | I | 0,06 |
| mPh | E | 3,5 | 3 | 4 | D | *Malus sylvestris* | - | - | - | - | + | - | - | - | - | I | 0,06 |
| H | Eua | 3 | 3 | 4 | D | *Primula elatior* | - | - | - | - | + | - | - | - | - | I | 0,06 |



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| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | ***Fagetalia sylvaticae*** | | | | | | | | | | | |
| H-G | E | 3,5 | 3 | 4 | P | *Mercurialis perennis* | - | + | + | + | + | + | + | + | + | V | 0,44 |
| G | E | 3,5 | 3 | 4 | P | *Anemone ranunculoides* | + | - | + | + | + | - | + | + | + | IV | 0,39 |
| H-G | Eua | 3,5 | 3 | 4 | D | *Asarum europaeum* | + | + | + | + | + | - | - | + | - | IV | 0,33 |
| Ch | E | 3 | 3,5 | 4 | D | *Euphorbia amygdaloides* | + | + | + | - | + | + | + | + | - | IV | 0,39 |
| G | Eua | 3 | 3 | 3 | P | *Galium odoratum* | + | + | + | + | - | + | + | - | + | IV | 0,39 |
| H | Cosm | 4 | 2,5 | 0 | P | *Athyrium filix-femina* | - | - | - | + | + | + | - | - | | III | 0,17 |
| G | E | 3,5 | 3,5 | 4 | D | *Allium ursinum* | - | 1 | 3 | 4 | 2 | 4 | - | - | - | III | 20,56 |
| H | E | 3,5 | 3 | 4 | P | *Carex sylvatica* | + | - | + | - | - | + | - | - | + | III | 0,22 |
| G | Eua | 3,5 | 3 | 4 | D | *Circaea lutetiana* | + | + | + | + | + | - | - | - | - | III | 0,28 |
| Th | Eua | 4 | 3 | 4 | D,P | *Impatiens noli-tangere* | + | - | + | + | - | - | + | - | - | III | 0,22 |
| H | E | 3,5 | 0 | 4 | D | *Lamium maculatum* | - | + | + | - | + | - | - | + | - | III | 0,22 |
| H-G | Cp-Bo | 4 | 3 | 3 | D | *Oxalis acetosella* | - | + | - | + | - | - | + | - | + | III | 0,22 |
| H | E | 3,5 | 3 | 3 | D | *Pulmonaria officinalis* | - | + | - | - | + | + | + | + | - | III | 0,28 |
| H | E | 3,5 | 3,5 | 3,5 | P | *Polystichum aculeatum* | - | - | + | - | - | + | - | + | + | III | 0,22 |
| H | Eua | 3,5 | 3 | 4 | D | *Salvia glutinosa* | - | - | + | + | - | + | - | + | + | III | 0,28 |
| H-Ch | Eua | 3 | 0 | 0 | P | *Veronica chamaedrys* | + | - | + | + | - | - | - | - | + | III | 0,22 |
| H | Eua | 3 | 2 | 0 | P | *Campanula rapunculoides* | - | - | + | - | - | + | - | - | - | II | 0,11 |
| G | E | 3 | 3 | 0 | D,P | *Corydalis solida* | - | + | - | - | - | - | - | + | - | II | 0,11 |
| H | Eua | 3 | 0 | 3,5 | P | *Epilobium montanum* | - | - | - | + | + | + | - | - | - | II | 0,17 |
| G | Eua | 3 | 3 | 3 | P | *Epipactis helleborine* | - | + | - | - | - | - | + | - | + | II | 0,17 |
| H | Ec | 4 | 3 | 3 | D,P | *Geranium phaeum* | + | - | - | - | - | + | - | - | - | II | 0,11 |
| H | Ec | 3 | 0 | 4 | D | *Lamium galeobdolon* | + | + | - | - | - | + | - | - | - | II | 0,17 |
| G | Ec | 4 | 3 | 3 | D | *Leucojum vernum* | - | + | - | - | - | - | - | - | + | II | 0,11 |
| G | Eua | 3 | 0 | 4 | D | *Lilium martagon* | - | + | - | - | - | - | + | - | - | II | 0,11 |
| H | Eua | 3,5 | 3 | 3 | D | *Myosotis sylvatica* | - | + | - | - | + | - | - | + | - | II | 0,17 |
| MPh | Eua | 4 | 3 | 3 | P | *Ulmus glabra* | + | - | - | - | - | - | - | + | - | II | 0,11 |
| H | Eua | 3,5 | 0 | 4 | P | *Paris quadrifolia* | - | - | + | - | - | - | + | - | + | II | 0,17 |
| nPh | E | 3 | 2,5 | 3 | P | *Rubus hirtus* | - | + | + | - | - | - | + | - | - | II | 0,17 |
| H-G | Ec | 3 | 3 | 3 | D,P | *Symphytum tuberosum ssp. nodosum* | + | - | + | - | - | - | - | - | + | II | 0,17 |
| H | Atl-M | 3,5 | 3 | 4 | D | *Sanicula europaea* | - | + | - | - | + | - | - | + | - | II | 0,17 |
| H | Eua | 3,5 | 3 | 0 | P | *Scrophularia nodosa* | - | - | - | + | - | + | - | + | - | II | 0,17 |
| H | Eua | 3,5 | 0 | 0 | P | *Stachys sylvatica* | - | + | - | - | - | - | + | - | - | II | 0,11 |
| H | Ec | 4 | 2,5 | 4 | D | *Aconitum vulparia* | - | - | - | - | - | - | - | + | - | I | 0,06 |
| H | Eua | 3,5 | 3 | 3 | D | *Actaea spicata* | - | + | - | - | - | - | - | - | - | I | 0,06 |
| nPh | Eua | 3,5 | 3 | 3 | D | *Daphne mezereum* | - | + | - | - | - | - | - | - | - | I | 0,06 |
| G | E | 3,5 | 3 | 4 | D | *Galanthus nivalis* | - | - | + | - | - | - | - | - | - | I | 0,06 |
| G | Ec | 3 | 3,5 | 3 | D | *Isopyrum thalictroides* | - | - | - | - | + | - | - | - | - | I | 0,06 |
| H | Eua | 3 | 3 | 3 | D | *Lathyrus vernus* | - | - | + | - | - | - | - | - | - | I | 0,06 |
| H | Atl-M | 3 | 3 | 3 | D | *Primula vulgaris* | - | - | - | - | - | - | + | - | - | I | 0,06 |
| | | | | | | ***Querco-Fagetea*** | | | | | | | | | | | |
| G | E | 3,5 | 4 | 0 | P | *Anemone nemorosa* | + | + | + | + | - | + | + | + | + | V | 0,44 |
| G | Ec | 3 | 3 | 4 | P | *Cardamine bulbifera* | + | - | + | + | + | + | + | + | + | V | 0,44 |
| H | Eua | 3 | 3 | 4 | D,P | *Brachypodium sylvaticum* | + | + | - | + | - | + | + | - | + | IV | 0,33 |
| H | Eua | 2,5 | 3 | 3 | P | *Carex pilosa* | + | + | + | + | + | + | - | + | - | IV | 0,39 |
| G | Ec | 2,5 | 3 | 3 | P | *Galium schultesii* | + | + | + | - | + | + | + | - | - | IV | 0,33 |
| H-Ch | Mp | 2,5 | 3 | 4 | P | *Glechoma hirsuta* | + | + | + | - | - | + | + | - | + | IV | 0,33 |
| H | E | 3 | 3 | 0 | D | *Mycelis muralis* | + | + | - | + | - | + | + | + | - | IV | 0,33 |

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MPh | Eua | 3 | 3 | 3 | D, P | *Acer platanoides* | - | + | + | - | - | + | - | - | + | III | 0,2 2 |
| H | Eua | 3 | 3 | 0 | D | *Campanula persicifolia* | - | + | - | - | + | - | - | + | + | III | 0,2 2 |
| H | Cp | 0 | 0 | 1 | P | *Deschampsia flexuosa* | + | - | + | - | + | - | - | - | + | III | 0,2 2 |
| Th | Cosm | 3, 5 | 3 | 3 | P | *Geranium robertianum* | - | + | + | - | + | + | - | - | - | III | 0,2 2 |
| H | Eua | 3 | 3 | 4 | P | *Geum urbanum* | + | + | - | + | - | - | - | + | - | III | 0,2 2 |
| l-nPh | Atl-M | 3 | 3 | 3 | P | *Hedera helix* | - | + | + | - | + | - | + | - | - | III | 0,2 2 |
| H | E | 2, 5 | 2, 5 | 2 | D | *Luzula luzuloides* | + | - | + | + | + | - | - | - | + | III | 0,2 8 |
| H | E | 2, 5 | 3 | 4 | D | *Melica uniflora* | + | + | - | - | - | + | - | + | - | III | 0,2 2 |
| G | E | 3, 5 | 3 | 4 | D, P | *Scilla bifolia* | + | - | + | - | - | + | - | + | - | III | 0,2 2 |
| H | E | 3, 5 | 3 | 3 | D | *Stellaria nemorum* | + | - | + | + | - | - | - | + | - | III | 0,2 2 |
| H | Eua | 3 | 3 | 3, 5 | P | *Viola reichenbachiana* | + | + | - | - | - | + | - | + | - | III | 0,2 2 |
| G | Cp-Bo | 3, 5 | 3 | 5 | D | *Asplenium scolopendrium* | - | + | - | - | + | - | - | - | + | II | 0,1 7 |
| H | Eua | 3 | 3 | 4 | D | *Astragalus glycyphyllos* | - | + | - | - | + | - | - | - | + | II | 0,1 7 |
| MPh | Ec | 4 | 3 | 0 | D | *Abies alba* | - | + | - | - | - | - | - | - | + | II | 0,1 1 |
| Th-TH | Eua | 3 | 3 | 4 | P | *Alliaria petiolata* | - | - | + | - | - | - | + | - | - | II | 0,1 1 |
| H | E | 3 | 3 | 3 | P | *Carex digitata* | + | + | + | - | - | - | - | - | - | II | 0,1 7 |
| G | E | 2, 5 | 3 | 4 | P | *Cephalanthera longifolia* | + | - | - | + | - | - | - | - | - | II | 0,1 1 |
| H | Eua | 3 | 2 | 2 | D, P | *Cruciata glabra* | - | - | + | - | - | - | - | + | - | II | 0,1 1 |
| G | Ec | 3 | 3 | 0 | D | *Corydalis cava* | - | - | - | - | + | - | - | - | + | II | 0,1 1 |
| H | Cosm | 4 | 3 | 0 | P | *Dryopteris filix-mas* | - | - | - | - | - | - | - | + | + | II | 0,1 1 |
| H | Cp-Bo | 3, 5 | 2 | 3 | P | *Dryopteris cristata* | + | - | + | - | - | - | - | - | + | II | 0,1 7 |
| G-H | Carp | 4 | 2 | 3 | D | *Festuca drymeja* | - | + | + | - | + | - | - | - | - | II | 0,1 7 |
| MPh | E | 3 | 3 | 4 | D | *Fraxinus excelsior* | - | + | - | - | + | - | - | - | + | II | 0,1 7 |
| Ch-H | Eua | 3, 5 | 3 | 0 | D, P | *Glechoma hederacea* | - | - | + | - | - | - | + | - | - | II | 0,1 1 |
| H | Ec | 4 | 3 | 4 | P | *Lunaria rediviva* | - | - | - | + | - | - | - | - | + | II | 0,1 1 |
| mPh | E | 2, 5 | 3 | 3 | D | *Ligustrum vulgare* | - | + | - | - | - | + | + | - | - | II | 0,1 7 |
| G | Eua | 3, 5 | 0 | 3 | P | *Platanthera bifolia* | - | + | - | - | + | - | - | - | - | II | 0,1 1 |
| G | Eua | 2 | 3 | 4 | D | *Polygonatum odoratum* | + | + | - | - | - | + | - | - | - | II | 0,1 7 |
| H | Eua | 3 | 3 | 0 | P | *Poa nemoralis* | + | + | - | - | - | + | - | - | - | II | 0,1 7 |
| MPh | Ec | 2, 5 | 3 | 4 | D | *Tilia platyphyllos* | - | - | - | + | + | - | - | - | - | II | 0,1 1 |
| H | Atl-M | 2, 5 | 3, 5 | 4 | P | *Viola odorata* | - | - | - | - | + | + | - | - | - | II | 0,1 1 |
| G | E | 3 | 3 | 4 | D | *Hepatica nobilis* | - | - | - | - | - | - | - | + | - | I | 0,0 6 |
| G | Eua | 3, 5 | 0 | 4 | D | *Listera ovata* | - | - | + | - | - | - | - | - | - | I | 0,0 6 |
| G | Ppn | 3 | 3, 5 | 4 | P | *Polygonatum latifolium* | - | + | - | - | - | - | - | - | - | I | 0,0 6 |
| MPh | Eua | 3 | 2 | 2 | D, P | *Populus tremula* | - | + | - | - | - | - | - | - | - | I | 0,0 6 |
| mPh | E | 2 | 3 | 4 | D | *Pyrus pyraster* | - | - | - | + | - | - | - | - | - | I | 0,0 6 |
| | | | | | | ***Quercetea pubescenti-Petraeae*** | | | | | | | | | | | |
| H | Ec | 2, 5 | 3 | 5 | D | *Melittis melissophyllum* | + | - | + | + | - | - | - | - | + | III | 0,2 2 |
| MPh | E | 2, 5 | 3 | 0 | D | *Quercus petraea* | - | + | + | - | 1 | + | + | - | - | III | 0,7 8 |
| H | Eua | 3 | 2 | 5 | D | *Primula veris* | + | - | - | - | + | - | - | - | - | II | 0,1 1 |
| G | Cosm | 3 | 3 | 0 | P | *Pteridium aquilinum* | - | + | - | - | - | - | - | + | - | II | 0,1 1 |
| MPh | E | 2, 5 | 3 | 4 | D | *Sorbus torminalis* | + | - | - | - | + | - | - | - | - | II | 0,1 1 |
| mPh | P | 2 | 3, 5 | 4 | D, P | *Cornus mas* | - | - | - | - | - | - | + | - | - | I | 0,0 6 |
| MPh | B | 2, 5 | 3, 5 | 3 | D | *Tilia tomentosa* | - | + | - | - | - | - | - | - | - | I | 0,0 6 |
| | | | | | | ***Rhamno-Prunetea*** | | | | | | | | | | | |
| mPh | E | 3 | 3 | 3 | D | *Corylus avellana* | + | + | - | + | - | + | - | - | + | III | 0,2 8 |
| mPh | E | 3 | 3 | 3 | P | *Sambucus nigra* | + | + | - | + | - | + | - | - | - | III | 0,2 2 |
| MPh | E | 2, 5 | 3 | 3 | D | *Acer campestre* | - | + | - | + | - | - | - | - | - | II | 0,1 1 |



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| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| nPh | E | 2 | 3 | 3 | P | *Rosa canina* | - | - | + | - | - | - | - | - | + | II | 0,1 1 |
| mPh | Eua | 3 | 2 | 3 | P | *Sambucus racemosa* | - | + | - | - | - | + | - | - | - | II | 0,1 1 |
| mPh | E | 2, 5 | 3 | 3 | D | *Crataegus monogyna* | - | - | - | - | - | - | + | - | - | I | 0,0 6 |
| l-nPh | Ec | 3 | 3 | 3 | D | *Clematis vitalba* | - | - | - | - | - | - | + | - | - | I | 0,0 6 |
| | | | | | | ***Epilobietea angustifolii*** | | | | | | | | | | | |
| H | Eua | 3 | 2, 5 | 0 | D | *Fragaria vesca* | + | - | + | + | - | + | - | + | - | III | 0,2 8 |
| Th | Eua-C | 3 | 2 | 0 | D | *Galeopsis speciosa* | - | + | + | + | - | - | + | - | - | III | 0,2 2 |
| H | Eua | 2 | 3 | 0 | P | *Calamagrostis arundinacea* | - | - | + | - | - | - | - | - | + | II | 0,1 1 |
| H | Eua | 3, 5 | 3 | 3 | P | *Senecio nemorensis ssp. nemorensis* | - | - | + | - | - | - | - | - | + | II | 0,1 1 |
| H | Eua | 4 | 3 | 0 | D, P | *Eupatorium cannabinum* | - | - | - | - | + | - | - | - | - | I | 0,0 6 |
| H-G | Cosm | 3 | 3 | 4 | P | *Urtica dioica* | - | - | - | - | - | - | + | - | - | I | 0,0 6 |
| | | | | | | ***Vaccinio-Picetea*** | | | | | | | | | | | |
| H | Eua | 4 | 3 | 2 | D | *Hypericum maculatum* | + | + | - | + | - | + | - | - | + | III | 0,2 8 |
| H | Ec | 4 | 2 | 4 | P | *Gentiana asclepiadea* | - | + | - | - | - | - | - | - | + | II | 0,1 1 |
| Ch-nPh | Cp | 0 | 2 | 1 | D | *Vaccinium myrtillus* | - | - | + | - | - | - | - | + | + | II | 0,1 7 |
| G | Eua | 4 | 2, 5 | 4 | D | *Veratrum album* | + | - | + | - | - | - | + | - | - | II | 0,1 7 |
| MPh | E | 0 | 0 | 0 | D | *Picea abies* | - | - | - | 2 | - | - | - | - | - | I | 1,9 4 |
| | | | | | | ***Variae syntaxa*** | | | | | | | | | | | |
| MPh | E | 4 | 3 | 4 | P | *Alnus incana* | - | - | + | - | - | - | - | - | + | II | 0,1 1 |
| G | Mp | 2 | 3, 5 | 4 | D | *Iris graminea* | - | - | + | - | - | - | - | - | + | II | 0,1 1 |
| G | Cp-Bo | 3, 5 | 3 | 4 | P | *Polypodium vulgare* | + | - | - | + | - | - | - | - | + | II | 0,1 7 |
| H-Ch | E | 3, 5 | 0 | 0 | P | *Ajuga reptans* | - | - | - | - | - | + | - | - | - | I | 0,0 6 |
| H | Eua | 3 | 3 | 4 | D | *Chelidonium majus* | - | - | - | - | - | - | - | + | - | I | 0,0 6 |
| H | Alp | 3, 5 | 2 | 3, 5 | P | *Doronicum columnae* | + | - | - | - | - | - | - | - | - | I | 0,0 6 |

Location and date of relevés: 1. Bețiu marsh - May 9, 2016; 2. Poiana Văranului hill - May 9, 2016; 3. Cioaca Bălean - May 9, 2016; 4. Poiana Cozia - May 9, 2016; 5. Liscovu Mic valley - May 10, 2016; 6. Bârzava ridge - May 10, 2016; 7. Liscovu Mare valley - May 11, 2016; 8. Stârnicului valley - May 11, 2016; 9. Culmea Mică - May 12, 2016; 10. Groparul Trei Movile - May 12, 2016; 11. Cracul Sebeșului - May 7, 2016; 12. Tâlva Cireșnei - May 7, 2016.

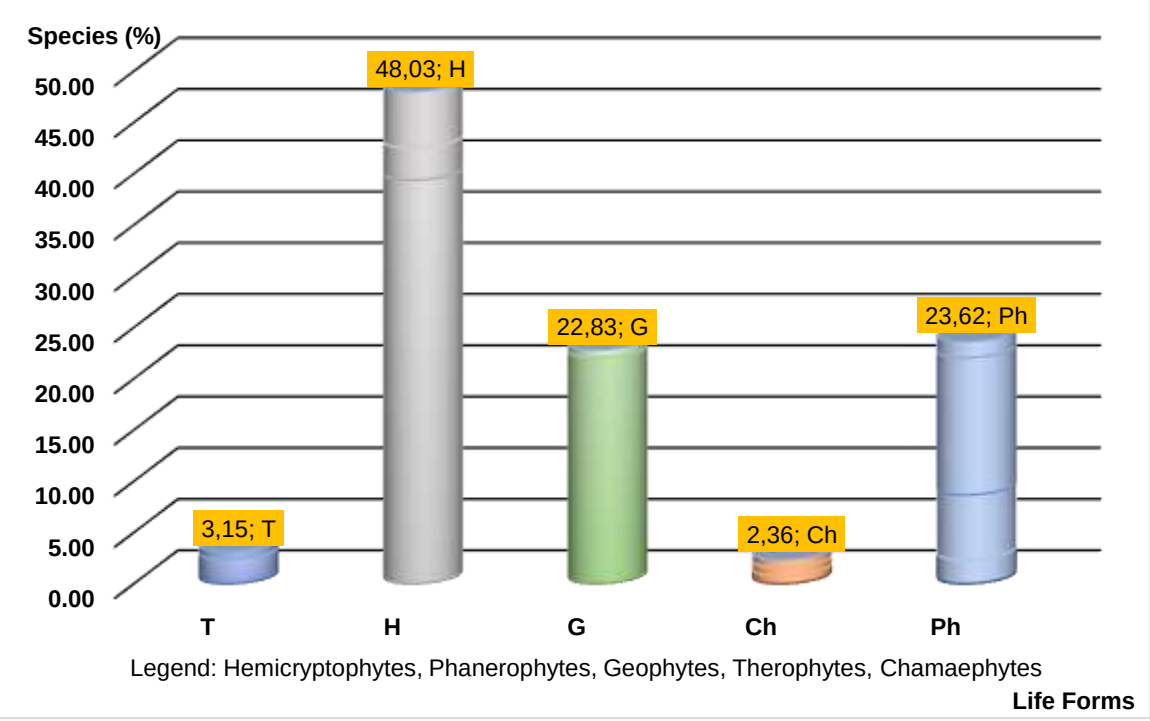


**Fig. 3.** The spectrum of life forms in the *Carpino-Fagetum* Paucă 1941 association.

The life forms (Figure 3) that constitute the phytocoenoses of this association are dominated by hemicryptophytes (48.03%), followed by phanerophytes (23.62%, including megaphanerophytes mesophanerophytes nanophanerophytes lianas), geophytes (22.83%), therophytes and camephytes.

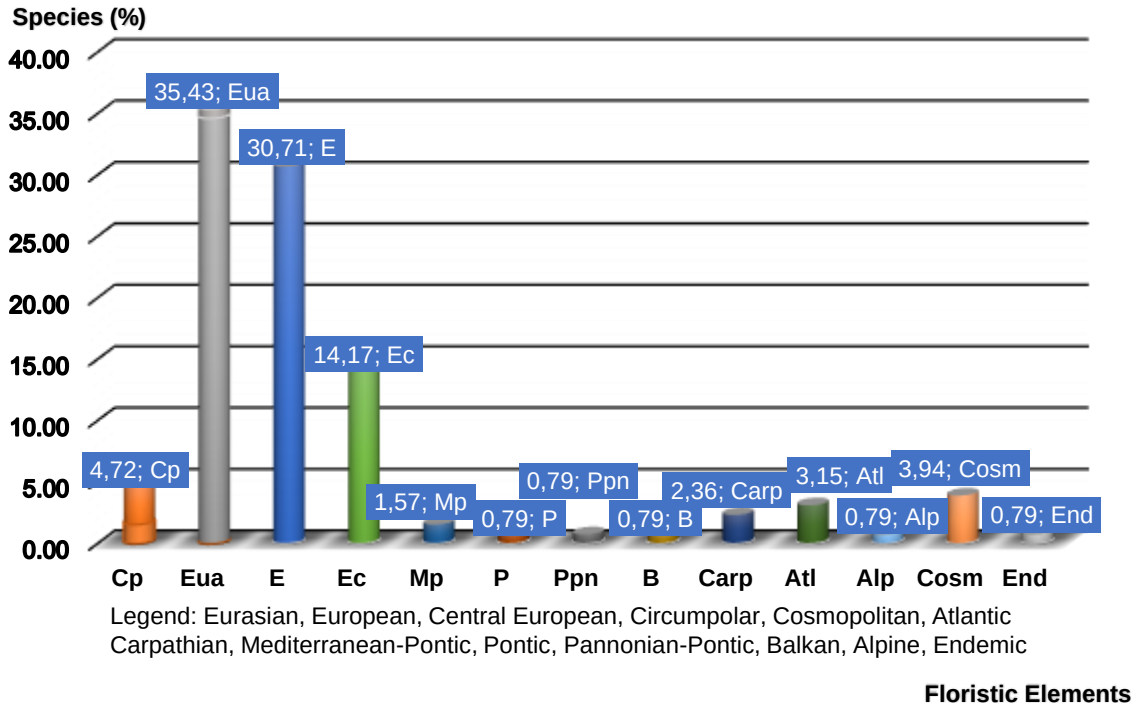


**Fig. 4.** The spectrum of floristic elements in the *Carpino-Fagetum* Paucă 1941 association.

From the analysis of the floristic elements of the association's phytocenoses (Figure 4), their diversity can be observed, with the largest proportion being occupied by Eurasian species (35.43%), followed by European species (30.71%), Central European species (14.17%), Circumpolar, Cosmopolitan, Atlantic, Carpathian, Mediterranean-Pontic, Pontic, Pannonian-Pontic, Balkan, Alpine and Endemic species.

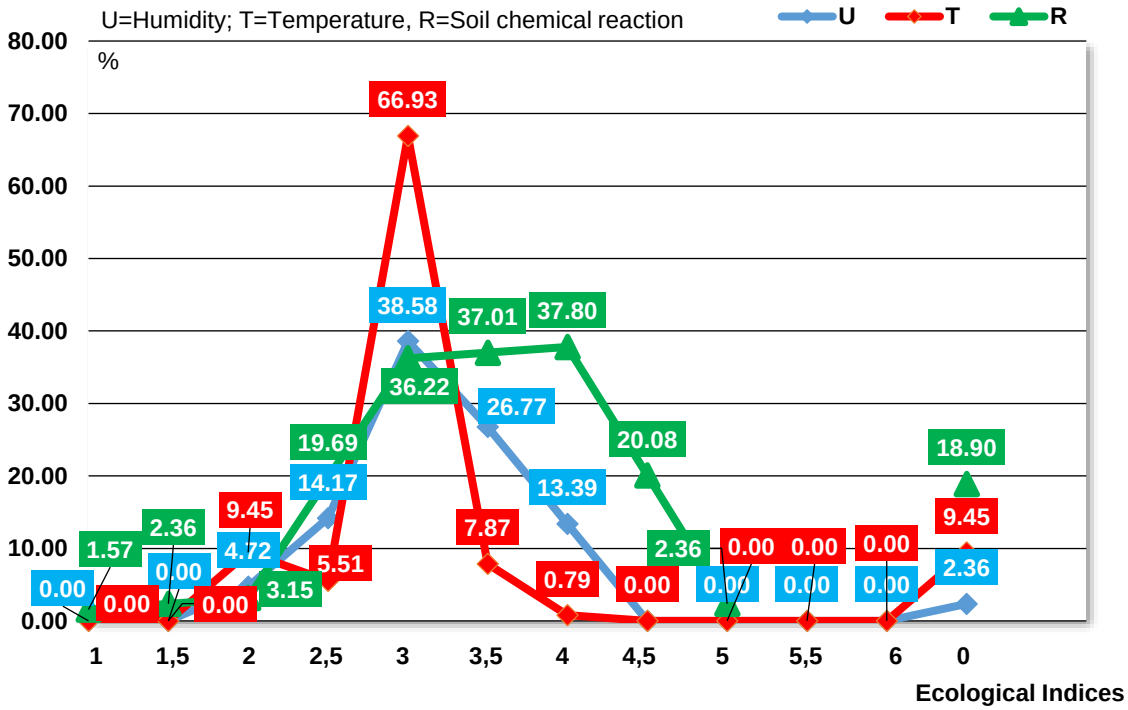


**Fig. 5.** Diagram of ecological indices for the association *Carpino-Fagetum* Paucă 1941.

The diagram of ecological indices (Figure 5), based on soil moisture, shows that the majority of species in the association are mesophytes (65.35%), followed by xero-mesophytes (18.89%) and meso-hygrophiles (13.39%), with a small percentage of euhydric species. In terms of temperature, micro-mesothermic species dominate significantly (74.80%), followed by microthermic species at a considerable distance (14.96%), with eurithermic and moderately thermophilic. The chemical reaction of the soil favors the predominant development of weakly acid-neutral species (37.80%), acid-neutral species (36.22%), euriionic species (18.90%), acidophiles, neutral-basic and strongly acidophilic species.

The research conducted in the northern part of the Semenic Mountains, during the period 2015-2022, revealed that the vegetation of the Banat beech forests is predominantly represented by the phytocenoses of the *Carpino-Fagetum* Paucă 1941 association. The analysis performed on the Carpino-Fagetum Paucă 1941 association demonstrates its stability both in terms of ecological balance and dynamic equilibrium.

Regarding the composition of the *Carpino-Fagetum* Paucă 1941 association, the research highlights relevant results regarding biodiversity in the Semenic Mountains, compared to that of the Codru-Moma Mountains, according to Păşcuţ's 2012 study. The analysis reveals numerous similarities between the two regions, as well as minor differences. The floristic inventory of beech and hornbeam forests in the northern part of the Semenic Mountains encompasses a total of 127 species, of which 94 are attributed to the subordinated cenotaxa of this association, while 31 are transgressive and accompanying species from other phytocenoses. In contrast, similar forests in the Codru-Moma Mountains (Păşcuţ, 2012) contain 158 species, of which 109 fall into the same cenotaxa group, and 49 are transgressive and accompanying species from other phytocenoses.

Analyzing the life forms present in the phytocenoses of the Semenic Mountains and the Codru-Moma Mountains (Păşcuţ, 2012), it can be observed that the quantitative results obtained by us are similar to those illustrated by Păşcuţ regarding the dominance of hemicryptophytes, geophytes, and phanerophytes in the two geographic regions. In the Semenic Mountains, our research indicated a percentage of 48.03% for hemicryptophytes, 23.62% for phanerophytes and 22.83% for geophytes. These figures are close to those obtained in the Codru-Moma Mountains (Păşcuţ, 2012), where the percentages correspond to the following values: hemicryptophytes - 45.57%, phanerophytes - 24.69% and geophytes - 23.42% (according to Table 2).

**Table 2.**

Comparative spectrum of life forms for the phytocenoses of the *Carpino-Fagetum* Paucă 1941 association, analyzed separately for the habitats in the Semenic Mountains and the Codru-Moma Mountains

| Location | Life forms | H | Ph | G | T | Ch | Total Species |
|---|---|---|---|---|---|---|---|
| M. Semenic | Nr. Species | 61 | 30 | 29 | 4 | 3 | 127 |
| | Percentages (%) | 48,03 | 23,62 | 22,83 | 3,15 | 2,36 | |
| M. Codru-Moma | Nr. Species | 72 | 39 | 37 | 6 | 4 | 158 |
| | Percentages (%) | 45,57 | 24,69 | 23,42 | 3,8 | 2,53 | |

The spatial distribution of geoelements within the *Carpino-Fagetum* Paucă 1941 association, according to their geographic origin, reveals extremely similar results to those obtained in our own research. These findings are supported by the predominance of Eurasian species in both geographical regions, with a percentage of 35.43% in the Semenic Mountains, the territory we investigated and 36.08% in the Codru-Moma Mountains (Păşcuţ, 2012). European species rank next, accounting for 30.71% in the Semenic Mountains and 27.85% in the Codru-Moma Mountains (Păşcuţ, 2012), while Central European species represent 14.17% in the Semenic Mountains and 14.56% in the Codru-Moma Mountains (Păşcuţ, 2012) (according to Table 3).

**Table 3.**

The comparative spectrum of floristic elements for the phytocenoses of the *Carpino-Fagetum* Paucă 1941 association, analyzed separately for the habitats in the Semenic Mountains and the Codru-Moma Mountains

| Location | Floristic Elements | Eua | E | Ec | Cp | Cosm | Atl | Carp | Mp | P | Ppn | B | End | Alp |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M. Semenic | Nr. Species | 45 | 39 | 18 | 6 | 5 | 4 | 3 | 2 | 1 | 1 | 1 | 1 | 1 |
| | Percentages (%) | 35,43 | 30,71 | 14,17 | 4,72 | 3,94 | 3,5 | 2,36 | 1,57 | 0,79 | 0,79 | 0,79 | 0,79 | 0,79 |
| M. Codru-Moma | Nr. Species | 57 | 44 | 23 | 5 | 5 | 6 | 4 | 3 | 2 | 1 | 1 | 1 | 2 |
| | Percentages (%) | 36,08 | 27,85 | 14,56 | 3,16 | 3,16 | 3,8 | 2,53 | 1,9 | 1,26 | 0,63 | 0,63 | 0,63 | 1,43 |

**Table 4.**

The comparative spectrum of ecological indices (U=soil moisture, T=air temperature, R=soil chemical reaction) for the phytocoenoses of the Carpino-Fagetum Paucă 1941 association, analyzed separately for the habitats in the Semenic Mountains and the Codru-Moma Mountains

| Location | Ecological indices | The value of ecological indices and the percentage of species | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 1,5 | 2 | 2,5 | 3 | 3,5 | 4 | 4,5 | 5 | 6 | 0 |
| M. Semenic | U nr. sp. | - | - | 6 | 18 | 49 | 34 | 17 | - | - | - | 3 |
| | % | - | - | 4,72 | 14,17 | 38,58 | 26,77 | 13,39 | - | - | - | 2,36 |
| | T nr. sp. | - | - | 12 | 7 | 85 | 10 | 1 | - | - | - | 12 |
| | % | - | - | 9,45 | 5,51 | 66,93 | 7,87 | 0,79 | - | - | - | 9,45 |
| | R nr. sp. | 2 | | 4 | | 46 | | 48 | | 3 | - | 24 |
| | % | 1,57 | | 3,15 | | 36,22 | | 37,80 | | 2,36 | - | 18,90 |
| M. Codru-Moma | U nr. sp. | - | - | 11 | 39 | 61 | 40 | 16 | - | - | - | 1 |
| | % | - | - | 6,96 | 18,35 | 38,6 | 25,32 | 10,13 | - | - | - | 0,63 |
| | T nr. sp. | - | - | 15 | 9 | 102 | 14 | 6 | 1 | - | - | 11 |
| | % | - | - | 9,49 | 5,06 | 64,56 | 8,86 | 3,8 | 0,63 | - | - | 6,96 |
| | R nr. sp. | - | | 8 | | 63 | | 58 | | 4 | - | 25 |
| | % | - | | 5,06 | | 39,87 | | 36,71 | | 2,53 | - | 15,82 |

## CONCLUSIONS

Analyzing the ecological valences of species in relation to the influence of environmental factors such as soil moisture, air temperature, and soil chemical reaction, a similarity of values is observed, with some minor exceptions, when comparing the results for the two geographic regions.

Regarding soil moisture, the phytocoenoses associated with the association's ecosystem exhibit a mesophilic character ($U_{3-3.5}$=65.35%), leaning towards xero-mesophilic ($U_{2-2.5}$=18.89%) and meso-hygrophytic ($U_{4-4.5}$=13.39%) in the Semenic Mountains, while in the Codru-Moma Mountains (Păşcuț, 2012), a similar mesophilic character dominates ($U_{3-3.5}$=63.92%), followed by xero-mesophilic ($U_{2-2.5}$=25.31%) and meso-hygrophytic ($U_{4-4.5}$=10.13%) (according to Table 4).

Regarding temperature, a more pronounced similarity is observed in the quantified values, with the phytocoenoses associated with the association in both geographic regions showing a micro-mesothermal character ($T_{3-3.5}$=74.80%), microthermal ($T_{2-2.5}$=14.96%) and amphotolerant (eurithermic) ($T_0$=9.45%) in the Semenic Mountains. In the Codru-Moma Mountains (Păşcuț, 2012), a similar micro-mesothermal character is also observed ($T_{3-3.5}$=73.42%), leaning towards microthermal ($T_{2-2.5}$=14.55%) and amphotolerant (eurithermic) ($T_0$=6.96%) (according to Table 4).

Regarding the soil chemical reaction, the phytocoenoses associated with the association exhibit a predominantly weakly acid-neutral character ($R_4$=37.80%), acid-neutral ($R_3$=36.22%) and amphotolerant (euriionic) ($R_0$=18.90%) in the Semenic Mountains. In the Codru-Moma Mountains (Păşcuț, 2012), a similar weakly acid-neutral character is also observed ($R_4$=36.71%), acid-neutral ($R_3$=39.87%) and amphotolerant (euriionic) ($R_0$=15.82%) (according to Table 4).

Following the phytocenological, ecological, ecoprotective, and bioeconomic study of the phytocoenoses associated with the two massifs, the following conclusions can be drawn:

– The composition of the phytocoenosis in biological categories of life forms is dominated by hemicryptophyte species, phanerophytes and geophytes, which constitute the main components of the herbaceous layer and vegetation.
– The composition of the phytocoenosis in categories of floristic elements (geoelements) reveals the predominance of Eurasian species, which have interacted in different phytohistorical stages, accompanied by European elements and Central European elements.
– The vegetation of the investigated ecosystem associated with the association exhibits a predominantly mesophilic character in terms of moisture, leaning towards xero-mesophilic. In terms of plant response to temperature, a predominantly micro-mesothermal character is observed, leaning towards microthermic. The chemical reaction of the soil favors the development of species that are weakly acid-neutral, leaning towards acid-neutral.

## AUTHOR CONTRIBUTION

Conceptualization, I.B.R.; methodology, I.B.R.; data collection, I.B.R.; data validation, I.B.R; data processing, I.B.R; writing - original draft preparation I.B.R; writing - review and editing, I.B.R

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## CONFLICT OF INTEREST

The author declares no conflict of interest.

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