Studia Quaternaria, vol. 38, no. 2 (2021): 133–141 DOI: 10.24425/sq.2021.136830

ANCIENT WOODLAND INDICATOR PLANT SPECIES IN THE PARKS AND GARDENS OF THE POMERANIAN CISTERCIAN TRAIL

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Abstract:

The research aimed to make an inventory of the vascular flora of 11 parks and gardens of the Pomeranian Cistercian Trail, with particular emphasis on taxa attached to old deciduous forests. A total of 62 species were registered, recognised as indicators of old deciduous forests in Poland. The presence of species of this group was confirmed in all of the analysed objects, but their number varied from 7 to 50. The group of ancient woodland species includes forest species for which the light indicator values are lower than or equal to 4 (plants of shadowy places, with a relative light intensity). The group of indicator species also includes forest geophytes and forest myrmecochores, autochores and barochores, as well as woodland species that can tolerate stress, under the classification of ecological strategy types S, S/CSR, S/SC and S/SR.

Keywords: Cistercians, ancient woodland, indicator species, parks and gardens, Pomerania

Manuscript received 3 April 2021, accepted19 July 2021

INTRODUCTION

In 1990 the Council of Europe decided to create a tourist trail "Cistercian Route" as part of the international "European Cultural Routes" programme. One of the reasons for its establishment was the 900th anniversary of the birth of St. Bernard of Clairvaux, a mystic and the main founder of the Cistercian Order, celebrated in 1990 and the anniversary of the order founding, which took place in 1998.

The Cistercian Order (Sacer Ordo Cisterciensis) was founded on March 21, 1098 in France. It was founded by Benedictine monks who wanted to combine the rule of St. Benedict of Norcia with asceticism and the ideal of the eremitic life. They settled in Cîteaux, which became the motherland of the Cistercian Order and its first branches La Ferté, Pontigny, Clairvaux and Morimond were recognized as proto-abbeys due to their seniority. They also gave rise to all monasteries of medieval Europe. In Poland, the first monasteries were established in 1153. Monasteries were located in all districts of medieval Poland: in Greater Poland, Lesser Poland, Silesia and Pomerania, as well as in Kujawy and the Dobrzyń region. From the mid-12th to the end of the 14th century, 26 abbeys were established in Poland. They were direct branches of the abbey in Morimond and Clairvaux (Wyrwa, 2008). The former glory and wealth of Cistercian monasteries are resembled by numerous buildings, including parish churches, chapels, wayside shrines, manors, gardens, parks and farm buildings. They determine the attractiveness of Pomerania, which has a significant natural, landscape and economic potential as well as a well-developed tourist base.

The aim of the work was to make an inventory of the dendroflora of parks and gardens of the Pomeranian Cistercian Trail, with particular emphasis on protected and rare taxa in the scale

Region. The statistical analysis of the ecological features of woodland species, performed by Hermy *et al*. (1999) and Dzwonko and Loster (2001), showed that ancient woodland species significantly better tolerate shading than other broadly understood forest species, there are significantly more geophytes and stress-tolerant species among them and that a significant part of them are myrmecochores, baro-

chores and autochores, i.e. species unable to spread over long distances, and therefore slowly colonizing new places (Dzwonko and Loster 1992; Dzwonko, 1993; Matlack, 1994). Therefore, it can be assumed that the majority of the most typical ancient woodland species show the above-mentioned features.

STUDY AREA

The subject of floristic research were 11 parks and gardens of the Pomeranian Cistercian Trail in Gdańsk Oliwa, Kartuzy, Starzyński Dwór, Żarnowiec, Puck, Bukowo Morskie, Iwięcino, Skibno, Słowino, Koszalin, Koszalin Góra Chełmska (Fig. 1). The research places are located within two sub-provinces:

A. Southern Baltic Coastland and mesoregions: Cassubian Coastland – Gdańsk, Puck, Starzyński Dwór; Choczewo Heights – Żarnowiec; Koszalin Coast – Bukowo Morskie; Słupsk Plain – Iwięcino, Skibno, Słowino, Białogard Plain – Koszalin, Góra Chełmska.

B. Southern Baltic Lake District and mesoregion: Cassubian Lakeland – Kartuzy (Solon *et al*., 2018).

1. The Cistercian Abbey in Gdańsk Oliwa is the oldest monastic institution in Gdańsk Pomerania. It is assumed that the monastery was founded in 1178. The foundation document issued by the Pomeranian duke Sambor I comes from this period. The Cistercians established a garden in the cleared meadows and fertile areas along the Oliwa Stream, where they cultivated mainly medicinal herbs. In the north-western part of the present park, they left oaks and beeches, which have survived to this day. Later, they planted the access roads to the monastery and the church with lime trees. They also brought, from their headquarters in Cîteaux, seeds of various trees and shrubs, both fruit and ornamental (Schwarz and Żmijewska, 1995). In 1750–1754, abbot Jacek Hiacynt Rybiński built a rococo-style palace and, under the direction of the outstanding gardener and architect Kazimierz Dembiński, established a park (Rozmarynowska, 2017). In 1813, Oliwa was incorporated into the Prussian state. In 1820, the authorities prohibited the admission of novices, and in 1829 cancelled the abbey. In 1831, the monastic and abbey estates were divided between the city of Gdańsk and the Prussian king Friedrich Wilhelm III. In 1836–1881, the park was managed by the royal gardener Gustav Schondorff. It was during his time that the park was replenished with *Castanea sativa*, *Juglans cinerea* and *Taxus baccata*. Along the regulated bank of the Oliwa Stream, linden bosquets up to 15 m high were created. The last director of the park, until 1929, was Erich Wocke. Under his supervision, *Betula papyrifera*, *Cercidiphyllum japonicum*, *Gleditsia triacanthos*, *Abies concolor* and *Picea omorika* were planted. In 1929, Gdańsk authorities took over the management of the park (Lakowitz, 1930).

2. In 1578 the abbot of the Cistercian monastery Kaspar Geschkau obtained from Pope Gregory III the consent to incorporate the Order of Carthusians in Kartuzy into the Oliwa Abbey. In 1580 the Carthusians adopted the Cistercian rule (Odyniec, 1998). After the dissolution of the monastery in 1823, the hermitages were demolished and only one of them lasted until present times. When in 1825 St. Catherine's church and the Evangelical cemetery were pulled down, the plantings of trees and shrubs began. From the mid-18th century, "*within Kartuzy landholdings, beech, linden, robinia, buckthorn and birch trees were planted...*" The author adds that ...*Quercus ilex* and *Syringa lusitanica* were planted there (Schwengel, 1746). Unfortunately, they have not survived to the present day. In the case of the latter taxon, it might have been *Prunus lusitanica* (Anioł-Kwiatkowska, 2003). The avenue trees: *Tilia cordata* and *Quercus robur* are the evidence of the former splendour of the monastery garden. The cloister garth was planted with a boxwood hedge and its interior filled with a rose garden.

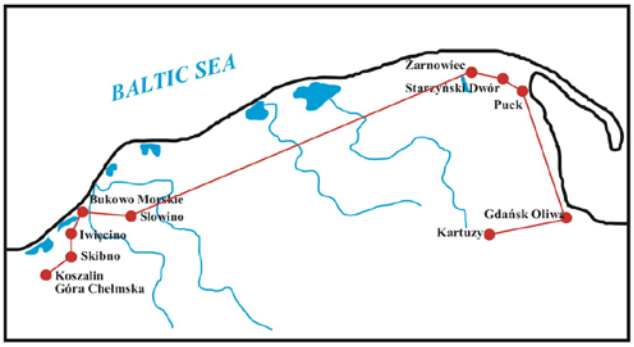

Fig. 1. Pomeranian Cistercian Trail.

3. Starzyński Dwór was from 1611 the property of the Oliwa Cistercians. By the decision of abbot Dawid Konarski the monks, apart from a farm, a water mill, a smithy and a soap factory, ran a manor here that served as a sanatorium for sick monks. The Prussian government, having taken over the monastic property, first leased it and finally sold it in 1818. The new owners – the von Grass family – built there a palace in 1822. In 1852 it was rebuilt in the neogothic style, according to the design of a Berlin architect Friedrich August Stüler (Grass, 2010). The tomb chapel, the *Aesculus hippocastanum* avenue leading to the chapel and the planting of red-leaved beeches *Fagus sylvatica* 'Purpurea' at the manor square (Jarosz and Rozmarynowska, 1984) come from this period. The common ash *Fraxinus excelsior* 'Pendula' (Sienicka and Kownas, 1968), recorded earlier, has not been identified.

4. The Cistercians of Oliwa were the founders of the Cistercian Nunnery in Żarnowiec. The foundation probably took place in 1235, which can be confirmed by the protective bull of Pope Innocent IV, taking the Oliwa Abbey together with its goods, including the lake next to the Cistercian Nunnery, into the custody of the papacy. In 1589 the Cistercian Nunnery in Żarnowiec was dissolved and its buildings and goods were taken over by the Benedictine nuns. In 1772, the Prussian authorities secularized the monastic property. The monastery was dissolved in 1834.

The present shape of the garden layout comes from 1835, when it was handed over to Ludwik Żelewski. It was then that the former monastery garden was transformed with the planting of *Syringa vulgaris* and *Philadelphus coronarius* shrubs as well as the hedge of *Carpinus betulus* (Jarosz and Rozmarynowska, 1983). The tree stand of the monastery garden has been complemented with conifers: *Picea abies, Larix decidua, Abies alba* and *Pseudotsuga menziesii*.

5. In 1358 the Grand Master of the Teutonic Order Konrad Zöllner von Rotenstein gave the Cistercians from Żarnowiec a parish in Puck (Kaczyńska and Kaczyński, 2010). There is a church garden at the parish of Saints Peter and Paul. By the monumental lime trees *Tilia platyphyllos* planted along the fence, the rows of *Abies alba* and *Picea pungens* are also noteworthy.

6. The beginnings of the foundation of the monastery at Bukowo date back to 1248. Until the end of the fourteenth century, the monastery's land property used to extend, mainly due to the grants made by the East Pomeranian, West Pomeranian and Rugian dukes as well as the Margraves of Brandenburg (Hinz, 1996). Thus, 26 settlements became the property of the Cistercians, including Iwięcino, Skibno and Słowino. The formal termination of the abbey took place in 1535 (Popielas-Szultka, 2009). In 1539 the property of the abbey was finished. From the mid-16th century the Bukowo estate was a fief of the von Podewils family (Rees, 1989). In 1821 Bukowo Morskie was owned by von Podewils. Kurt Shulz was the owner of the property from 1913 and his nephew Rudolf Shulz until the end of the Second World War (Hoevel, 1989). Since 1964 it has been owned by the Polish-Catholic parish of the Sacred Heart of Jesus, which is part of the Polish Catholic diocese of Wrocław. In the centre of the park, there is a common beech *Fagus sylvatica* 'Purpurea' and three *Tilia cordata* trees, the most impressive of which has a circumference of 420 cm (requiring maintenance). Particularly noteworthy, however, is a 9-leader small-leaved linden with an impressive circumference of 580 cm. These trees were planted in 1920 when Kurt Shulz was the owner of the park (Engel, 1977).

7. Source data confirm that Iwięcino was a Cistercian village. In 1278 Bishop Herman issued two diplomas for the Cistercians from Bukowo. It should be noted that the western border of the Bukowo estate, established in 1278, did not change until the end of the abbey existence. Thus, Iwiecino belonged to the monastery at Bukowo for 257 years, until its cancelling, which followed the Reformation. The inventory of the monastery property, written in 1539, reflects the property status of the Cistercians at the termination of the abbey. It is also the most comprehensive source of data on the size of monastic villages, land areas owned by peasants, the salaries of monastic tenants and the amount and types of burdens of the abbey subjects (Popielas-Szultka, 1980). Under the canopy of *Tilia cordata*, there are *Galanthus nivalis* and *Lilium martagon*, both legally protected (Regulation of the Ministry of the Environment, 2014).

8. Skibno was owned by the von Heydebreck family until the 18th century. In 1856 Skibno was bought by Franz Michael Prebendow von Przebendowski (Sobisz and Truchan, 2010). In 1928 Fritz Bucholz bought Skibno and Niemica, thus becoming their last owner. After the Second World War, the property was taken over by the State Treasury. The park at Skibno is located in the south-eastern part of the village. It is a landscape park with an area of 2.7 ha, established in the 19th century, with the features of an English garden with a centrally located manor, a vegetable and fruit garden and farm buildings. The park is based on a renovated manor house facing north and separated from the yard by a row of trees and two large flower beds with shrubs of *Symphoricarops albus* and *Rhododendron catawbiense*. It was mentioned also by Kownas and Sienicka (1965). The park stand includes common beeches *Fagus sylvatica*, chestnut trees, small-leaved lindens, Norway maples *Acer platanoides* and sessile oaks. *Picea abies* grows among them, in groups. At the edge of the clearing, from the side of the garden façade, three small-leaved lindens draw attention, two of which are four-leader trees with a circumference of 365 and 555 cm and one is a three-leader specimen with a circumference of 380 cm. Next to them there are two firs *Pseudotsuga menziesii*, *Quercus rubra* and *Thuja occidentalis*.

9. The high green area around the Church of the Exaltation of the Holy Cross at Słowino is well-kept, with the groups of *Tilia cordata* and *Quercus robur* trees. The linden trees have a circumference of 310 to 320 cm, only the one growing on the left side of the entrance to the church is a natural monument with a circumference of 340 cm. At the obelisk of the Capuchin friars from 1968, there are two *Abies alba* trees. A nice specimen of *Ulmus minor* var. *suberosa* with cork outgrowth grows nearby (Seneta and Dolatowski, 2003). *Parthenocissus tricuspidata* creeps up the cemetery fence. Near the obelisk dedicated to the German soldiers who died in 1914–1917, the plants of *Sedum maximum*, *Kerria japonica* and *Rudbeckia laciniata* grow (Sobisz, 2007). The latter one has been recognized as an invasive species (Tokarska-Guzik *et al*., 2012).

10. The Cistercian Nunnery in Koszalin started to function in 1288, although the first land grants and the right to patronage over the churches in Koszalin, Kraśnik, Jamno and the pilgrim chapel on Góra Chełmska had been given to the Cistercian nuns a few years earlier. In the 15th century, the Order experienced its heyday and owned a dozen villages, mills and saltworks. About 50 nuns used to live in the monastery, some of them came from prominent families, e.g. the Griffins. After the dissolution of the order, the church gradually fell into disrepair and in 1560 the remains of the former monastery walls were pulled down. Until the 20th century, not much remained from the Koszalin convention – only the aforementioned church, later serving as a castle chapel and from 1954 as the Orthodox parish church of the Dormition of the Most Holy Mother of God in Koszalin (Brzustowicz, 2013).

11. In 1215 the first chapel was established on Góra Chełmska. It was built by the Premonstratensians of

Białoboki; today, next to the present chapel on the mountain, there is a stone outline of this 13th century temple. From 1278 the patronage over it was taken by Koszalin Cistercian nuns (Hoogeweg, 1924; Rydz and Olejnik, 2004). At present, a small chapel serves as the Sanctuary of Mother of God Thrice Admirable. Since 1991 the Sanctuary has been under the care of the Secular Institute of the Schoenstatt Sisters of Mary (Janocha and Lachowicz, 1991).

MATERIAL AND METHODS

Field studies of vascular plants in parks and gardens in Gdańsk Oliwa, Kartuzy, Starzyński Dwór, Żarnowiec, Puck, Bukowo Morskie, Iwięcino, Skibno, Słowino, Koszalin, Koszalin Góra Chełmska were carried out in 2017–2019. Method based on for floristic lists. the collective list of species recorded in the parks studied is presented in Table 1.

Table 1. List of vascular plant species in the parks and gardens of the Pomeranian Cistercian Trail.

Syntaxon/Species	Life form	Degrees of hemeroby	Dispersal type	Indicator value for light	The life of strategy	GO	KA	SD	ŻA	PU	BM	IW	SK	SŁ	KO	KGCh
					Area (ha)	13.8	2.6	8.1	2.1	0.8	1.9	1.3	2.7	1.4	0.7	9.8
					Number of taxa	28	29	33	28	10	21	7	23	9	14	50
ChCl. Querco-Fagetea Br.-Bl. et Vlieger 1937																
Acer campestre L.	F–1	ome	An2	4	SR	+	–	+	–	–	–	–	–	–	–	–
Adoxa moschatellina L.	G	om	En	2	N	+	–	+	+	–	+	–	+	–	–	+
Aegopodium podagraria L.	H	ome	B	3	CR/CSR	+	+	+	+	+	+	+	+	+	–	+
Allium ursinum L.	G	me	En	2	CR/CSR	–	–	–	+	–	–	–	–	–	–	–
Anemone nemorosa L.	G	om	M	3	S/SR	+	+	–	+	–	+	–	–	–	+	+
Anemone ranunculoides L.	G	om	M	3	S/SR	–	+	–	+	–	–	–	+	–	–	+
Athyrium filix–femina (L.) Roth	H	m	An1	3	C/SC	–	+	+	–	–	+	–	–	+	–	+
Carex digitata L.	H	m	M	3	S	–	–	+	–	–	–	–	–	–	–	–
Carex sylvatica Huds.	H	m	M	2	S	–	–	–	+	–	–	–	–	–	–	+
Chrysosplenium alternifolium L.	H	o	Hy	2	CSR	+	+	+	+	–	+	+	+	–	+	+
Circaea lutetiana L.	G	om	Ep	2	CR	–	–	–	+	–	–	–	+	–	–	+
Corydalis intermedia (L.) Mérat	G	m	M	3	N	–	–	–	–	–	–	–	–	–	–	+
Corylus avellana L.	F–2	om	B	4	N	+	+	+	–	–	–	–	+	–	–	+
Dryopteris filix–mas (L.) Schott	H	ome	An1	3	SC	–	–	+	–	–	+	–	+	–	–	+
Epipactis helleborine (L.) Crantz	G	m	An1	3	S	–	–	–	–	–	–	–	–	–	–	+
Equisetum sylvaticum L.	G	m	An1	3	N	–	–	–	–	–	–	–	–	–	–	+
Euonymus europaea L.	F–2	ome	En	3	SC	+	+	+	–	–	–	–	+	–	+	–
Festuca gigantea (L.) Vill.	H	om	Ep	4	CSR	–	–	+	–	–	–	–	–	–	–	+
Ficaria verna Huds.	G	ome	M	4	R/SR	+	–	+	–	+	–	–	+	+	+	+
Gagea lutea (L.) Ker Gawl.	G	om	M	4	N	–	–	–	+	–	–	–	–	–	–	+
Galeobdolon luteum Huds.	Ch	om	M	3	S/SC	–	+	–	+	–	–	–	–	–	+	+
Galium odoratum (L.) Scop.	H	om	Ep	2	CS/CSR	–	–	+	+	–	–	–	–	–	–	+
Impatiens noli–tangere L.	T	om	Au	4	N	–	–	+	–	–	–	–	–	–	–	+
Lilium martagon L.	G	om	M	3	SC	–	+	–	–	–	+	+	–	–	–	–
Milium effusum L.	H	om	An2	4	S/CSR	–	–	+	+	–	–	–	–	–	–	+
Oxalis acetosella L.	H	om	Au	1	S/CSR	+	+	–	+	–	+	–	–	+	+	+
Phyteuma spicatum L.	H	om	An2	2–4	N	–	–	–	–	–	–	–	–	–	–	+
Poa nemoralis L.	H	ome	An2	3	S/CSR	+	–	+	–	–	+	–	–	–	–	–
Polygonatum multiflorum (L.) All.	G	om	En	2	N	–	–	–	+	–	–	–	+	–	+	+
Pulmonaria obscura Dumort	H	om	M	4	N	–	–	–	+	–	–	–	–	–	–	+
Ranunculus lanuginosus L.	H	ome	Ep	2–3	N	+	+	–	–	–	+	–	–	–	–	+
Ribes spicatum E. Robson	F–2	me	En	4	N	–	+	+	+	–	–	–	–	–	–	–
Scrophularia nodosa L.	H	om	An1	3	CR	–	–	–	–	–	+	–	–	–	–	–
Stachys sylvatica L.	H	om	Ep	3	C/CR	–	+	–	+	–	–	–	–	–	–	+
Stellaria holostea L.	Ch	om	B	3	CSR	–	+	–	–	–	–	–	+	–	–	+
Stellaria nemorum L.	H	om	An2	3–4	N	+	–	–	+	–	–	–	–	–	–	+
Tilia cordata Mill.	F–1	ome	An1	3	C	+	+	+	+	–	+	+	+	+	+	+
Tilia platyphyllos Scop.	F–1	me	An1	3	C	+	+	+	–	+	–	–	+	+	–	+
Ulmus laevis Pall.	F–1	ome	An1	3	C	+	+	–	+	–	–	–	–	–	–	+
Ulmus minor Mill. emend. Richens	F–1	me	An1	3	C	+	–	+	–	–	–	–	–	–	–	–

Syntaxon/Species	Life form	Degrees of hemeroby	Dispersal type	Indicator value for light	The life of strategy	GO	KA	SD	ŻA	PU	BM	IW	SK	SŁ	KO	KGCh
					Area (ha)	13.8	2.6	8.1	2.1	0.8	1.9	1.3	2.7	1.4	0.7	9.8
					Number of taxa	28	29	33	28	10	21	7	23	9	14	50
Ch/DCl. Quercetea robori-petraeae Br.-Bl. et R. Tx. 1943 nom. mut																
Hieracium murorum L.	H	om	An2	2–4	N	–	+	–	–	+	–	–	–	–	–	+
Lonicera periclymenum L.	Ch	me	En	3–4	N	+	+	+	–	–	–	–	–	–	–	+
ChCl. Vaccinio-Piceetea Br.–Bl. in Br.–Bl. et al. 1939																
Melampyrum nemorosum L.	pp	m	M	3–4	N	+	–	–	–	–	–	–	–	–	–	+
Melampyrum pratense L.	pp	om	M	3–4	SR	–	–	+	–	–	–	–	–	–	–	+
Vaccinium myrtillus L.	Ch	om	En	3–4	SC	–	–	+	.	.	.	.	+	.	.	+
Vaccinium vitis–idaea L.	Ch	om	En	3–4	S/SC	–	–	+	–	–	–	–	–	–	–	+
ChCl. Rhamno-Prunetea Rivas-Goday et Borja Carbonell 1961 ex R. Tx. 1962																
Cornus sanguinea L.	F–2	ome	En	3–4	N	+	+	–	–	–	–	–	–	–	–	–
Crataegus laevigata (Poir.) DC.	F–2	m	En	3–4	N	+	+	+	–	–	+	–	+	–	–	+
Pteridium aquilinum (L.) Kuhn	G	om	An1	4–3	C	+	–	–	–	+	+	–	+	–	–	+
Viburnum opulus L.	F–2	m	En	3	N	+	+	+	+	–	–	–	–	–	–	–
Companying species																
Ajuga reptans L.	H	om	M	3	CSR	–	–	+	–	–	–	–	–	–	–	+
Convallaria majalis L.	G	om	En	3	N	+	–	+	+	–	+	–	+	–	+	+
Galanthus nivalis L.	G	eu	M	3	N	+	+	+	–	–	+	+	–	–	+	–
Geum urbanum L.	H	ome	Ep	4	S/CSR	–	+	+	–	+	–	–	+	–	–	+
Hedera helix L.	Ch	me	En	3–5	SC	+	+	+	+	+	+	+	+	+	+	+
Luzula pilosa (L.) Willd.	H	m	M	2	S	–	+	–	–	–	+	–	+	–	–	+
Maianthemum bifolium (L.) F.W. Schmidt	Ch	om	En	3	N	+	+	–	+	+	–	–	–	–	+	+
Moehringia trinervia (L.) Clairv.	H	om	M	4	CSR	+	–	+	+	–	–	–	–	–	–	+
Mycelis muralis (L.) Dumort.	H	om	An2	4	CSR	–	+	–	+	–	–	–	+	–	–	+
Solidago virgaurea L.	H	om	An2	3–4	S	+	–	+	+	–	+	–	–	–	+	+
Vinca minor L.	Ch	me	M	3	N	+	+	+	+	+	+	+	+	+	+	+
Viola riviniana Rchb.	H	om	M	2–3	S	–	+	–	–	+	+	–	–	+	–	+

Life forms: Ch – chamaephytes, F–1 – megaphanerophytes F–2 – nanophanerophytes, G– geophytes, H – hemicryptophytes, Pp – semiparasites, T – terophytes; **degrees of hemeroby:** eu – euhemeroby, m – mesohmeroby, o – oligohemeroby, me, om, ome – intermediate degrees, **dispersal types:** An1 – anemochores winged or flattened; An2 – anemochores light and heavy, Au – autochores , B – barochores, Hy – hydrochores, En – endozoochores, Ep – epizoochores, M – myrmecochores, **indicator value for light:** 2 – moderate shade, 3 – half–shade, 4 – moderate light, e.g. 2–4 – species occupying conditions ranging from 2 to 4, **the life strategy:** C – competitor, CR – competitive ruderal, R – ruderal, S – stress tolerator, SC – stress tolerant competitor, SR – stress tolerant ruderal, CSR – intermediate, N – unspecified.

Selected floristic indicators for each species: life form, range of hemeroby, dispersal type, indicator value for light and the life strategy. The presence of a species in a specific site (a park) is marked with a + sign.

When determining the share of indicator plant species for ancient woodlands, both the list prepared for Poland (Dzwonko and Loster, 2001) and the list of species showing attachment to old deciduous forests in Western Europe (Hermy *et al.*, 1999) were used. The authors mentioned published a list of 287 species of old deciduous forests, compiled on the basis of all available observations from north-west and central Europe.

The group of ancient woodland species includes forest species for which the light index values according to Zarzycki *et al.* (2002) are lower than or equal to 4 (plants of shady and half-shady places) with a value of 3 as the threshold value. The group of indicator species also includes forest geophytes and forest myrmecochores, autochores and barochores, as well as woodland stress-tolerant species, under the classification of ecological strategy types S, S/CSR, S/SC and S/SR (Grime, 2002). The following types of indirect strategies have been interpreted as follows: C/CR = C, C/CSR = C, C/SC = C, CR/CSR = CR, R/SR = R, S/CSR = S, S/SC = S, S/SR = S, SC/CSR = SC (Hermy *et al.*, 1999).

For herbaceous species, the nomenclature by Mirek *et al.* (2002) and for dendroflora – by Seneta and Dolatowski (2003) were used. The nomenclature of plant communities was adopted from Ratyńska *et al.* (2010). The classification of life forms presented by Christian Raunkiær (1905) was determined according to Zarzycki *et al.* (2002). The degrees of hemeroby were applied according to Sukopp (1969, 1972) and Jackowiak (1998). The types of species dispersion were established on the basis of (Murray, 1986; van der Pijl, 1986; Podbielkowski, 1995).

RESULTS

The total flora of the analysed parks and gardens of the Pomeranian Cistercian Trail includes 457 species. Among them 237 are woody species, belonging to 48 families and 109 genera (Sobisz and Truchan, 2019). On the other hand, among the herbaceous species, 220 species representing 50 families and 164 genera were recorded (Sobisz and Truchan, 2020). From the above-mentioned lists, 62 species of ancient woodland indicator plants were identified (Table 1). Their number in particular parks and gardens varies from 7 to 50 species. The smallest numbers of them were recorded at Iwięcino (7 species) and Słowino (9), respectively. The highest number was inventoried in Koszalin: Góra Chełmska (50), Starzyński Dwór (33), Kartuzy (29) as well as in Gdańsk Oliwa and Żarnowiec (28 species in each).

The influence of the sub-Atlantic climate and soil conditions on the species composition of ancient woodlands is related to their phytosociological affiliation, as almost 64% of these species are characteristic of zonal mesophilic and azonal hygrophilous deciduous forests of *Querco–Fagetea* class and their syntaxes, which in Western Europe have the centre of their occurrence. The share of species of other classes is much lower (6.5% each). The first one, *Vaccinio–Piceetea*, includes communities of pine forests associated with a cool and humid climate. The second class of *Rhamno–Prunetea* includes shrub communities functionally associated with forest edges or gaps in the tree stand (Matuszkiewicz, 2001).

The shares of the five basic groups of life forms (phanerophytes, chamaephytes, hemicryptophytes, cryptophytes and therophytes) are distributed in a manner typical for Poland (Table 2). Also in the flora of the Cistercian parks and gardens, hemicryptophytes dominate and their share ranges from 47.6% in Bukowo Morskie to 28.6% in Gdańsk Oliwa, Iwięcino and Koszalin. The most common representatives of this life form are *Aegopodium podagraria, Chrysosplenium alternifolium* and *Geum urbanum.* The majority of cryptophytes are geophytes, with the highest percentage of these long-lived herbaceous plants, reaching 30.4% in Skibno. Over 28% of their share was recorded in Żarnowiec, Bukowo Morskie, Iwięcino and Koszalin. An equally relatively high share of chamaephytes (28.6%) was recorded in Iwięcino and Koszalin. These include *Hedera helix, Maianthemum bifolium and Vinca minor.* Similar quantitative relationships among chamaephytes were observed in north-eastern Germany (Wulf, 2003). Among phanerophytes, tree forms predominate over shrub forms.

In the process of diaspora dispersion, species with the weakest dispersal abilities constitute a high proportion. In the Cistercian parks and gardens, these are myrmecochores and barochores (Table 3). The highest dispersal by ants rates were recorded in the parks of Iwiecino (42.8%) and Słowino

Table 2. Percentage and number share of species from individual life forms in the studied parks and gardens of the Pomeranian Cistercian Trail.

Life forms	GO		KA		SD		ŻA		PU		BM		IW		SK		SŁ		KO		KGCh	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Ch	3	10.7	5	17.2	5	15.2	3	10.8	3	30.0	3	14.3	2	28.6	4	17.4	2	22.2	4	28.6	8	16.0
F-1	5	17.9	3	10.3	4	12.1	2	7.2	1	10.0	1	4.8	1	14.2	2	8.7	2	22.2	1	7.1	3	6.0
F-2	6	21.4	6	20.8	5	15.1	2	7.2	–	–	1	4.8	–	–	3	13.1	–	–	1	7.1	2	4.0
G	6	21.4	4	13.7	4	12.1	8	28.5	2	20.0	6	28.5	2	28.6	7	30.4	1	11.1	4	28.6	11	22.0
H	8	28.6	11	38.0	13	39.3	13	46.3	4	40.0	10	47.6	2	28.6	7	30.4	4	44.4	4	28.6	23	46.0
Pp	–	–	–	–	1	3.1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	4.0
T	–	–	–	–	1	3.1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	2.0
Total	28	100	29	100	33	100	28	100	10	100	21	100	7	100	23	100	9	100	14	100	50	100

Life forms: Ch – chamaephytes, F–1 – megaphanerophytes F–2 – nanophanerophytes, G– geophytes, H – hemicryptophytes, Pp – semiparasites, T – terophytes.

Table 3. Percentage and number share of species from dispersal types in the studied parks and gardens of the Pomeranian Cistercian Trail.

Dispersal type	GO		KA		SD		ŻA		PU		BM		IW		SK		SŁ		KO		KGCh	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
An1	5	17.8	4	13.8	5	15.1	2	7.2	2	20.0	5	23.7	1	14.3	5	21.7	3	33.3	1	7.1	8	16.0
An2	4	14.3	2	6.9	4	12.1	4	14.3	1	10.0	2	9.5	–	–	1	4.3	–	–	1	7.1	6	12.0
Au	1	3.6	1	3.4	1	3.1	1	3.6	–	–	1	4.8	–	–	–	–	1	11.1	1	7.1	2	4.0
B	2	7.1	3	10.3	2	6.1	1	3.6	1	10.0	1	4.8	1	14.3	3	13.1	1	11.1	1	7.1	3	6.0
Hy	1	3.6	1	3.4	1	3.1	1	3.6	–	–	1	4.8	1	14.3	1	4.3	–	–	1	7.1	1	2.0
En	8	28.6	6	20.8	10	30.2	8	28.5	2	20.0	4	19.1	1	14.3	8	34.8	1	11.1	4	28.7	9	18.0
Ep	1	3.6	4	13.8	3	9.1	3	10.7	1	10.0	1	4.8	–	–	2	8.7	–	–	1	7.1	6	12.0
M	6	21.4	8	27.6	7	21.2	8	28.5	3	30.0	6	28.5	3	42.8	3	13.1	3	33.3	4	28.7	15	30.0
Total	28	100	29	100	33	100	28	100	10	100	21	100	7	100	23	100	9	100	14	100	50	100

Dispersal types: An1 – anemochores winged or flattened; An2 – anemochores light and heavy, Au – autochores , B – barochores, Hy – hydrochores, En – endozoochores, Ep – epizoochores, M – myrmecochores.

(33.3%). *Vinca minor*, a species propagated in myrmecochoric way, was found in all objects. However, the share of endozoochores and anemochores is also significant. The first group includes, among others, *Crataegus laevigata, Euonymus europaea*, *Hedera helix* and *Convallaria majalis*, while the latter comprises gliding anemochores, e.g. *Athyrium filix–femina*, *Epipactis helleborine*, *Equisetum sylvaticum*, *Pteridium aquilinum* and *Tilia cordata.*

The indicators of the CSR strategy reflect the response of the plant species to the influence of external factors, where C stands for a competitive strategy, S reflects a stress-tolerant strategy and R – a ruderal strategy (Westoby, 1998; Hodgson *et al*., 1999). Most species do not reflect extreme features, therefore they were assigned with intermediate features: CR, CS, SR, CSR and their combinations (Table 4). Plants with a competitive strategy are represented by i.a. *Tilia cordata*, *T. platyphyllos*, *Ulmus laevis*, *U. minor*. This group of species avoids extreme climatic and habitat conditions. Species of this group have a high growth rate, great height and crown spread. Another important feature of the competitive strategy is the extended time of vegetative growth, which is an essential element in maintaining high reproductive performance (Brzeziecki and Kienast, 1994). Stress-tolerant species include *Carex digitata*, *C. sylvatica*, *Luzula pilosa*, *Solidago virgaurea*. Among the groups of plants with mixed strategies, ruderal and stress-tolerant (type CR) were distinguished, including *Circaea lutetiana* and *Scrophularia nodosa;* competitive and stress-tolerant (type CS), including *Dryopteris filix–mas* and *Lilium* martagon and ruderal and stress-tolerant (type SR) with *Acer campestre* and *Melampyrum pratense.* The field maple has some features referring to the ruderal strategy – short life span, fast generative maturation, high growth rate, as well as stress tolerance strategies – small final size, high wood density and high resistance to its decomposition, relatively large seeds (Jaworski, 2019). In the group showing three main types of strategies: stress-tolerant, competitive and ruderal (CSR type), the identified species included *Ajuga reptans, Festuca gigantea, Moehringia trinervia* and *Stellaria holostea*.

The hemeroby indices refer to flora transformation and are adequate to the species behaviour of plants in response to human activity, which is expressed by assigning species to different categories – from the least to the most degraded – oligohemerobes, mesohemerobes and euhemerobes. The oligohemerobic degree indicates a slight intensity of anthropopressure, the mesohemerobic degree shows a moderate human impact, and the euhemerobic degree shows that the constant and intense anthropopressure causes significant changes in habitats (Chmiel, 1993). For the majority of taxa, the values of the indicators reflect habitats on the border of oligo- and mesohemeroby, and to a lesser extent euhemeroby (Table 5). Oligohemerobic habitats are represented only by *Chrysosplenium alternifolium* in nine, and euhemerobic habitats – by *Galanthus nivalis* in seven Cistercian parks and gardens. On mesohemerobic habitats, the fol-

Table 4. Percentage and number share of species from life strategy type in the studied parks and gardens of the Pomeranian Cistercian Trail.

Life strategy	GO		KA		SD		ŻA		PU		BM		IW		SK		SŁ		KO		KGCh	
	n	%	n	%	n	%	n	%	n		n	%	n	%	n	%	n	%	n	%	n	%
C	4	14.3	5	17.3	4	12.1	3	10.7	1	10.0	4	19.1	1	14.2	3	13.1	3	33.4	1	7.1	7	14.0
CR	1	3.6	–	–	1	3.1	2	7.2	–	–	1	4.8	–	–	1	4.3	–	–	–	–	2	4.0
R	1	3.6	–	–	1	3.1	–	–	1	10.0	–	–	–	–	1	4.3	1	11.1	1	7.1	1	2.0
S	2	7.1	7	24.1	5	15.1	9	32.1	2	20.0	7	33.3	1	14.2	4	17.4	2	22.2	3	21.5	11	22.0
SC	3	10.7	3	10.3	4	12.1	3	10.7	1	10.0	2	9.5	2	28.7	4	17.4	2	22.2	2	14.3	4	8.0
SR	1	3.6	–	–	2	6.1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	2.0
CSR	2	7.1	3	10.3	4	12.1	3	10.7	–	–	1	4.8	1	14.2	3	13.1	–	–	1	7.1	6	12.0
N	14	50.0	11	38.0	12	36.3	8	28.6	5	50.0	6	28.5	2	28.7	7	30.4	1	11.1	6	42.9	18	36.0
Total	28	100	29	100	33	100	28	100	10	100	21	100	7	100	23	100	9	100	14	100	50	100

Life strategy: C – competitor, CR – competitive ruderal, R – ruderal, S – stress tolerator, SC – stress tolerant competitor, SR – stress tolerant ruderal, CSR – intermediate, N – unspecified. The following intermediate strategy types were interpreted as follows: C/CR = C, C/CSR = C, C/SC = C, CR/CSR = CR, R/SR = R, S/CSR = S, S/SC = S, S/SR = S, SC/CSR = SC (see Table 1 and Hermy *et al.*, 1999).

Table 5. Percentage and number share of species from hemeroby in the studied parks and gardens of the Pomeranian Cistercian Trail.

Degrees of hemeroby	GO		KA		SD		ŻA		PU		BM		IW		SK		SŁ		KO		KGCh	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
eu	1	3.6	1	3.4	1	3.1	–	–	–	–	1	4.8	1	14.2	–	–	–	–	1	7.1	–	–
m	3	10.7	4	13.8	4	12.1	2	7.2	–	–	3	14.3	–	–	3	13.1	1	11.1	–	–	8	16.0
me	5	17.8	5	17.3	6	18.2	4	14.3	3	30.0	2	9.5	2	28.7	4	17.4	3	33.3	2	14.3	4	8.0
o	1	3.6	1	3.4	1	3.1	1	3.6	–	–	1	4.8	1	14.2	1	4.3	–	–	1	7.1	1	2.0
om	10	35.7	11	38.0	13	39.3	18	64.2	4	40.0	8	38.1	1	14.2	9	39.1	2	22.2	7	50.0	30	60.0
ome	8	28.6	7	24.1	8	24.2	3	10.7	3	30.0	6	28.5	2	28.7	6	26.1	3	33.3	3	21.5	7	14.0
Total	28	100	29	100	33	100	28	100	10	100	21	100	7	100	23	100	9	100	14	100	50	100

Degrees of hemeroby: eu – euhemeroby, m – mesohmeroby, o – oligohemeroby, me, om, ome – intermediate degrees.

lowing *species were noted: Athyrium filix–femina*, *Carex digitata*, *C. sylvatica*, *Crataegus laevigata*, *Epipactis helleborine*, *Equisetum sylvaticum*, *Luzula pilosa, Melampyrum* nemorosum and *Viburnum opulus.* In all habitats, from oligo- to euhemerobic, the following species were distinguished: *Acer campestre*, *Aegopodium podagraria*, *Cornus sanguinea*, *Dryopteris filix–mas, Euonymus europaea*, *Ficaria verna*, *Geum urbanum*, *Poa nemoralis*, *Ranunculus lanuginosus*, *Tilia cordata* and *Ulmus laevis*.

CONCLUSIONS

- The climatic and soil preferences of ancient woodland species are related to their phytosociological affiliation, as almost 64% of these species are characteristic of *Querco–Fagetea* class.
- The shares of the five basic groups of life forms (phanerophytes, chamaephytes, hemicryptophytes, cryptophytes and therophytes) are distributed in a manner typical for Poland. The flora of Cistercian parks and gardens is dominated by hemicryptophytes.
- A large percentage are species with the weakest dispersal ability, e.g., *Aegopodium podagraria, Anemone nemorosa*, *Corydalis intermedia*, *Corylus colurna*, *Melampyrum nemorosum.* In the Cistercian parks and gardens, these are myrmecochores and barochores.
- The indicators of the CSR strategy reflect the response of the plant species to the influence of external factors, where C stands for a competitive strategy, S reflects a stress-tolerant strategy and R – a ruderal strategy. Most species do not reflect extreme features, therefore they were assigned with intermediate features: CR, CS, SR, CSR and their combinations.
- The quantitative assessment of flora transformations is expressed by the concept of hemeroby. It is based on the criteria of the behaviour of individual plants and indirectly entire phytocoenoses towards human activities. For the majority of taxa, the values of the indicators reflect habitats on the border of oligo- and mesohemeroby, and to a lesser extent euhemeroby.

Acknowledgements

The researches were conducted within project no. 5125.3.1.2019. ES financed by Provincial Heritage Monuments Protection Office in Szczecin. We thank anonymus reviewers for valuable suggestions that improved the quality of the paper.

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