10.2478/v10067-011-0023-3

ANNALES
UNIVERSITATIS MARIAE CURIE-SKŁODOWSKA
LUBLIN – POLONIA

VOL. LXVI, 1 SECTIO C 2011

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Encroachment of thermophilous species on the transformed habitats (sand and gravel pits) near Świecie on the Vistula

Wkraczanie gatunków termofilnych na siedliska przeobrażone (piaskownie i żwirownie) w okolicach Świecia nad Wisłą

SUMMARY

Sand and gravel pits are specific, artificial habitats which are elements of the transformed landscapes. The emergence of excavation involves both the destruction of both vegetation cover and habitat. Soil and water relations are disturbed, and over time there are forming new, different from the initial, abiotic conditions. The brand-new open space is colonized by the diaspore of various species, mostly from the immediate environment. Exploration of resources also leads to the emergence of various new structures of the terrain. Special attention deserve here: slopes, heaps, mounds and uplifts. As objects strongly insolated, often with a southern or southwestern exposure, they create optimum conditions for the entry of thermophilous species.

Floristic diagnoses were conducted within 31 excavations, located near Świecie on the Vistula River. 503 species of vascular plants were found during the study. As many as 80 taxa (16%) belong to a class grouping plants of warm and sunny habitats (*Festuco-Brometea*, *Koelerio-Corynephoretea* and *Trifolio-Geranietea*), of which the most numerous class is *Koelerio-Corynephoretea* (36 taxa, 45%). The richest in thermophilous species are pits located among forest replacement communities (11–64 taxa; 13.7–80%) and near the edge of the Wda valley in the meadow landscape (22–26 species; 27.5–32.5%). As far as xerophytes are concerned the weakest objects are located in the area of suburbium Świecie (4–14 species; 5–23.7%), and surrounded by hygrophilous tall herbs and scrub (1–10 taxa; 1.3–12.5%).

The number of xerophytes is also influenced by the time that elapsed since the cessation of exploitation of raw materials in sand and gravel pits. It was shown that the largest share of thermophilous taxa is concentrated in the objects representing second stage of secondary succession (5–15 years after cessation of operations) to a small extent dominated by tall herbs and light-seminal phanerophytes (6–64 species; 7.5–80%).

12 protected species and 11 endangered nationally and locally were found in the analyzed excavations. Among the protected plant species two thermophilous species were recorded, and three among the endangered ones.

STRESZCZENIE

Piaskownie i żwirownie to specyficzne, sztuczne biotopy, będące elementami przekształconych krajobrazów. Powstanie wyrobiska wiąże się zarówno ze zniszczeniem pokrywy roślinnej, jak i siedliska. Zaburzeniu ulegają stosunki glebowe i wodne, a w miarę upływu czasu kształtują się nowe, inne od wyjściowych warunki abiotyczne. Nowopowstała, otwarta przestrzeń kolonizowana jest przez diaspory różnych gatunków, w większości pochodzących z najbliższego otoczenia. Eksploatacja surowców prowadzi także do powstania różnych nowych struktur rzeźby terenu. Wśród nich na szczególną uwagę zasługują: zbocza, hałdy, kopce i wypiętrzenia. Jako obiekty silnie insolowane, często o południowej bądź południowo-zachodniej ekspozycji, stwarzają optymalne warunki do wkraczania gatunków termofilnych.

Rozpoznania florystyczne prowadzone były w obrębie 31 wyrobisk, położonych w okolicach Świecia nad Wisłą. Stwierdzono w nich 503 gatunki roślin naczyniowych. Aż 80 taksonów (około 16%) należy do klas grupujących rośliny siedlisk ciepłych i nasłonecznionych (*Festuco-Brometea*, *Koelerio-Corynephoretea* i *Trifolio-Geranietea*), z których najliczniej reprezentowana jest klasa *Koelerio-Corynephoretea* (36 taksonów; 45%). Najbogatsze w gatunki termofilne są wyrobiska zlokalizowane wśród leśnych zbiorowisk zastępczych (11–64 taksony; 13.7–80%) oraz w pobliżu krawędzi doliny Wdy w krajobrazie łąkowym (22–26 gatunków; 27.5–32.5%). Obiekty najuboższe w kserofity położone są w strefie świeckiego suburbium (4–14 gatunków; 5–23.7%) oraz w otoczeniu higrofilnych ziołorośli i zarośli (1–10 taksonów; 1,3–12,5%).

Na liczbę kserofitów wpływ ma również czas, jaki upłynął od zaprzestania eksploatacji surowców w piaskowniach i żwirowniach. Wykazano, że największy udział taksonów termofilnych przypada na obiekty reprezentujące II stadium sukcesji wtórnej (5–15 lat od zaprzestania eksploatacji), w małym stopniu opanowane przez ziołorośla i lekkonasienne fanerofity (6–64 gatunki; 7.5–80%).

W obrębie analizowanych wyrobisk stwierdzono 12 gatunków objętych ochroną prawną oraz 11 zagrożonych w skali kraju i lokalnie. Wśród roślin prawnie chronionych zanotowano 2 gatunki termofilne, a 3 spośród zagrożonych.

K e y w o r d s: thermophilous species, sand pit, gravel pit, anthropopressure, artificial habitat, secondary succession

S ł o w a k l u c z o w e: gatunek termofilny, piaskownia, żwirownia, antropopresja, biotop sztuczny, sukcesja wtórna

INTRODUCTION

In Pomerania, there exist very favourable conditions for the development of flora and plant communites of xerothermic grasslands. This region is rich in river valleys (e.g. the Vistula, Noteć, Wda), which are important migratory routes for xerothermophilous species. Slopes and edges of the valleys, similarly to slopes of hills and ravines, also function as centers of xerophytes occurrences. These habitats are characterized by adequate exposure and a specific type of substrate.

Persistence in their positions within the unique and rare thermophilous plants is conditioned by cattle grazing, as well as mowing and periodic burning of vegetation cover. The cessation of extensive use causes launch of the plant succession related to the interference and the development of phanerophytes. Therefore, many valuable xerothermophilic flora refuges are about to disappear, and xerophytes begin to enter different types of converted habitat, which includes sand and gravel pits. Such sites imitate typical habitats for xerophytes environmental conditions. Within the excavations there are: uplifts, hills, slopes and heaps of proper exposure and composition of the substrate, forming an attractive secondary habitat for thermophilous species. Also important are the adaptations of xerophytes to extreme conditions. Resistance to environmental stress such as drought or high and low temperatures enables their existence and expansion within the artificial habitat. Other factors determining the presence of thermophilic plants are also initial stages of succession within the sand and gravel pits.

Polish literature devoted to both flora and plant communities and the succession processes in the excavations is relatively rich. The greatest degree of diagnoses is characteristic of the objects located in Lower and Upper Silesia (1, 3, 8, 10, 12, 14, 31, 32). Less attention has been paid to sand and gravel pits located north of the country (Western Pomerania) and the Mazowsze region (near Siedlce), which has been mentioned in publications by Młynkowiak and Kutyna (21, 22), Czortek (6) and Bzdon (5). Well recognized with regard to geobotanical aspect are the excavations located in central and southern Sweden (2, 15, 35). Noteworthy are also studies from the Czech Republic (25, 26).

The literature about the expansion of thermophilous species at the excavation is very poor. A significant study concerning the participation of xerophytes in the quarry was conducted by Maciejczak (16).

The purpose of this publication is to present the share of thermophilous species in the flora of selected sand and gravel pits surrounding Świecie, and to highlight the role of these artificial habitats in the preservation of resources of xerothermophilous plants.

CHARACTERISTICS OF THE STUDY AREA

Świecie region is divided into two parts: a plateau, which bears the stigma of glacial morphogenesis, and the valley of fluvial morphogenesis. The plateau is built of moraine clay, boulder sands and gravels. The part covering the valley of the Lower Vistula and Wda consists of fluvioglacial sands and gravels, moraine tills, and varved clays (7).

According to Matuszkiewicz et al. (19), potential natural vegetation of this area constitute: *Tilio-Carpinetum* (dominant), *Circaeo-Alnetum*, *Leucobryo-Pinetum*, *Cladonio-Pinetum*, *Molinio-Pinetum*, *Querco roboris-Pinetum* and *Serratulo-Pinetum*.

In terms of physiographic, the analyzed area lies at the borderline of the two macroregions: South-Pomeranian Lake District, and Valley of the Lower Vistula, and the two mesoregions: Fordońska Valley and Świecka Upland (13). According to the climatic regionalization of Woś (36), it is the Chełmińsko-Toruński region, characterized by the dominance of very hot weather with high cloud. In the geobotanical aspect, it is Mazovian-Polesie Division and Chełmińsko-Dobrzyńska Land (17).

The studied sand and gravel pits are located in a suburban area of Świecie and within a radius of 7 km from the administrative borders of the city. They are situated in different types of landscape and represent different stages of succession.

MATERIALS AND TEST METHODS

Terrain diagnoses, including 31 sand and gravel pits, were conducted in 2010. Within the studied excavation there were made lists of species of vascular plants occurring spontaneously. For the purposes of this paper special attention is given to termophilous species recognised as taxa typical of the classes: *Koelerio-Corynephoretea*, *Festuco-Brometea,* and *Trifolio-Geranietea sanguinei.*

The nomenclature of species and higher taxa has been adopted by Rutkowski (29). Within the analysis, the affinity of the plants to geo-historical groups has been observed (9, 23). To the classification of xerophytes in terms of belonging to life forms was used the study of Jackowiak (9) and my own terrain diagnosis.

According to Zarzycki et al. (38), thermophilous plants were characterized also in terms of thermal and trophic requirements and requirements for light. Phytosociological affiliation of species was adopted after Ratyńska et al. (24).

Legally protected species are based on the Minister of the Environment Decree of 9th July 2004, on wildly growing, protected, endangered plants (27). Also threatened and endangered plants on the Polish scale (20) as well as on the scale of the Kujawy-Pomeranian province (28) were taken into consideration.

The studied objects were divided depending on the time elapsed since the omission of exploitation (6). In this way there have been distinguished the following objects: abandoned 0–5 years ago (stage I of the succession), unused for 5–15 years (stage II of the succession), and exempted from use more than 15 years ago (stage III of the succession).

CHARACTERISTICS OF THERMOPHILOUS FLORA

Within the studied sand and gravel pits, 503 species of vascular plants were found (6), of which 80 taxa (16%) represent indicators of warm and sunny habitats (Table 1). They belong to 22 families and the most numerous ones are: *Caryophyllaceae* (13), *Asteraceae* (12) and *Fabaceae* (11). Of the 58 genera the richest in species are: *Potentilla* (4) and *Sedum* (4), as well as *Silene* (3) and *Trifolium* (3).

As many as 97.5% of the thermophilous flora of the pits are native taxa – apophytes. There have been only two plants of foreign origin: *Senecio vernalis* and *Silene conica*. Identified xerophytes represent five basic life forms. Dominating plants are hemicryptophytes, representing approximately 59% of the total number of these plants (47 species). Less represented are therophytes (Fig.1).

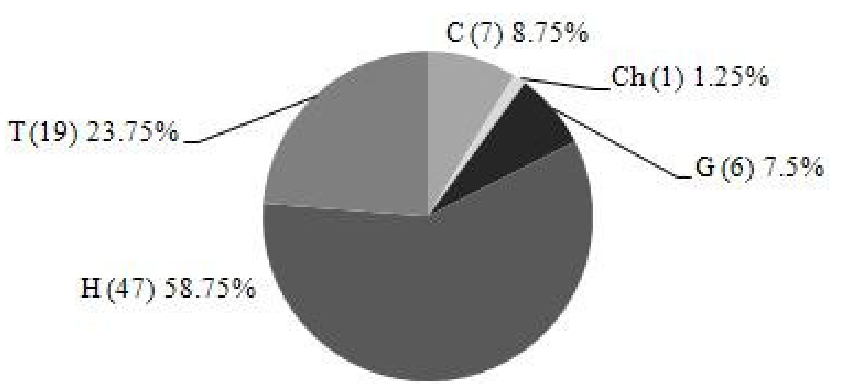

Fig. 1. Share of life forms in the studied flora. H – hemicryptophytes, Ch – woody chamephytes, C – lignified chamephytes, G – geophytes, T – therophytes

Approximately 74% (59 species) of thermophilous flora shows optimum growth in full light (Fig. 2). Moderately warm climatic conditions are optimal for more than 26% xerophytes (21 taxa). Slightly fewer species represent a range from moderate to high growth temperature (Fig. 3). In excavations prevail plants with the optimum of the moderately poor soils (42.5%, 32 species). A smaller number of xerophytes prefer poor soils (Fig. 4).

In phytosociological terms, definitely predominate indicators of the psammophilous grasslands (class *Koelerio-Corynephoretea*), which constitute 45% of thermophilous flora of the studied pits (36 species). The second largest group are the species characteristic of *Festuco-Brometea* (32 taxa, 40%). The fewest were found indicators of thermophilous forest border communities (class *Trifolio-Geranietea sanguinei*, 12 plants, 15%). The share of xerophytes class and the number of xerophytes in particular excavations are presented in Figure 5.

Within the whole flora of the pits there were found 12 protected species. Only five taxa are threatened on a national scale, and six are endangered in the Kujawy-Pomeranian

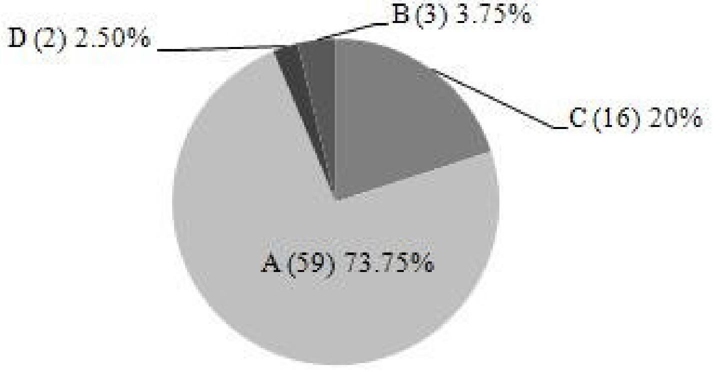

Fig. 2. Characteristics of xerophytes in terms of light requirements. A – full light, B – moderate–full light, C – moderate light, D – others

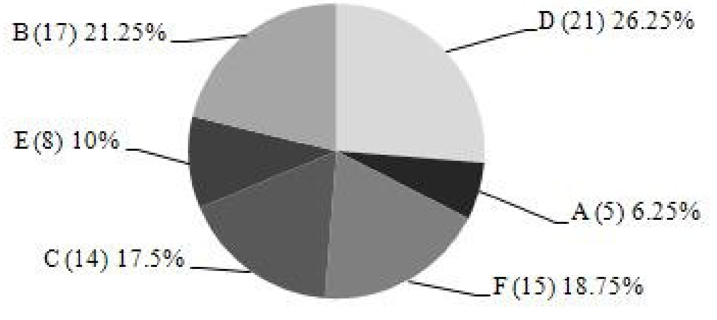

Fig. 3. Characteristics of thermophilous flora due to thermal requirements. A – very warm climatic conditions, B – very warm–moderate warm, C – moderate–very warm, D – moderate, E – very warm–moderate cool climatic conditions, F – others

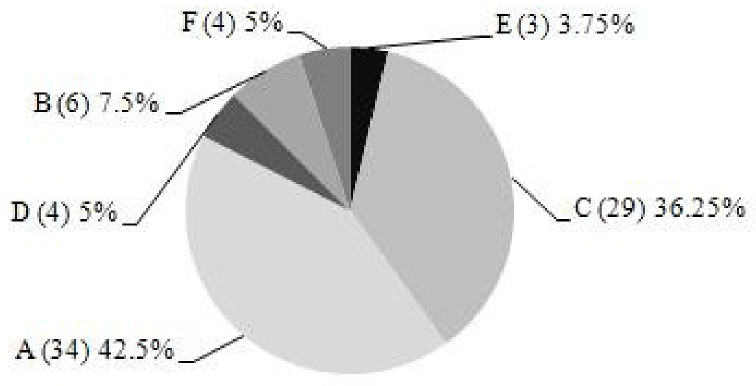

Fig. 4. Characteristics of thermophilous species in terms of soil requirements. A – moderate poor soil conditions, B – poor–moderate poor, C – poor, D – very poor–poor, E – very poor soil conditions, F – others

province (6). Among the protected plants there exist two xerophytes (*Helichrysum arenarium* and *Ononis spinosa*), and among the endangered – three thermophilous plants: *Carex praecox*, *Potentilla collina* and *Silene chlorantha* (Table 1).

In addition to protected and endangered plants, special attention need rare taxa, which are local peculiarities of flora: *Androsace septentrionalis*, *Plantago arenaria*, *Scleranthus polycarpos*, *Silene conica*, *Scabiosa ochroleuca*, *Vicia lathyroides* and *V. tenuifolia*.

The participation of thermophilous taxa is highly influenced by the time elapsed since the cessation of operations (Fig. 6). It was observed that thermophilous plants have the optimum of their own presence in objects representing the second stage of succession (5–15 years after discontinuing the use), characterized by a low degree of biochore controlling by tall herbs and pioneer phanerophytes (6–64 taxa). This is consistent with the environmental requirements of

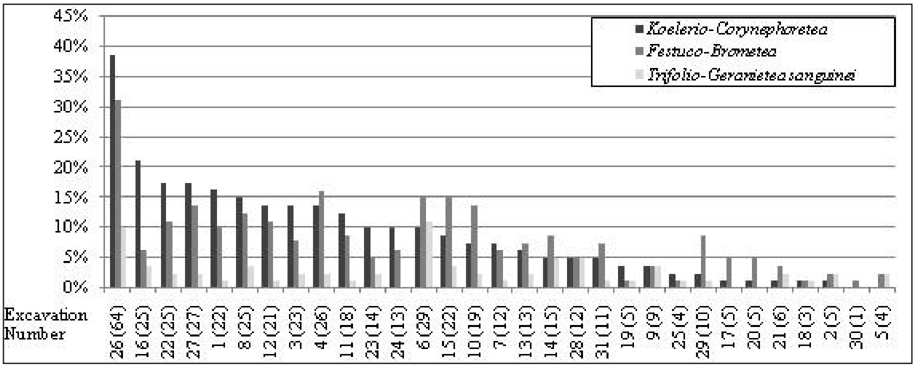

Fig. 5. Share of xerophytes in excavations. Number – number of xerophytes; Excavation – number of excavation

Table 1. Characteristics of xerophytes in the studied objects

A	B	C	D	E	F	G	H
Achillea pannonica	*Asteraceae*	Ap	H	F-B	5	4-5	3
Acinos arvensis	*Lamiaceae*	Ap	TH	F-B	5	4-5	3
Agrimonia eupatoria	*Rosaceae*	Ap	H	T-G	5	4-5	3
Ajuga genevensis	*Lamiaceae*	Sp	H	F-B	3	4-5	3
Allium oleraceum	*Liliaceae*	Ap	G	F-B	4	4-5	3
Alyssum alyssoides	*Brassicaceae*	Ap	T	F-B	5	4-5	2
Androsace septentrionalis	*Primulaceae*	Sp	T	K-C	5	4	2-3
Anthemis tinctoria	*Asteraceae*	Ap	H	F-B	5	5-4	3
Anthylis vulvenaria	*Fabaceae*	Ap	H	F-B	5	4-3	3
Arenaria serpyllifolia	*Caryophyllaceae*	Ap	T	F-B	4-5	5-2	2
Armeria maritima	*Plumbaginaceae*	Ap	H	K-C	5	4	3
Artemisia campestris	*Asteraceae*	Ap	Ch	F-B	5	4	2
Asparagus officinalis	*Liliaceae*	Ap	G	F-B	5	4-5	3
Astragalus arenarius	*Fabaceae*	Ap	H	K-C	4	4	2
Astragalus glycyphyllos	*Fabaceae*	Ap	H	T-G	4	4	3
Campanula rapunculoides	*Campanulaceae*	Ap	H	T-G	4	5-3	3
Carex praecox	*Cyperaceae*	Ap	GH	F-B	5	5	2
Carlina vulgaris	*Asteraceae*	Ap	HT	F-B	4	4-3	3
Centaurea scabiosa	*Asteraceae*	Ap	H	F-B	5	5-3	3
Centaurea stoebe	*Asteraceae*	Ap	H	F-B	5	4-5	2
Cerastium arvense	*Caryophyllaceae*	Ap	C	K-C	5	4	2
Cerastium semidecandrum	*Caryophyllaceae*	Ap	TG	K-C	5	4	2
Chondrilla juncea	*Asteraceae*	Ap	H	K-C	5	4-5	2
Coronilla varia	*Fabaceae*	Ap	H	T-G	5	4-5	3
Corynephorus canescens	*Poaceae*	Ap	H	K-C	4	4	2
Dianthus carthusianorum	*Caryophyllaceae*	Ap	C	F-B	5	5-4	2
Eryngium planum	*Apiaceae*	Sp	H	F-B	4	4-5	3
Euphorbia cyparissias	*Euphorbiaceae*	Ap	HG	F-B	5	5-3	3
Festuca trachyphylla	*Poaceae*	Ap	H	F-B	5	5-4	3
Fragaria vesca	*Rosaceae*	Ap	H	T-G	3-4	4-2	3
Fragaria viridis	*Rosaceae*	Sp	H	T-G	4-5	5	3
Galium album	*Rubiaceae*	Sp	H	F-B	5	5	3
Galium verum	*Rubiaceae*	Ap	H	T-G	5	5-3	3
Helichrysum arenarium	*Asteraceae*	Ap	H	K-C	5	5-4	2
Herniaria gabra	*Caryophyllaceae*	Ap	H	K-C	4	4-3	2

Cont. Table 1

Hieracium pilosella	*Asteraceae*	Ap	H	K-C	5	5-2	2
Holosteum umbellatum	*Caryophyllaceae*	Ap	T	K-C	5	4-3	2
Hypericum perforatum	*Clusiaceae*	Ap	H	T-G	4	5-3	3-4
Jasione montana	*Campanulaceae*	Ap	H	K-C	4	4-3	2
Knautia arvensis	*Dipsacaceae*	Ap	H	T-G	5	5-3	3-4
Koeleria glauca	*Poaceae*	Sp	H	K-C	5	4	1-2
Logfia (= *Filago*) *arvensis*	*Asteraceae*	Ap	T	K-C	5	4-3	2
Logfia (= *Filago*) *minima*	*Asteraceae*	Ap	T	K-C	5	4	2
Medicago falcata	*Fabaceae*	Ap	H	F-B	5	5-4	3-4
Ononis spinosa	*Fabaceae*	Ap	H	F-B	5	4-5	3
Petrorhagia prolifera	*Caryophyllaceae*	Ap	T	F-B	5	4-5	2
Phleum boehmeri	*Poaceae*	Sp	H	F-B	5	5	2-3
Pimpinella nigra	*Apiaceae*	Ap	H	F-B	5	5-2	3
Pimpinella saxifraga	*Apiaceae*	Ap	H	F-B	5	5-2	3
Plantago arenaria	*Plantaginaceae*	Ap	T	K-C	5	4	2
Poa angustifolia	*Poaceae*	Ap	H	F-B	4	5-4	3
Poa compressa	*Poaceae*	Ap	H	F-B	5	5-4	3
Potentilla arenaria	*Rosaceae*	Ap	H	F-B	5	5-4	2-3
Potentilla argentea	*Rosaceae*	Ap	H	K-C	5	4-3	3
Potentilla collina	*Rosaceae*	Sp	H	K-C	5	5-4	2
Potentilla recta	*Rosaceae*	Ap	H	F-B	5	5-4	3
Ranunculus bulbosus	*Ranunculaceae*	Ap	GH	F-B	5	5-4	3
Rumex acetosella	*Polygonaceae*	Ap	GH	K-C	4-5	4-2	2
Rumex tenuifolius	*Polygonaceae*	Sp	GH	K-C	5	5	2
Scabiosa ochroleuca	*Dipsacaceae*	Sp	H	F-B	5	4-5	3
Scleranthus perennis	*Caryophyllaceae*	Ap	CH	K-C	5	4	1
Scleranthus polycarpos	*Caryophyllaceae*	Ap	T	K-C	5	4	2
Sedum acre	*Crassulaceae*	Ap	C	K-C	5	5-4	1
Sedum maximum	*Crassulaceae*	Ap	HG	T-G	5	5-4	3
Sedum reflexum	*Crassulaceae*	Ap	C	K-C	5	5-4	2
Sedum sexangulare	*Crassulaceae*	Sp	C	K-C	5	4	1
Senecio vernalis	*Asteraceae*	Kn	T	K-C	5	4	2-3
Silene chlorantha	*Caryophyllaceae*	Sp	H	K-C	5	4	2-3
Silene conica	*Caryophyllaceae*	Kn	T	K-C	5	4	2-3
Silene otites	*Caryophyllaceae*	Sp	H	F-B	5	5-3	3
Spergula morisonii	*Caryophyllaceae*	Ap	T	K-C	5	4	2
Teesdalea nudicaulis	*Brassicaceae*	Ap	TH	K-C	5	4	1-2

Cont. Table 1

Thymus serpyllum	*Lamiaceae*	Ap	C	K-C	4	4	1-2
Trifolium alpestre	*Fabaceae*	Sp	H	T-G	4	5-4	3
Trifolium arvense	*Fabaceae*	Ap	T	K-C	5	5-3	1-2
Trifolium campestre	*Fabaceae*	Ap	T	K-C	5	4-3	3
Veronica dillenii	*Scrophulariaceae*	Ap	T	K-C	4	4-3	2
Veronica spicata	*Scrophulariaceae*	Ap	HC	K-C	4	5-4	2
Vicia lathyroides	*Fabaceae*	Ap	TH	K-C	5	4	2
Vicia tenuifolia	*Fabaceae*	Sp	HG	T-G	4	5-4	4-3

Key: A – species; B – family; C – historical and geographical group: Sp – spontaneophytes; Ap – apophytes; Kn – kenophytes; D – life form: T – therophytes; H – hemicryptophytes; G – geophytes; C – lignified chamephytes; Ch – woody chamephytes; E – syntaxonomy: F–B – *Festuco-Brometea*; K–C – *Koelerio-Corynephoretea*; T–G – *Trifolio-Geranietea sanguinei;* F – light: 3 – penumbra; 4 – moderate light; 5 – full light; G – temperature: 2 – moderately cold positions; 3 – moderately cool positions; 4 – moderately warm positions; 5 – the warmest positions; H – trophic requirements: 1 – extremely poor soil, 2 – poor soil, 3 – moderately poor soil, 4 – rich soil

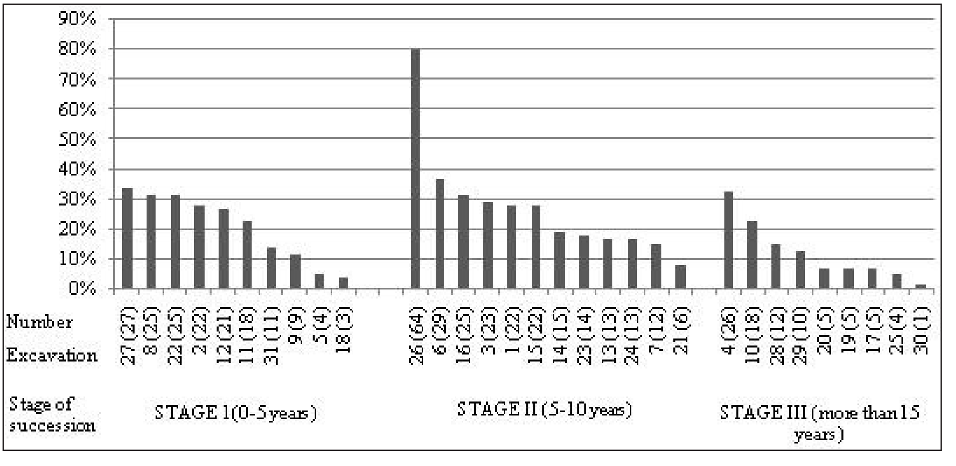

Fig. 6. Share of xerothermic species, depending on the stages of succession studied objects. Number – number of xerophytes, Excavation – number of excavation

xerophytes, preferring open, non-forest habitats. Xerophytes in the areas under the first stage of a series of succession (0–5 years off from use) were reported less frequently. Their smallest share falls on pits abandoned more than 15 years ago (the third stage of succession).

DISCUSSION

Thermophilous flora of the analyzed sand and gravel pits is relatively rich, representing more than 3% of all vascular plants of Poland (37), and 22.5% of the number of native thermophilous species (18). The above-mentioned author discussed thermophilic taxa which are characteristic of the classes: *Agropyretea intermedio-repentis*, *Violetea calaminariae*, *Koelerio-Corynephoretea*, *Festuco-Brometea*, *Trifolio-Geranietea* and some indicators of ruderal tall herbs (*Onopordetalia acanthii*).

To compare, the share of xerophytes in the "Ostnicowe Parowy Gruczna" reserve adds up to 30%, while the total number of species is 403 (34). Similar results were obtained by Wachowiak (33), studying the thermophilous flora of the Noteć valley with 311 taxa altogether. Maciejczak (16), in the flora of Kadzielańskie Pasmo quarries, indicated 500 plants including 95 thermophilous ones. The cited author considered thermophilic taxa which are characteristic of the classes: *Festuco-Brometea*, *Trifolio-Geranietea sanguinei* and *Agropyretea intermedio-repentis*.

Among 163 taxa listed by Rutkowski (30) on the xerophytes list of the Kujawy-Pomeranian region, 36 species are present in the studied objects (more than 22% of the list). As xerophytes the author considered, except the species characteristic of the classes: *Koelerio-Corynephoretea*, *Festuco-Brometea* and *Trifolio-Geranietea sanguinei*, also thermophilous plants from other syntaxonimic groups, basing on numerous floristic and phytosociological studies (4, 11).

Within the analyzed sand and gravel pits dominate psammophilous grasslands indicators (*Koelerio-Corynephoretea*) constituting 45% (36 species) of tested thermophilous flora. The most frequently they were noted in the objects recently excluded from the operation (0–5 years ago). In the Noteć valley dominate species characteristic of the class *Festuco-Brometea* (15.3%, 47 species) gathering indicators of thermophilous steppe grasslands (33). Similar results were obtained by Waldon (34) and Maciejczak (16).

Xerophytes requirements in terms of light, temperature and trophic status of the substrate are very close to each other. For the growth of most of the observed xerophytes great insolation is essential, as well as high temperatures and relatively poor substrate, which is in line with their ecological requirements.

CONCLUSIONS

The results of the initial floristic diagnoses within selected excavations of the Świecka Upland indicate a considerable wealth of thermophilous species. In all objects dominate home xerophytes, showing great ability to apophytisation.

In addition to the predominant hemicryptophytes, notable are plants with short life cycles (therophytes), whose optimum of incidence falls on the objects representing stage I of succession. Most of these are pioneering plants that first colonize the newly exposed space.

The participation of thermophilous taxa in the studied flora excavations varies depending on their surroundings and the time elapsed since cessation of the use of raw materials. The indicator of poor habitats supremacy is domination of indicators of psammophilous grasslands.

The presented results show the important role of sand and gravel pits as specific, secondary refuges for the thermophilous species. Apart from the commonly occurring xerophytes, also rare plants which are local peculiarities of flora enter the excavations areas.

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