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Arnoserido-Scleranthetum annui (CHOUARD 1925) R. TX. 1937 corr. MATUSZKIEWICZ 1981 em. WARCHOLIŃSKA 1990 in Poland

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Abstract: Results of the analysis of differentiation of *Arnoserido-Scleranthetum annui* in Poland are presented. Species richness and the structure of communities of this association were stated on the basis of the published material and field observations. Its phytosociological characteristics and conditions of occurrence are given. Moreover, regional and local habitat variability as well as distribution range of the association are presented.

Keywords: segetal vegetation, association, synmorphology, phytosociology, synecology, syntaxonomy, synchorology, Poland.

Introduction

It was only after 1945 when the problem of segetal vegetation attracted greater attention in Poland. Communities of *Arnoserido-Scleranthetum annui,* due to their restricted range, interesting from the biogeographical point of view, have been a subject of interest of phytosociologists, including Polish ones, for a long time. The first localities of this association at segetal habitats in Poland were given by: KORNAŚ(1950), SALATA (1965), WÓJCIK (1965) and also WIŚNIEWSKI (1971). The number of papers has considerably increased for the last three decades (cf. Fig. 2 - Sources). During the above periods, the communities of *Arnoserido-Scleranthetum annui* were described on the basis of local investigation, and were given various names (cf. e. g. ANIOL-KWIATKOWSKA 1974; KORNAŚ 1950; PAWLAK 1979; SICIŃSKI 1986; WARCHOLIŃSKA 1974, 1976, 1978, 1981b, 1988-1990a, b; WIŚNIEWSKI 1971; WNUK 1976; WÓJCIK 1965) and

this unit was mainly accommodated in the classification systems suggested by KORNAŚ (1972) and MATUSZKIEWICZ (1981). Since the time when the paper by KORNAŚ (1950) came out it has been widely accepted that *Arnoserido-Scleranthetum annui* belongs to a group of subatlantic communities. In further works this opinion has been maintained, although particular syntaxonomical solutions are various (cf. Fig. 1 and Fig. 2).

There has not been any comprehensive phytosociological-syntaxonomical elaboration of this group of communities in Poland. This paper is intended to fill in this gap. Owing to the lack of phytosociological materials from several regions of Poland (cf. Fig. 2 - Sources), the synthesis cannot give explicit answers to some problems concerning, for instance, regional variability or range boundaries of individual units. Hence, in the paper presented an initial attempt has been made to characterize the *Arnoserido-Scleranthetum annui* association in Poland. This group of communities is intermediate between communities of extremely oligotrophic habitats and those of eutrophic habitats. This "transitional" character caused considerable difficulty in defining syntaxonomical position of some forms of the analyzed association. Therefore, knowledge of specific features and differentiation of *Arnoserido-Scleranthetum annui* all over Poland is very important from the cognitive and practical points of view.

The analysis deals with the communities of *Arnoserido-Scleranthetum annui* in Poland and particulary with their species richness, structure, phytosociological characteristics, conditions of occurrence, variability in its ecological-habitat and regional aspects, distribution and range.

In the given paper actual data concerning the association of *Arnoserido-Scleranthetum annui* in Poland have been presented. These data are based on an analysis of published works or papers in press (Fig. 2), as well as on my observations. The presented data can be referred to in further studies such as investigation of changes in time against the background of biotopic modifications, evaluation of causes and a scale of recession of particular types of the *Arnoserido-Scleranthetum annui* phytocoenoses, and state and a degree of threat of species making up their composition. The above information should be regarded as a starting point for a proper strategy of research on biological diversity of species and ecosystems.

Study area

Physiographical characterization of Poland was given in paper by ANDRZEJEWSKI & BARANOWSKI (1993).

Material and method

Material of this paper mostly consists of published and unpublished phytosociological records from the entire area of Poland (cf. Fig. 2 - Sources).

Floristical-ecological characterization as well as phytosociological-syntaxonomical analysis were carried out on the basis of table specifications from each region of Poland.

To present local variability of the *Arnoserido-Scleranthetum annui* communities, data of various authors were taken into consideration (Fig. 2; Tab. 1, WARCHOLIŃSKA 1990).

Analysis of the dynamics of communities of this association was based on the conception of degeneration process (FALIŃSKI1966, 1972; WARCHOLIŃSKA 1979), degenerate rows (OLACZEK 1974) and degenerate forms (WARCHOLIŃSKA 1976, 1979, 1981b, c, 1988-1990a, 1990).

The source of evaluation of variability of *Arnoserido-Scleranthetum annui* in its geographical aspect were various data concerning distribution and spreading of the units within this association. A map of distribution of the data used represents the range of the *Arnoserido-Scleranthetum annui* communities in Poland (Fig. 2).

Arrangement and nomenclature of syntaxonomical units of various rank were adopted after MATUSZKIEWICZ (1981) and WARCHOLIŃSKA (1990). The names of syntaxa are in agreement with the code of phytosociological nomenclature (BARKMAN, MORAVEC & RAUSCHERT 1986). In addition, names used by the authors of the works used are quoted as well. Nomenclature of vascular plants is given according to the work "Flora Europaea" (TUTIN & al. 1964-1980) and the Polish vascular plant species checklist (JASIEWICZ 1984).

Characteristics of the association

Species richness and structure

Phytocoenoses of the *Arnoserido-Scleranthetum annui* association do not belong to floristically rich field communities in Poland. Floristic richness of the phytocoenoses of this association is differentiated. It is mainly dependent on climate, soil moisture and nutrients available, but also on a standard of agriculture and participation of dominant species. Twenty-two to seventy-two plant species have usually been registered in this subatlantic association. Communities of this association including hygrophilous species are characterized by quite great species richness, with 27 to 34 species in a stand. Number of species in stands of typical phytocoenoses is lower and comprises 9 to 27 species.

Precise definition of the structure of the *Arnoserido-Scleranthetum annui* association is not easy owing to a great variety of records. The communities of association are usually two - or three - layered. The lower herb layer is well developed. The majority of species e. g. *Arnoseris minima, Teesdalia nudicaulis, Scleranthus annuus, Spergula arvensis, Rumex acetosella, Equisetum arvense, Bilderdykia convolvulus, Anthemis arvensis, Spergularia rubra, Mentha arvensis, Polygonum hydropiper* grow there. It shows very variable density, from scarce to almost 100% coverage. Most frequently the density of this layer reaches 20 to 60%. The middle layer is poorly developed. It consists of species, for instance: *Agrostis stolonifera, Holcus mollis, Lysimachia vulgaris.* The upper layer does not usually exist or is developed only fragmentarily. In this layer with impoverished species composition, the most frequent taxa are: *Apera spica-venti, Centaurea cyanus, Vicia sativa* subsp. *nigra.*

The structure of the individual phytocoenoses of the *Arnoserido-Scleranthetum annui* association is very varied. It is mostly due to natural susceptability of these communities to changes of balance among specific populations as well as various human activity. The largest density has been observed in the area inhabited by the communities of this association with *Anthoxanthum aristatum, Scleranthus annuus, Spergula arvensis, Apera spica-venti* dominating there. Furthermore, species of the communities with *Mentha arvensis* also densely cover the ground. In these communities the following species often occur: *Mentha arvensis, Juncus bufonius, Polygonum hydropiper, Bidens tripartita, Filaginella uliginosa, Holcus mollis, Agrostis stolonifera.* Species of the communities with *Veronica dillenii* grow in less density.

Tab. 1 Differentiation of *Arnoserido-Scleranthetum annui* (CHOUARD 1925) R. TX. 1937 corr. MATUSZKIEWICZ 1981 em. WARCHOLIŃSKA 1990 [Source: WARCHOLINSKA (1990)].

		A						
		I					II	
							1	2
		a	b	c	d	e		
Cp	*Secale cereale*	V 3	V 2-3	V 3	V 3	V 2-3	V 3-4	V 2-4
Dass, DF	*Scleranthus annuus*	V 3	V 1	V 1	V +-2	V +-1	V +-1	V +-1
ChAss	*Arnoseris minima*	V 1-2	V +-1	V 1	V +	V 1-2	V +-1	V +-1
Chenop	*Bilderdykia convolvulus*	V +-1	V +-1	V +-1	V +-1	V +-1	V +-1	V +-1
Comp	*Equisetum sylvaticum*	V +	V +	V +	V +	V +	V +-1	V +
Chenop	*Conyza canadensis*	V +	V +	V +	V +	V +	V +	V +
Comp	*Erodium cicutarium*	V +	V +	V +	V +	V +	V +	V +
DAss	*Rumex acetosella*	V +-1	V +-1	IV +-1	V 1	V +-1	V +-1	V +-1
Comp	*Equisetum arvense*	V +-1	V +-1	IV +-1	V +-1	V +-1	V +-1	V +-1
ChO	*Apera spica-venti*	III +	III +-1	IV +-1	V +-1	V +-1	V 1	V +-1
ChCl	*Centaurea cyanus*	II +	IV +-1	IV +-1	V +	V +-1	IV +	IV +
DAss	*Teesdalia nudicaulis*	V 2	V +-1	IV +-1	II +	IV +-1	V +-1	III +-1
ChO	*Vicia sativa* subsp. *nigra*	V +	III +	IV +	V +-1	III +-1	III +	V +
Comp	*Viola arvensis*	III +	III +-1	IV +	V +-1	III +-1	III +	V+
	Convolvulus arvensis	V +	III +	IV +	IV +	III +	II +	II +
Plantag	*Agrostis stolonifera*	V +	II +	II +	V +-1	II +-1	III +	III +
Secal	*Polygonum lapathifolium* subsp. *incanum*	II +	V +	II +	III +	III +	III +	III +
Comp	*Elymus repens*	II +	II +	III +	V +-1	III +-1	II +-1	II +-1
Chenop	*Raphanus raphanistrum*	II +	II +	II +	III +	IV +	II +	II +
	Chenopodium album	II +	II +	II +	III +	III +	II +	II +
Mol-Arrh	*Achillea millefolium*	I +	II +	II +	II +	II +	II +	II +
Comp	*Pteridium aquilinum*	II +	III +	II +	I +	II +	I +	I +
	Polygonum persicaria	II +	II +	II +	II +	II +	I +	I +
	Viola tricolor		V +-1	V +-1				
	Erophila verna		V +-1	V +-1				
	Galeopsis ladanum		V +	V +-1				
DF	*Veronica dillenii*		V 1					
Chenop	*Setaria pumila*			V +	V +	V +-1	V +-1	V +
DO, DF	*Spergula arvensis*			IV +-1	V 1-2	V +-1	V +-1	V +-1
Comp	*Anthemis arvensis*			V +-1	V +-1	V +-1	IV +-1	V +-1
	Galeopsis bifida			II +	III +	V +	V+	II +
Chenop	*Setaria viridis*			V +	I +	III +	I +	I +
	Digitaria ischaemum			V +	II +	I +	I +	I 1
	Geranium pusillum				V +	V +	V +	V +
	Polygonum heterophyllum				IV +	III +	II +	V +
	Capsella bursa-pastoris				III +	III +	I +	V +
Artem	*Erysimum cheiranthoides*				V +		V +	V +
Comp	*Cirsium arvense*				V +		V +-1	III +-1
Secal	*Sonchus arvensis*				V +		V +-1	III +-1
	Myosotis arvensis				V +		II +-1	V +-1
Comp	*Veronica arvensis*				V +		II +	V +
ChO	*Vicia hirsuta*				V +		II +-1	II +-1

Tab. 1 - continued

		A						
		I					II	
							1	2
		a	b	c	d	e		
DF	*Anthoxanthum aristatum*					V 1-4		
DVar	*Juncus bufonius*						V +-1	V +-2
	Mentha arvensis						V +-1	V +-1
	Polygonum hydropiper						V +-1	V +-1
Chenop	*Stellaria media*						V +-1	V +-1
Comp	*Polygonum amphibium* var. *terrestre*						V +-1	V +
DVar	*Stachys palustris*						V +-1	V +-1
Chenop	*Rumex crispus*						V +	V +-1
ChCl	*Rhinanthus angustifolius* subsp. *grandiflorus*						V +-1	V +
DVar	*Bidens tripartita*						III +-1	V +-1
	Potentilla anserina						V +	III +
ChAll	*Aphanes microcarpa*						V +	III +
DVar	*Rorippa sylvestris*						V +	III +
	Ranunculus repens						V +	II +
	Filaginella uliginosa						V +	II +
	Spergularia rubra						III +	III +
Mol-Arrh	*Cerastium fontanum* subsp. *triviale*						V +	I +
DVar	*Sagina procumbens*						III +	III +
	Gypsophila muralis						II +	III +
Comp	*Holcus mollis*						V 1-2	
DSubvar	*Illecebrum verticillatum*							V 1
Isoët-Nanojunc	*Hypericum humifusum*							V 1
	Anagallis minima							V +-1
	Radiola linoides							V +-1
	Plantago major subsp. *intermedia*							V +-1
Mol-Arrh	*Lysimachia vulgaris*							V +-1
Secal	*Arabidopsis thaliana*							V +-1
DAll	*Hypochoeris glabra*							V +
Isoët-Nanojunc	*Juncus capitatus*							V +
	Lythrum portula							V +
	Gnaphalium luteo-album							V +

A - Association *Arnoserido-Scleranthetum annui*
I - A.-S. a. var. typicum
a - form with *Scleranthus annuus*
b - form with *Veronica dillenii*
c - form typicum
d - form with *Spergula arvensis*
e - form with *Anthoxanthum aristatum*
II - A.-S. a. var. with *Mentha arvensis*
1 - subvar. typicum
2 - subvar. with *Illecebrum verticillatum*

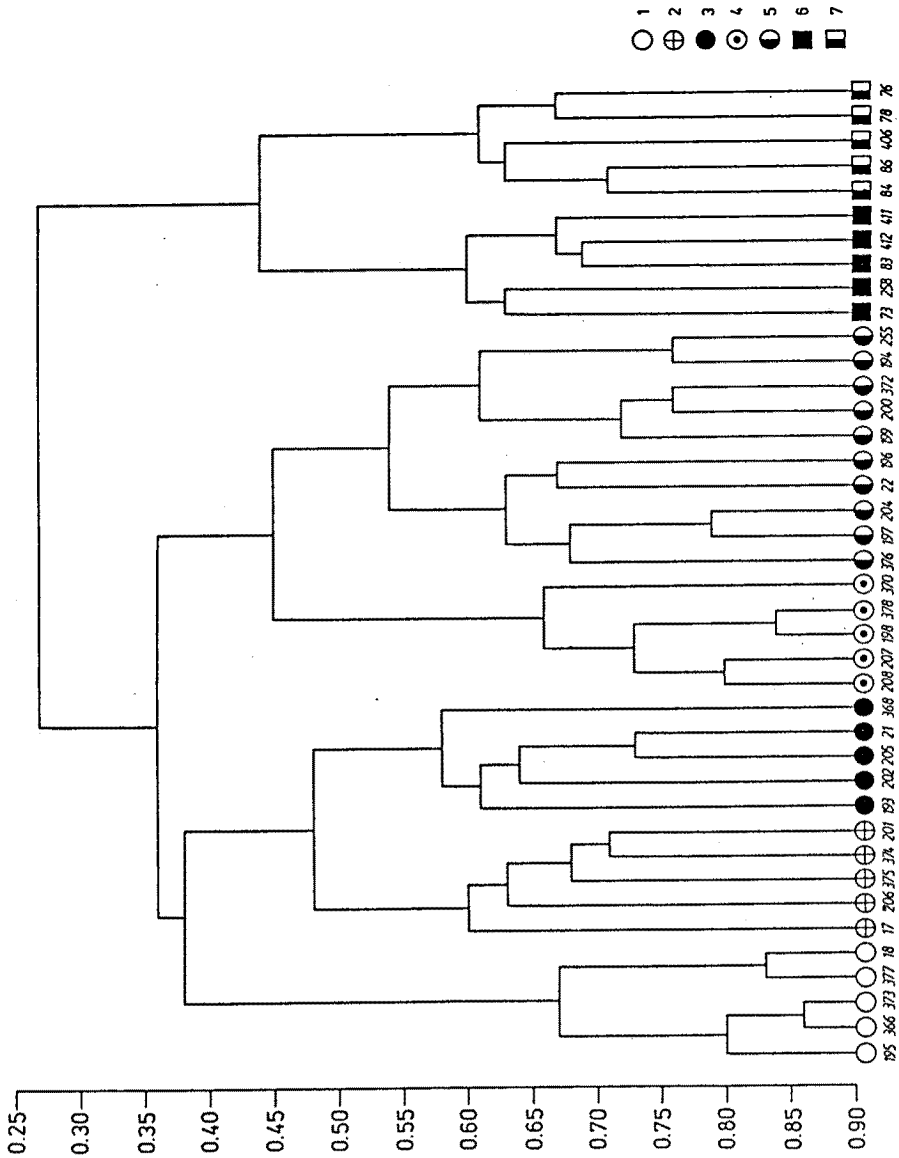

Fig. 1. Numerical classification [Source: WARCHOLIŃSKA (1990)].
1. *Arnoserido-Scleranthetum annui* var. typicum, form with *Scleranthus annuus*
2. *A.-S. a.* var. typicum, form with *Veronica dillennii*
3. *A.-S. a.* var. typicum, form typicum
4. *A-S. a.* var. typicum, form with *Spergula arvensis*
5. *A.-S. a.* var. typicum, form with *Anthoxanthum aristatum*
6. *A.-S. a.* var. with *Mentha arvensis,* subvar. typicum
7. *A.-S. a.* var. with *Mentha arvensis,* subvar. with *Illecebrum verticillatum*

Phytosociological characteristics

Floristical individuality of the *Arnoserido-Scleranthetum annui* association, in relation to other native segetal associations, does not raise any doubts. The communities included in this association are typified by a specific combination of species. A characteristic feature of this combination is that species constituting it may appear in poor habitats. This distinctive species combination of the *Arnoserido-Scleranthetum annui* association consists of several groups of species (cf. e. g. Tab. 1). An important diagnostic group is formed by characteristic and differential species of the association.

To the most common species of this group belong: *Arnoseris minima, Scleranthus annuus, Rumex acetosella* and, in some regions, *Teesdalia nudicaulis.* Presence of *Ornithogalum umbellatum* in the phytocoenoses of Cracow Jura (KORNAŚ 1950) and Piotrków Plain (WARCHOLIŃSKA 1974) requires further investigations. The characteristic species in respect of its territorial fidelity is undoubtedly *Arnoseris minima,* which in this association achieves full growth. Phytocoenoses of *Arnoserido-Scleranthetum annui* in eastern and southern Poland have smaller contribution of characteristic and differential species. Classification of the discussed communities into class, order, alliance and suballiance (WARCHOLIŃSKA 1990) is beyond any doubt. Characteristic species of the class of *Secalietea* are represented by *Rhinanthus angustifolius* subsp. *grandiflorus* and *Centaurea cyanus.* Characteristic and differential species of the order of *Aperetalia,* of the alliance of *Arnoseridion minimae* and of the suballiance of *Teesdalio-Arnoseridenion minimae* commonly occur in the above-mentioned association. Most frequently appearing species of these groups are: *Scleranthus annuus, Rumex acetosella, Spergula arvensis, Vicia sativa* subsp. *nigra, Apera spica-venti* and in some regions also *Anthoxanthum aristatum.* Less frequent species are *Aphanes microcarpa, Hypochoeris glabra* and also *Illecebrum verticillatum, Juncus capitatus* in some forms of the association.

Subatlantic species e.g. *Juncus bufonius, Filaginella uliginosa, Spergularia rubra* have considerable contribution in the communities of *Arnoserido-Scleranthetum annui.* Among these species a special attention should be paid to less commonly occurring little terophytes such as: *Illecebrum verticillatum, Juncus capitatus, Gnaphalium luteo-album, Lythrum hyssopifolia, Hypericum humifusum, Anagallis minima, Radiola linoides.*

Association of characteristic and differential species with particular syntaxonomic categories has not been unequivocally settled in Poland yet (cf. e.g. ANIOŁ-KWIATKOWSKA 1990; HERBICH 1982; JACKOWIAK, CHMIEL & LATOWSKI 1990; KORNAŚ 1950, 1972; MATUSZKIEWICZ 1981; NOWIŃSKI 1964; SICIŃSKI 1974; WARCHOLIŃSKA 1974, 1990). This problem needs further research.

Habitat conditions

The communities of *Arnoserido-Scleranthetum annui* usually occupy a flat or undulating terrain. They develop in rye-fields and on different types of poor sandy soils. They are, first of all, podzolic earths, brown earths and less common post-boggy soils. They mostly consist of loamy sands which are underlain by shallow or medium-deep loose sands. These habitats, according to the type of subsoil and location in the area, are characterized by a different degree of moisture. There are habitats among them which

are periodically dry as well as moist and wet. The majority of *Arnoserido-Scleranthetum annui* stands are formed on dry soils. Reaction of the soil is usually acid or acidulous with pH most often of 4.0-5.0 in the upper layers. Amplitude of the habitat-ecological association is very narrow as regards soils, but markedly wider taking into account their moisture. It is reflected in local and habitat differentiation of the association into lower syntaxonomic units (cf. Fig. 1, Tab. 1). Phytocoenoses of this association can be mostly met in the habitats following mixed pine woodlands of *Pino-Quercetum* (cf. e.g. ANIOŁ-KWIATKOWSKA 1990; KĘPCZYŃSKI & NORIŚKIEWICZ 1989; KRASICKA-KORCZYŃSKA 1990; WARCHOLIŃSKA 1981a, b, c, 1982, 1988-1990a, b, 1990). The connection of this association with order types of potential habitats, for example with *Leucobryo-Pinetum*, needs further research.

Variability of the association

Arnoserido-Scleranthetum annui is an association of subatlantic character. In Poland it occurs in an already impoverished form (MATUSZKIEWICZ 1981). Nevertheless, dissimilarity of *Arnoserido-Scleranthetum annui* to other associations appearing in Poland is quite visible. Comparatively great similarity can be observed between this association and some forms of *Spergulo-Veronicetum dillenii* on the one hand, and *Vicietum tetraspermae sperguletosum* on the other hand. It is very difficult to separate the *Arnoserido-Scleranthetum annui* phytocoenoses, especially when they are deformed, from the *Spergulo-Veronicetum dillenii* phytocoenoses. It is caused by the fact of the occurrence of such dune species as *Veronica dillenii* and *Spergula morisonii*. The difficulty in identification of phytocoenoses is also due to the fact that many stands of the *Arnoserido-Scleranthetum annui* phytocoenoses may have appeared as a result of degeneration of the *Papaveretum argemones* and *Vicietum tetraspermae sperguletosum* phytocoenoses. Hence, floristical individuality of the recognized forms of the *Arnoserido-Scleranthetum annui* association e.g. forms with *Veronica dillenii, Teesdalia nudicaulis, Digitaria ischaemum, Scleranthus annuus, Anthoxanthum aristatum, Apera spica-venti, Myosotis arvensis* is not always clear (cf. e. g. ANIOŁ-KWIATKOWSKA 1990; BALCERKIEWICZ & PAWLAK 1990; HERBICH 1982; PAWLAK 1979; SZMEJA 1993; WARCHOLIŃSKA 1987, 1990).

Variability of the *Arnoserido-Scleranthetum annui* association has not been studied in detail up to now. On the basis of the analysis of the available phytosociological material it can be assumed that this association does not display regional variability within the boundaries of Poland. In the western and central part of Poland it is optimally developed as regards floristic richness, presence of characteristic species, structure of phytocoenoses as well as differentiation into lower syntaxonomical units. Towards the south and east, a certain impoverishment of the *Arnoserido-Scleranthetum annui* association can be observed. Its range of variability is decreasing, which manifests itself in gradual disappearance of characteristic and differential species. They represent marginal forms of this association (cf. KORNAŚ 1950; POLAKOWSKI, KORNIAK & HOLDYŃSKI 1989; SAŁATA 1965).

The association of *Arnoserido-Scleranthetum annui* shows marked local habitat variability. Water conditions are a basic factor bringing about local differentiation of *Arnoserido-Scleranthetum annui*. Two ecological forms are commonly distinguished

within its limits. The first one groups communities with bigger contribution of stenothermic species, the latter deals with hygrophilous ones. On this basis, with a help of classical and numerical methods (cf. e.g. Fig. 1; Tab. 1, WARCHOLIŃSKA 1990), the communities of *Arnoserido-Scleranthetum annui* from the Polish territory have been divided into two groups corresponding to two lower syntaxonomic units predominantly in the rank of subassociation or variant, typical or moist ones.

The typical unit does not have its own differential species. Its communities commonly occur almost in the whole area of Poland. However, their frequency is diminishing in the south-eastern direction. It occupies flat or slightly slopping terrains. It develops in dry habitats not being influenced by ground waters.

The group of communities of the wet unit is differentiated by a series of hygrophilous species such as *Mentha arvensis, Stachys palustris, Polygonum hydropiper, Juncus bufonius, Bidens tripartita, Filaginella uliginosa, Lysimachia vulgaris, Spergularia rubra, Gypsophila muralis, Potentilla anserina.* The communities representing this unit are more scarce and they usually occur in depressions. Within this group of the communities, an interesting unit of a subvariant rank has been distinguished in Central Poland, consisting of a lot of subatlantic species, e. g. *Illecebrum verticillatum, Hypericum humifusum, Juncus capitatus, Lythrum portula, Gnaphalium luteo-album, Anagallis minima, Radiola linoides, Plantago major* subsp. *intermedia* (cf. Tab. 1; WARCHOLIŃSKA 1981a, c, 1990). They belong to the group of threatened species (WARCHOLIŃSKA 1986-1987, 1993b). In Poland and Europe the communities including *Illecebrum verticillatum* are included to other syntaxa, e. g. *Spergulario-Illecebretum verticillati* (FIJAŁKOWSKI 1978, SISSINGH 1957) and *Spergulo-Illecebretum* (OBERDORFER 1964). Research in a larger area, perhaps in the near future, may allow to determine and establish their specific position in the syntaxonomic system.

Arnoserido-Scleranthetum annui has a narrow ecological amplitude of the amount of nutrients available and therefore it does not show apparent variability in this respect. Nevertheless, within this association, as well as a typical form, poorer forms with *Veronica dillenii, Teesdalia nudicaulis, Digitaria ischaemum* (cf. ANIOŁ-KWIATKOWSKA 1990; BALCERKIEWICZ & PAWLAK 1990; SZMEJA 1992; WARCHOLIŃSKA 1987), which refer to *Spergulo-Veronicetum dillenii,* have also been singled out. Besides, the more nutrient rich form of this association including *Myosotis arvensis* (BALCERKIEWICZ & PAWLAK 1990; HERBICH 1982) has been described.

Phytocoenoses of the typical and wet units of *Arnoserido-Scleranthetum annui* are in decline at present due to changes of their habitats. It is reflected in floristic differentiation (WARCHOLIŃSKA 1993a). The degenerated communities, also called degenerate forms, are characterized by the appearance of *Veronica dillenii* or a bigger contribution of *Scleranthus annuus, Anthoxanthum aristatum, Spergula arvensis, Apera spica-venti, Agrostis stolonifera, Holcus mollis* (cf. WARCHOLIŃSKA 1976, 1979, 1987, 1990). Terophytes and apophytes prevail among both units. There is a conspicuous predominance of the apophytes in the wet unit. A lower degree of synanthropization (37%) of the phytocoenoses belonging to the wet unit in comparison with the phytocoenoses of the typical unit (75%) indicates a smaller influence of human management on their habitats (cf. WARCHOLIŃSKA 1990).

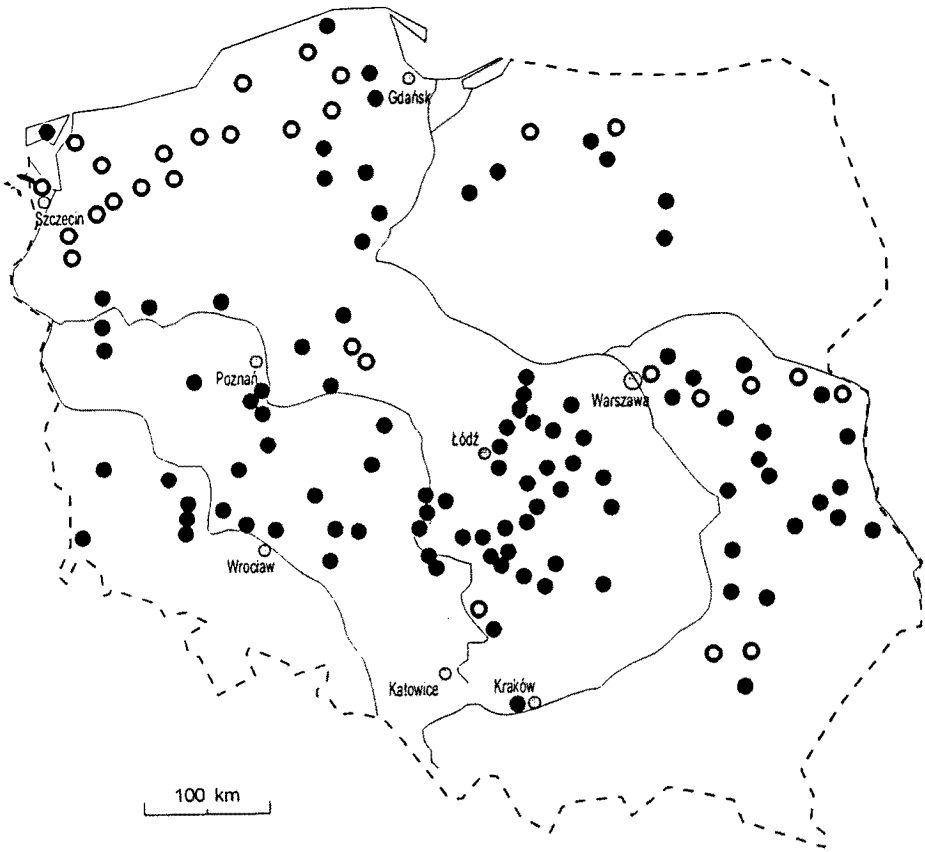

Fig. 2 Distribution of *Arnoserido-Scleranthetum annui* in Poland.
Sources:
● Papers with phytosociological records (ANIOŁ-KWIATKOWSKA 1974, 1990; BALCERKIEWICZ & PAWLAK 1990; BIELSKA 1989; DOMINIAK 1984; FIJAŁKOWSKI 1978; HERBICH 1982; HOŁDYŃSKI & KORNIAK 1993; JACKOWIAK, CHMIEL & LATOWSKI 1990; KĘPCZYŃSKI & NORIŚKIEWICZ 1989; KORNAŚ 1950; KORNIAK 1970; KRASICKA-KORCZYŃSKA 1990; KUTYNA 1988; KUŹNIEWSKI 1976; MISIEWICZ 1970; NOWIŃSKI 1964, 1965; PASSARGE 1963; PAWLAK 1979; POLAKOWSKI, KORNIAK & HOŁDYŃSKI 1989; SAŁATA 1965; SICIŃSKI 1974, 1986; SICIŃSKI & WARCHOLIŃSKA 1989; SKRZYCZYŃSKA & SKRZYCZYŃSKI 1989; SZMEJA 1993; WARCHOLIŃSKA 1974, 1976, 1978, 1979, 1981a, b, c, 1982, 1987, 1988-1990a, b, 1990, 1993a, b, 1994a, b, c; WARCHOLIŃSKA & SICIŃSKI 1976, 1991; WIŚNIEWSKI 1971; WNUK 1976, 1989; WNUK, GRZEBYK 1989; WÓJCIK 1965).
O Papers without phytosociological records (BOROWIEC 1977; BOROWIEC & KUTYNA 1976, 1980; BOROWIEC, KUTYNA & MAZUREK 1980; BOROWIEC, KUTYNA & SKRZYCZYŃSKA 1976, 1977; CHMIEL 1993; CHOJNACKI 1991; CIOSEK & SKRZYCZYŃSKA 1987; KORNIAK 1974; PAWŁOWSKI, KAPELUSZNY, KOLASA & WESOŁOWSKI 1989; WIKA 1986).

Distribution of the association

It results from the data available that the communities of *Arnoserido-Scleranthetum annui* occur quite frequently in Poland. They do not cover large areas but they mostly grow in spatial complexes together with phytocoenoses of *Spergulo-Veronicetum dillenii, Papaveretum argemones, Vicietum tetraspermae sperguletosum.* The situation of the localities is correlated with the occurrence of sandy soils, mainly podzolic earths and brown earths (KERN 1989). The distribution of the typical forms of the association manifests a very noticeable connection with decrease of influence of an oceanic climate. The communities of *Arnoserido-Scleranthetum annui* have a limited range in Poland and they are irreguraly distributed. Most localities have been recorded in Central Poland (Fig. 2). A smaller local concentration of the localities and the majority of the dispersed localities have been found in the north-western part of the country. The communities of *Arnoserido-Scleranthetum annui* occur scattered to the east of the Lower Vistula and in the south-eastern Poland, they are represented by the impoverished marginal forms of the association. It is not certain whether the range of the association crosses the eastern Polish border. They can still be met in Polesie within the Polish territory (Fig. 2). Absence of the localities in quite large areas of southern and northern Poland suggests a need for further research. The map of the distribution (Fig. 2) depicts a degree of phytosociological exploration of *Arnoserido-Scleranthetum annui* rather than its actual occurrence within the range. It can be accepted that the range of the discussed association in Poland is wider than it results from the investigations carried out hitherto (cf. MATUSZKIEWICZ 1984). Human influence on the distribution of the *Arnoserido-Scleranthetum annui* communities is controversial. On the one hand human activity causes increase of the area occupied by these communities, but on the other hand it brings about their decline (cf. e.g. WARCHOLIŃSKA 1979, 1981b, 1988-1990a; WARCHOLIŃSKA & SICIŃSKI 1991; WNUK 1989).

Conclusions

The recapitulation of the knowledge of the specific character and the differentiation of *Arnoserido-Scleranthetum annui* in Poland carried out in the present paper shows that considerable progress has been made, partly thanks to a number of papers describing these communities in local conditions. It can be stated that in many regions the communities of the analyzed association are quite well known. Among these regions the following can be mentioned: the Central Belt of Mid-Poland Lowlands and the north-western part of Poland. On the other hand, our knowledge of these communities in north-eastern and southern Poland is still not sufficient. Therefore, standard phytosociological investigations are needed in the areas not having been explored enough till now. It is mostly a question of finding out the missing information on distribution and ranges of individual syntaxa.

It seems especially useful to carry out further special investigations to explain a difference of opinions concerning a range and a rank of recognized syntaxonomic units as well as rules and a way of their hierarchical grouping.

Disproportion in the store of information concerning floristical composition and structure in comparison with other aspects of the *Arnoserido-Scleranthetum annui* communities as ecological systems has been found. There are rare attempts of a thorough analysis of the communities and relationship between phytosociological differentiation of the communities of this association and conditions of their natural environment. It is vital and urgent to do ecological and habitat

research, the investigated object of which would be precisely identified syntaxonomical units as types of ecosystems and the aim of which would be to determine dependence of the *Arnoserido-Scleranthetum annui* communities on their habitat and their participation in forming the biotope.

It is also advisable to intensify investigations into the structure of the *Arnoserido-Scleranthetum annui* communities in its quantitative and dynamic aspect.

Special attention should be paid to decline of the communities of this association and their transformations under the influence of increasing anthropic pressure, and also to the studies on ecological plasticity and resistance of its phytocoenoses.

The research on productivity and other functional aspects of the *Arnoserido-Scleranthetum annui* ecosystems are also indispensable.

A basis of all these detailed ecological investigations ought to be a correct syntaxonomical identification of the studied objects securing univocal character and comparability of the research results.

The attempt to summarize the syntaxonomy of the *Arnoserido-Scleranthetum annui* communities, undertaken in this paper, is to serve this purpose.

Summary

A survey of the *Arnoserido-Scleranthetum annui* communities in Poland has been carried out.

The floristical composition and range of the association indicates its subatlantic character. Although it does not cover large areas, it has a considerable role in the Polish agricultural landscape. It mostly grows in the central and north-western part of Poland (Fig. 2). The communities belonging to *Arnoserido-Scleranthetum annui* occupy quite a narrow range of habitats. They chiefly appear in poor, sandy habitats. The ecological amplitude of the associations finds expression in the local-habitat differentiation into lower syntaxonomical units, predominatly in a rank of subassociations or variants. The most frequent local form of the association is a typical subassociation (variant). The regional variability of the association is small. The impoverished marginal forms of the association occur on dispersed sites in southern and eastern Poland. These communities are characterized by low constancy of characteristic and differential species or by lack of a certain amount of subatlantic species in their composition.

In the light of the previous studies, the syntaxonomy of the communities of the *Arnoserido-Scleranthetumm annui* association, chiefly presented in two systems (KORNAŚ 1972, MATUSZKIEWICZ 1981, WARCHOLIŃSKA 1990), is summarized as follows:
Class: *Secalietea (Rudero-Secalietea)*
Order: *Aperetalia (Aperetalia spicae-venti, Secali-Violetalia arvensis)*
Suborder: *Centauretalia cyani*
Alliance: *Arnoseridion minimae (Aperion spicae-venti)*
Suballiance: *Teesdalio-Arnoseridenion minimae*
Association: *Arnoserido-Scleranthetum annui (Teesdaleo-Arnoseridetum minimae).*

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