Zeszyty Naukowe Wyższej Szkoły Pedagogicznej w Bydgoszczy STUDIA PRZYRODNICZE Scientific Papers of Pedagogical University in Bydgoszcz NATURAL STUDIES (Zeszyty Nauk. WSP, Stud. Przyr.)	14	5–18	1998

A NUMERICAL DATA BASE AND CHECKLIST OF TAXA OF POLISH FLORA APPLICABLE IN PHYTOSOCIOLOGY, PARTICULARLY FOR THE TURBOVEG

METODY NUMERYCZNE I LISTY FLORY POLSKIEJ DO TWORZENIA FITOSOCJOLOGICZNYCH BAZ DANYCH, ZE SZCZEGÓLNYM UWZGLĘDNIENIEM PROGRAMU TURBOVEG

Wojciech Szwed[1], Stefan M. Hennekens[2], Tim A.H.M. Pelsma[3], Halina Ratyńska[4], Anna Rusińska[5]

[1] Department of Forest Botany, Agricultural University, Wojska Polskiego 71d, 60-625 Poznań, Poland

[2] Institute for Forest and Nature Research (IBN-DLO) Agricultural University, Bosrandweg 20, 6700 AA Wageningen, The Netherlands

[3] Vereniging Natuurmonumenten, Noordereinde 60, 1243 JJ s'Graveland, The Netherlands

[4] Department of Botany, Pedagogical University, Chodkiewicza 51, 85-667 Bydgoszcz, Poland

[5] Department of Geobotany, Adam Mickiewicz University, Al. Niepodległości 14, 61-713 Poznań, Poland

ABSTRACT: The intensive development of the plant ecology, the collection of an increasing number of ecological data and the growing use of numerical methods result in a growing interest in the application of new achievements of computer science in this field. Numerical software is used for storage and processing of relevés. Recently it has became necessary to create a complete checklist of the Polish flora including synonyms and unique codes and numbers for all the taxa, applicable in phytosociology, particularly for the TURBOVEG.

This paper presents the way how a checklist was prepared and the Turboveg introduce by the Section of Geobotany and Vegetation Protection of the Polish Botanical Society and reviews selected software (TURBOVEG, INTAKE =OPNAME, CEDIT, CLUTER, CLUTAB, ELLEN, ORDIPLOT), that can be used for storage and processing of relevés, floristic and environmental data and, in the future, data of geocomplexes. The paper gives also the taxonomical sources and methods used during the construction of the checklist, made especially for the TURBOVEG.
KEY WORDS: phytosociology, numerical methods, TURBOVEG

Introduction

The intensive development of the plant ecology involves the collection of an increasing number of data. Scientific institutions collect the data in various ways and store them in files or in computerised data bases or spreadsheets (e.g. dBASE, EXCEL or LOTUS). In connection with this, numerous glossaries, checklists and codes are being created. As a result, many of the data bases are not compatible with one another since only in some countries the methods of data storage have been standardised. Consequently, there exists an urgent need for a uniform system of data inputting, storage and processing that would be used in all Polish scientific institutions, so that their data bases would be compatible with one another and, preferably, also with foreign data bases. Thus, it is necessary to standardise botanical nomenclature and popularise a simple method of data collection, storage and processing.

The problems mentioned above may be solved by the application of numerical methods. In Poland these methods are increasingly used, so it is possible and necessary to standardise them (see also Matuszkiewicz et al. 1995). The importance of this issue has been emphasised also by Mucina in Austria, Rodwell in Great Britain, Schaminée in the Netherlands and Dierschke in Germany (Mucina et al. 1993).

Our aim was to create a standard floristic data base for Poland including a complete checklist of algae, liverworts, mosses, lichens and vascular plants, together with their synonyms and authors of the names. The list was specially prepared for the TURBOVEG, database management program for vegetation data. Our own experiences and contacts with Dutch academics and authors of software proved to be very useful in coping with this task. When creating the checklist, we asked taxonomists specialising in various groups for co-operation.

Materials and methods

Some years of experience in the collection of relevés from the whole area of Poland, both recent and historical, made us aware of the enormous diversity of the existing materials. There are many differences in the classification and names applied to taxa (e.g. species, subspecies, varieties and forms) included in the relevés. Over the last 50 years the views on the taxonomy and nomenclature of the living organisms changed considerably. As a result, it was necessary to create a complete checklist of vascular plants, liverworts, mosses, algae and lichens that would include synonyms, author's names, as well as a unique code and number for each species. The checklist is not, and cannot be, identical with the checklist of the Polish flora since it has to include names used in the past (e.g. at the beginning of this century), and taxa lower than species which often distinguish syntaxonomical units.

At present there exists a TURBOVEG and the list for Polish vascular plants (Rutkowski et al. 1994), liverworts (Szweykowski et al. 1994), mosses (Ochyra et al. 1994), lichens (Nowak et al. 1994) and algae (Szańkowski 1994) prepared for it. The program TURBOVEG has been accepted by the Geobotany and Vegetation Protection Section of the Polish Botanical Society, as a standard in Poland (Warszawa, December 18, 1993). Also the Working Group Council during meeting in Rome (March 1994) proposed to use TURBOVEG as the central computer package, as it was specially written for a user-friendly input and handling of large amounts of vegetation data. At the moment the program has already been implemented or is willing to implement among the others in the Netherlands, Germany, Italy, Slovakia, Slovenia, the United Kingdom, France, Portugal, Russia and Ireland (Hennekens & Schaminée 1995).

For the TURBOVEG the national lists of flora are required. Our checklist includes numbers and codes of the taxa, their complete scientific names (including the names of their authors) and their most widely used synonyms. In order to facilitate the communication between Polish and foreign scientists, the checklist was based on the names used in Flora Europea (Tutin et al. 1964-1980) and prepared according to the principles presented at the meetings concerned with the creation of a European checklist.

The following botanists co-operated in the creation of the checklist of the Polish flora:
Vascular plants - L. Rutkowski, H. Ratyńska & W. Szwed
Liverworts - J. Szweykowski, A. Rusińska & W. Szwed
Mosses - R. Ochyra, A. Rusińska & W. Szwed
Lichens - J. Nowak, H. Ratyńska & W. Szwed
Algae - M. Szańkowski;

The checklist is based on the recent taxonomic concepts. Its creation involved the use of both collected and monographic works, such as floras, guides to plant identification, atlases and floristic checklists, e.g.:
Vascular plants: Tutin *et al.* (1964-1980), Jasiewicz (1984), Dostál (1982), Flora

polska (1919-1980), Oberdorfer (1990), Pawłowski (1956), Rothmaler (1976), Szafer *et al.* (1967), Rutkowski (1998).
Liverworts: Grolle (1983), Reyment-Grochowska (1966), Schljakov (1976-1982), Schuster (1966-1992), Szweykowski (1958), Szweykowski & Koźlicka (1974), Müller (1951-1958), Düll (1983).
Mosses: Corley *et al.* (1982), Düll (1984-1985), Nyholm (1954-1965), Ochyra & Szmajda (1978), Ochyra, Szmajda & Bednarek-Ochyra (1992), Podpera (1954), Smith 1978, Szafran (1957-1960).
Lichens: Nowak & Tobolewski (1975), Fałtynowicz (1993).
In all groups of plants also the original taxonomic concepts of the authors were used.
Algae: Dąmbska (1964), Kornaś *et al.* (1960), Pankov (1971) & Starmach (1977).

The proposed checklist allows for making use of the existing ecological software (mainly imported from West Europe but so far rarely used in Poland), and will greatly facilitate international exchange of information.

The checklist was created using an original program devised especially for inputting species names, their synonyms and for the generation of codes and numbers of the taxa.

Sample entry:

The vascular plants with numbers from 1 to 4500, e.g.

1254 DANTHDEC *Danthonia decumbens* (L.) DC.
1254 DANTHDEC *Sieglingia decumbens* (L.) Bernh.
1254 DANTHDEC *Sieglingia decumbens* (L.) Lam.

The liverworts (4501-5000), e.g.

4661 MARSUFUN *Marsupella funckii* (Web. & Mohr) Dum.
4661 MARSUFUN *Marsupella hungarica* Boros & Vajda
4661 MARSUFUN *Marsupella pygmaea* (Limpr.) Steph.

The mosses (5001-6000), e.g.

5072 BRYUMBAD *Bryum badium* (Brid.) Schimp.
5072 BRYUMBAD *Bryum caespiticium* v. badium (Bruch. ex Ruthe.) Brid.

The lichens (6001-8000), e.g.
6402 CLADIPOR *Cladina portentosa* (Duf.) Follm.
6402 CLADIPOR *Cladonia impexa* Harm.

The algae (8001-8200), e.g.
8016 CHARAHIS *Chara hispida* L.
8017 CHARAJUB *Chara contraria var. jubata* Nordstaedt
8017 CHARAJUB *Chara filiformis* Hertzsch
8017 CHARAJUB *Chara jubata* A.Br.

The checklist includes also genera (8201-9989), e.g.
8201 ABIES-SP *Abies species*

and the conventionally replacing taxa (9990-9999).

Collection of data

History of data collection

The computerised flora register was invented in the Netherlands. In the early 80's computer systems were huge and slow, except for some very expensive ones. As a result only a small number of scientists did use a (very preliminary) flora register at that time. The „Standard list of the Dutch flora" (Arnolds & van der Meijden 1976) was useful for floristic and phytosociological research. In this publication, all Dutch species were given a number. This gave the possibility to use them for the data analyses made by computer. After the Dutch State Forest Institute „Staatsbosbeheer" made the first copy of a computerised flora register; the work was continued (till 1985) by the Central Agency of Statistics „Centraal Bureau voor Statistiek (CBS)". The CBS appended new features and developed protocols for conflicting abbreviations of species names. Mosses and lichens were also numbered. Two years later a new register was published in the form of book (CBS 1987, 1991), and it was distributed on magnetic carriers as well. The main difference between this new register and the earlier standard list was that a lot of information was added to the register. All kinds of taxonomical, syntaxonomical, ecological and morphological data were added. The information about ecological characteristics was available for higher plants only. Mosses and lichens were still excluded from the register.

In the meantime, computerisation developed rapidly. Computers became cheaper, smaller and faster. An increasing number of people have been occupied with flora statistics. The preliminary and in most cases very user-unfriendly computer programs from the middle 80's, were improved and some others developed.

Computerised base register

In the 80's there was some multivariate analysis programs (such as TWINSPAN, Hill 1979) available, but without a standard species list. People, who used these programs were forced to make their own lists of species. It is clear that one can save a lot of work using a standard flora register. The advantage will even increase if the register is easy accessible and commonly known. A widely accepted register on European scale would be ideal.

Collecting of data

Now-a-days use of computerised register is common during collecting data in the field. Such a register contains species together with a unique number. A next step is the use of a field computer. In this case, data are stored in computer memory promptly, without writing them down. To enable a good control and avoiding errors, it is advisable to write down the results on paper as well. If not written down, it is likely that the advantage in speed comes with loss of data accuracy. The more routine-like the work is the bigger advantage of a field computer.

When collecting data in the field, the following questions are important for the purpose of multivariate analysis:

- Is the reléve scale easy transferable to an ordinal scale? An ordinal scale (this is a scale in equal scale parts e.g. 1, 2, ... 9, instead of the common reléve scale) is required for computerised analysis.
- What accuracy is required with the relevé scale? Should the scale be in equal parts or in continuous figures?
- Are the data just qualitative (present/absent) or is there quantitative information (abundance) as well? These characteristics might also be combined.

The user of the program can also be faced with some other problems, such as:

- If anyone wants to analyse a relation between vegetation and its environment, he should consider how the environmental data have been collected - in continuous figures or fixed number of classes.
- If permanent quadrates (PQ's) are monitored, it is important to use exactly the same technique over the different years. If not, difficulties could occur on interpretation, and in fact monitoring data cannot be analysed without loss of information.

– If one is working on experiments, every type of experiment should be represented by an appropriate number of cases (this is often forgotten); otherwise there will be no statistical significance.

Entering data into computer memory

In the phase of entering the data, a computerised species list plays an important role. Checks on validity of the observation can be done directly on „entering". Users are able to enter their data on a computer screen containing species names. Just by picking one out, a species is selected and an abundance is being asked for (Pot 1991).

After an intensive control on errors, there are numerous possibilities to process the data. First of all one should be aware of the way in which data are stored. Two main forms can be distinguished:

1 - A simple ASCII file with a matrix of samples (relevés) and variables (species). The „Cornell Condensed format" (introduced by Cornell University) is an example of this category. This kind of format can be convenient when analysing data with use of some multivariate programs. On the other hand these files are static and difficult to use for other purposes.

2 - It is therefore recommended to store data in a database, preferably a relational database (a relational database contains several tables linked by a „key" like species number). Such a database offers the same possibilities as a static (ASCII) file, but in addition much more, such as selections, controlled input of data and different output formats. In fact, for further analysis ASCII file can be derived from a relational database. Creation of a relational database, however, takes a lot of time and is therefore expensive. Systems based on DBASE structure (on MSDOS-PC) appeared as useful.

At the beginning of 1995, except of many smaller databases, over 120.000 relevés have been stored centrally for the Netherlands (Institute for Forest and Nature Research in co-operation with the Central Office for Statistics [IBN-DLO & CBS] - Hennekens, Schaminée 1995). This number will probably grow over 170.000 in a short time. Each relevé was evaluated; its location was recorded in a national, 1 x 1 km grid system, and its provisional syntaxon code was determined. After judging, each «new» relevé is compared with existing data-bank to prevent double occurrence of relevés. For processing of all these data, a computer software has been developed, which is called TURBOVEG (Hennekens 1994).

Ecological software:

Many phytosociological programs have been created and/or are used in the Department of Terrestrial Ecology and Nature Management of the Agricultural University Wageningen. Thanks to the co-operation between this department and the Agricultural University in Poznań, Poland, the programs are used also by the latter institutions. The list of these programs is given later on in the article.

Data input and control programs:

INTAKE =OpName (Pot 1991) Input module for condensed formats, uses species lists; input of relevés to a data base.

TURBOVEG 9.21 (Hennekens 1994) is a user-friendly, menu driven, database management program for vegetation data. The program not only allows input of species and their cover abundance but also a lot of environmental data. It can handle an unlimited number of databases. Each database may consist of up to about 50.000 relevés. Generally a database is a logical unit, it comprises for example the relevés of a specific year, a specific author or a specific project.

Each database consist of three database files (DBASE III+ compatible), which are related by means of a unique relevé number. One database includes the so-called header data (environmental data), a second the species and their cover values and third the remarks which did not fit in the file with the header data. To speed up the database each database file is supported by an index file. The index files are of a special type (FOXPRO compatible).

The table gives a description of the structure of the database file for the header data in standard format. This format is obliged for everyone working with TURBOVEG. The advantage of the standard format is that data can easily be exchanged, even with extended databases. The header fields are described as: Relevé number, Country code, Biblioreference, No. of table in publication., No. of relevé in table, Cover abundance scale, Project code, Author code, Date, Syntaxon code, Relevé area (m^2), UTM grid system code, Altitude (m), Aspect (degrees), Slope (degrees), Total cover (%), Cover of tree layer (%), Cover of shrub layer (%), Cover of herb layer (%), Cover of moss layer (%), Cover of lichen layer (%), Cover of algae layer (%), Cover of litter layer (%), Cover of open water (%), Cover of bare rock (%), Height of highest trees (m), Height of lowest trees (m), Height of highest shrubs (m), Height of lowest shrubs (m), Average height of highest herbs (cm), Average height of lowest herbs (cm), Maximum height of herbs (cm), Maximum height of cryptogams (mm), Mosses identified (y/n), Lichens identified (y/n), Remarks (with the maximum number of 350 characters).

Each database is connected with a set of global database files, included lists with species codes, and names, syntaxa, codes and names, author's codes and names, and cover scale. Besides these lists it is possible to link more lists, as list with provinces, soil types, and others. The following options are available after opening the database: change or view relevé, select relevé, input new data, hunt duplicates, delete relevé, automatic renumbering of relevé, automatic renumbering of species, and extending the database structure. For the input new data tree options are available: input of separate relevés, input of tables, and import of Cornell Condensed Format files. For the selection of relevés from one or more databases several criteria (defined on the basis of one or more header items and an unlimited number of species) can be used. These criteria can be combined.

After selection of several options there are available, e.g. selected header for each relevé and the species with their cover abundance, a distribution map of selected relevés (in Dutch version). Selected relevés can be send to a printer or a file, and the next, the most important option - export - which provides further analysis, as TURBOVEG database format, Cornell Condensed Format files of species and cover values (which is suitable for many programs, e.g. CANOCO, CEDIT, DECORANA, ORDIFLEX, TWINSPAN); and some input files as MULVA, TAB and ESPRESSO, SYNTAX-5, TAXAL, and others (Hennekens & Schaminée 1995), CEDIT (van Tongeren 1989) processing of all kinds of formats.

Classification, ordination and others programs:

TWINSPAN (Hill 1979) divisive cluster analyses based on indicators.

CANOCO (ter Braak 1991) Canonical Correspondence Analyses. Analyses relationship between species, communities and environmental factors.

DECORANA (Hill 1979) Detrended Correspondence Analyses.

DENDRO (Schaffers 1993) Calculates and draws dendrogramms based on agglomerative relationships.

Data processors:

CLUTAB (Pelsma & van der Zee 1992). Creates synoptic tables, files with cluster centroids, etc.

ELLEN (van der Zee & Pelsma 1992). Statistical analysis of floristic data bases. Calculation of the ranges and average values of environmental factors (e.g. indication Ellenberg value's) for relevés or groups of relevés.

TABLEFIT - for identification of vegetation types (Hill 1993).

CLUTER - a clutering program complementing CLUTAB.

CLUTAB - making a synoptic tables (Pelsma 1989).

ORDIPLOT - (van der Zee 1991) plots diagrams of relevés and species analysed by DECORANA, and diagrams of cover, and Ellenberg's values for each species.

The above list shows that there existing programs which have been used by foreign phytosociologists for years and can be used in Poland without any special adaptations. The most important modification was produce of an adequate checklist of the Polish flora that would be compatible with the existing software.

Since late 1980's plant ecologists of the Polish Academy of Sciences and the Agricultural University in Poznań have been using the above-mentioned programs for relevés collection and analysis. Some programs were rendered accessible to Polish botanists by the Department of Terrestrial Ecology and Nature Management of the Agricultural University in Wageningen, the Netherlands. So far specialists from the following institutions have been using this software: Adam Mickiewicz University and Agricultural University in Poznań, Nicolaus Copernicus University in Toruń, Łódź University and the Institute of Geography and Spatial Management of the Polish Academy of Sciences in Warsaw.

Information on the available software (including user's manuals) was presented at a conference of the Polish Botanical Society in Toruń in September 1994. In June 1993 a course on the use of the ecological software was organised by W. Szwed at the Agricultural University in Poznań. Some presentations have been also held during the meetings of Polish Botanical Society (Section of Geobotany and Protection of Vegetation) as well as, in co-operation with the Netherlands, for co-workers of the special IMUZ (Instytut Melioracji i Użytków Zielonych) project, and others.

Conclusions

The making of the floristic checklist will allow the standardisation of the methods of data collection, processing and storage in all scientific institutions in Poland, and their compatibility with data bases in other European countries.

The checklist, which is based on uniform principles, will be useful in all branches of geobotany, e.g. in floristic, phytosociological and landscape (geocomplex) analyses. It will facilitate all kinds of comparative analyses, on both a local and regional scale. It will also allow the exchange of information between scientists, collection of data helpful in the evaluation of the natural environment, and the creation of a gene bank.

At present the checklist is being supplemented with data on the following aspects:

1. plant geography (affiliation of the taxa to geographical-historical groups, characteristics of geographical elements, vertical and horizontal ranges);
2. morphology and phenology (Raunkiaer's life forms, plant size, colour of flowers, anatomy, life-span of leaves, flowering period);
3. synopsis of species in the syntaxonomic classification system, e.g. according to Matuszkiewicz, Oberdorfer or Ellenberg;
4. ecology - in relation to abiotic factors;
5. protection (protected and endangered species - the red list of species).

Correction, addition or any other changes in the checklist introduced arbitrarily by a botanist will lead to incompatibility of his/her data base with data bases of other people. All changes have to be introduced on a national scale. Appended or revised versions of the checklist will be then distributed among all botanists using it, so that their data bases would be always compatible with one another. All users of the software are welcome to suggest corrections and amendments to the checklist. The suggestions should be sent to Mr. Marcin Szańkowski, Instytut of Botany, University of Warsaw (address: al. Ujazdowskie 4, 00-478 Warszawa, fax 02-6226646), who will be responsible for introducing all the accepted changes. When sending the letter, please enclose a two floppy disc so that we could send you back a copy of the new, revised version of the checklist.

References:

Arnolds F. & Meijden van der R. 1976: *Standaardlijst van de Nederlandse flora* 1975. Rijksherbarium, Leiden.

Botanisch Basisregister 1987: Centraal Bureau voor de Statistiek afdeling Natuurlijk Milieu, CBS. Voorburg/Heerlen. 121 pp.

Botanisch Basisregister 1991 (1992): Centraal Bureau voor de Statistiek, CBS. Voorburg/ Heerlen. 79 pp.

Braak ter C. 1991: *CANOCO an extension of DECORANA*. Agricultural Mathematics Group DLO. Wageningen.

Corley M.F.V., Crundwell A.C.; Düll R., Hill M.O. & Smith A.J.E. 1982: *Mosses of Europe and the Azores; an annotated list of species, with synonyms from the recent literetu-re*. J.Bryol. 11: 609-689.

Dostál J. 1982: *Seznam cévnatých rostlin květeny československé*, Pražská botanická zahrada [Plantarum vascularum Bohemo-Slovacae]. Praha-Troja. 409 pp.(in Czech).

Düll R. 1983: *Distribution of the European and Macronesian liverworts (Hepaticophytina)*. Bryologische Beitrage, 2. 114 pp.

Düll R. 1984-1985: *Distribution of the European and Macronesian mosses (Bryophytina)*. Bryologische Beitrage, 4. (Part I): 1-114 (1984); 5. (Part II): 110-234. (1985).

Fałtynowicz W. 1993: *A checklist of polish lichene forming and lichenicolous fungi including parasitic and saprophitic fungi occuring on lichens*. Polish Bot. Stud. 6: 1-65.

Flora Polska. Rośliny naczyniowe Polski i ziem ościennych. 1919-1980. T. 1-14. 1. M. Raciborski (ed.) I-VII + 427 pp. (1919); 2. W. Szafer (ed.) 254 pp. (1921); 3. A. Jasiewicz (ed.) 330 pp. (1982); 4. A. Jasiewicz (ed.) 306 pp. (1985); 5. A. Jasiewicz (ed.) 48 pp. (1987); 6. W. Szafer (ed.) 70 pp. (1947); 7. W. Szafer & B. Pawłowski (eds.) 302 pp. (1955); 8. W. Szafer W. & B.Pawłowski (eds.), 428 pp. (1959); 9. W. Szafer & B.Pawłowski (eds.) 137 pp. (1960); 10. B. Pawłowski (ed.) 401 pp. (1963); 11. B.Pawłowski (ed.) 371 pp. (1967); 12. B. Pawłowski & A.

Jasiewicz (eds.) 416 pp. (1971); 13. B. Pawłowski & A. Jasiewicz (eds.) 201 pp. (1972); 14. pp. (1980). PAU, PWN. Kraków-Warszawa, Kraków.

Grolle R. 1983: *Hepatics of Europe including the Azores; an annotated list of species, with synonyms from the recent literature*. J. Bryol. 12: 403-459.

Hennekens S. M. 1994: *TURBOVEG 9.2, a relational database for vegetation relèves.* Institut for Forest and Nature Research. OBN-DLO. Wageningen.

Hennekens S. M. & Schaminée J.H.J. 1995: *TURBOVEG, a comprehensive database management system for vegetation data.* Agricultural University Wageningen. mscr.

Hill M. O. 1979 a: *DECORANA. A fortran program for detrended correspondence analysis and reciprocal analysis averaging*. Cornell University, Ithaca, New York.

Hill M. O. 1979 b: *TWINSPAN. Ecology and systematics*. Cornell University, Ithaca, New York.

Hill M. O. 1993: *TABLEFIT. A program to indentify types of vegetation by measuring goodnes-of-fit to association tables*. Institute of Terriestrial Ecology. Monkswood.

Jasiewicz A. 1984: *Nazwy gatunkowe roślin naczyniowych flory polskiej - The species-name of Polish vascular plants*. Fragm. Flor. et Geobot. 30(3): 217-285.

Mirek Z., Piękoś-Mirek H., Zając A. & Zając M. 1995: *Vascular plants of Poland - a checklist*. Polish Botanical Studies, Guidbook Series. 15: 1-303. Kraków.

Matuszkiewicz J. M., Chojnacki J., Nienartowicz A., Ratyńska H., Szańkowski M. and Szwed W. 1995: *W sprawie opracowania ujednoliconego systemu gromadzenia danych geobotanicznych. [Towards standarized geobotanical data base system in Poland].*Wiadomości Botaniczne, 39 (3/4): 19-26 (in Polish with English summary).

Mucina L., Rodwell J.S., Schaminée J.H.J. & Dierschke H. 1993: *European Vegetation Survey: Current state of some national programmes*. J.Vegetation Sc. 4: 429-438.

Müller K. 1951-1958: *Die Lebermoose Europas. Eine Gesamtdarstellung der Europäischen Arten*. - In: Dr L. Rabenhorst's Kryptogamen-Flora van Deutschland, Östereich und Schweiz. 3 Auflage. 6 xii + 1365 pp. Akademische Ferlagsgesellschaft Geest & Portig K.-G. Leipzig.

Nowak J., Ratyńska H. & Szwed W. 1994: *Porosty. Listy taksonów roślin Polski przeznaczone do tworzenia geobotanicznych baz danych.* in: Hennekens S. 1991-1994 Turboveg (versie 9.07). IBN Wageningen.

Nowak J., Tobolewski Z. 1975: *Porosty polskie. Opisy i klucze do oznaczania porostów w Polsce dotychczas stwierdzonych lub prawdopodobnych. [„Polish lichens. Description and keys to determination of lichens found in Poland"]* Warszawa-Kraków: PWN 1180 pp. (in Polish).

Nyholm E. (1954-1965): *Illustrated Moss Flora of Fennoscandia*. II Musci, 1: 1-87 (1954); 2: 85-189 (1956); 3: 189-288 (1958); 4: 287-408 (1960); 5: 406-647 (1965). Lund.

Oberdorfer E. 1990: *Pflanzensoziologische Exkursionsflora*, Ulmer: 1054 pp.

Ochyra R. & Szmajda P. 1978: *An Annotated List of Polish Mosses*. Fragm. Flor. Geobot. 24(1): 93-145.

Ochyra R., Rusińska A., Szwed W. 1994: *Mchy. Listy taksonów roślin Polski przeznaczone do tworzenia geobotanicznych baz danych.* In: Hennekens S. 1991-1994 Turboveg (versie 9.07). IBN Wageningen.

Ochyra R., Szmajda P. & Bednarek-Ochyra H. 1992: *List of mosses to be published in*

ATMOS. In: Ochyra R. & Szmajda P. (eds.). *Atlas of the geographical distribution of mosses in Poland*. 8: 9-14.

Pawłowski B. 1956: *Flora Tatr. Rośliny naczyniowe*. [*Flora Tatrorum. Plantae Vasculares*.] Tom 1. Warszawa, PWN. 672 pp.

Pelsma T.A.H.M. 1989: CLUTER. *Adviesgroep Vegetatiebeheer*, Wageningen.

Pelsma T.A.H.M. & Zee F.F. van der. 1992: *CLUTAB a FORTRAN program to create synoptic tables*. Department of Vegetation Science, Agricultural University. Wageningen.

Podpěra J. 1954: *Conspectus muscorum europaeorum*. Česk. Akad. Věd. Praha. 697 pp.

Pot R. 1991: *INTAKE a PASCAL program to enter data in computer memory*. Adviesgroep Vegetatiebeheer. Wageningen.

Rejment-Grochowska I. 1966: *Flora Polska, Wątrobowce (Hepaticae)* [*„Polish flora, the spore plants of Poland and the adjacent areas*"], 1. 258 pp. Państ. Wyd. Nauk., Warszawa (in Polish).

Rothmaler W. 1976: *Excursionsflora für die Gebiete der DDR und der BRD*, Volk und Wissen Volkseigener Verlag Berlin. 816 pp.

Rutkowski L. 1998: *Klucz do oznaczania roślin naczyniowych Polski niżowej*. [*„Keys to determination plants of Poland*"], PWN. Warszawa, 812 pp.

Rutkowski L., Ratyńska H., Szwed W. 1994: *Rośliny naczyniowe. Listy taksonów roślin Polski przeznaczone do tworzenia geobotanicznych baz danych*. in: Hennekens S. 1991-1994 Turboveg (versie 9.23). IBN Wageningen.

Schaffers A. 1991: *DENDRO a dendrogram generator*. Department of Vegatation Science, Agricultural University. Wageningen

Schljakov R. N. 1976-1982: *Pechenochnye mchi severa SSSR* [*„The liverworts of the north of the USSR*"] 1. 90 pp. (1976); 2. 191 pp. (1979); 3. 188 pp. (1980); 4. 221 pp (1981); 5. 195 pp.(1982). Izdatel'stwvo „Nauka", Leningradskoye Otdelenye, Leningrad (in Russian).

Schuster R. M. 1966 - 1992: *The Hepaticae and Anthocerotae of North America east of hundredth meridian*. 1: xvii + 802 pp. (1966); 2: xii + 1062 pp. (1969); 3: xiv + 880 pp. (1974); 4. xviii + 1334 pp. (1980), Columbia University Press, New York; 5. xvii + 854 pp. (1992a); 6. vii + 937 pp. (1992b), Field Museum of Natural History, Chicago.

Smith A.J.E. 1978: *The moss flora of Britain and Ireland*. 707 pp. Cambridge University Press, Cambridge.

Starmach K. 1989: *Plankton roślinny wód słodkich. Metody badań i klucze do oznaczania gatunkówwystępujących w wodach Europy Środkowej*. [*„Plankton of fresh water. Methods of investigation and keys to determination the species occurring in the waters of Middle-Europa*"]. PWN. Warszawa - Kraków, 496 pp. (in Polish).

Szafer W., Kulczyński S., Pawłowski B. 1967: *Rośliny polskie. Opisy i klucze do oznaczania wszystkich gatunków roślin naczyniowych rosnących w Polsce bądź dziko, bądź też zdziczałych lub częściej hodowanych*. [*„Polish plants. Descriptions and keys to determination of all species of the wild, naturalised and often cultivated vascular plants in Poland*"]. xxviii + 1024. PWN Warszawa (in Polish).

Szafran B. 1957-1961: *Mchy (Musci)* [*„Mosses (Musci)*"] - In: *Flora Polska, rośliny zarodnikowe Polski i ziem ościennych* [*„Polish flora, the spore plants of Poland and* *the adjacent areas*"]. 1. 229 pp. (1957); 2. 407 pp. (1961), PWN, Warszawa (in Polish).

Szańkowski M. 1994: *Glony. Listy taksonów roślin Polski przeznaczone do tworzenia geobotanicznych baz danych.* in: Hennekens S. 1991-1994 Turboveg (versie 9.07). IBN Wageningen.

Szweykowski J. 1958: *Prodromus Florae Hepaticarum Poloniae*. PWN pp. 596+map. (in Polish).

Szweykowski J. & Koźlicka M. 1974: *Liverworts (Hepaticae), List of liverworts wchich will be edited in the Atlas*. - In: J. Szwejkowski & T. Wojterski (eds.), *Atlas of geographical distribution of spore plants in Poland*. Series IV.8: 3-4. Komitet Botaniczny & Instytut Botaniki Polskiej Akademii Nauk, Warszawa-Poznań (in Polish and English).

Szweykowski J., Rusińska A. & Szwed W. 1994: *Wątrobowce. Listy taksonów roślin Polski przeznaczone do tworzenia geobotanicznych baz danych.* in: Hennekens S. 1991--1994 Turboveg (versie 9.23). IBN Wageningen.

Tongeren O.F.R. van 1989: *CEDIT a FORTRAN program to edit sparse multivariate data*. Limnological Institute, Nieuwersluis.

Tutin T. G., Heywood V. H., Burges N. A., Moore D. M., Valentine D. H., Walters S. M. & Webb D. A. (eds.). 1964 - 1980: *Flora Europaea*. Vol. 1-5. 1. xxxii + 464 pp (1964); 2. xxvii + 455 pp. (1968); 3. xxix + 370 pp. (1972); 4. xxix + 505 pp. (1976); 5. xxxvi + 452 pp. (1980). Cambridge University Press, Cambridge.

Zee F. van der. 1991: *ORDIPLOT-PC versie en eitbreiding*. LU Wageningen. Vakgroep VPO. Wageningen.

Zee F. van der & Pelsma T.A.H.M. 1992: *ELLEN a FORTRAN program for the calculation of spectra and weighed averages for relévés*, Department of Vegetation Science, Agricultural University, Wageningen.

Streszczenie

Intensywny rozwój ekologii roślin, gromadzenie coraz to większej ilości informacji, danych ekologicznych, a przy tym coraz szersze stosowanie metod numerycznych powoduje wzrastające zainteresowanie wykorzystaniem współczesnych osiągnięć informatyki. Programy numeryczne służą do gromadzenia, przechowywania, selekcjonowania i analizy zdjęć fitosocjologicznych. Aktualnym problemem stało się w ostatnim czasie stworzenie narzędzia do tych celów - opracowanie krajowej listy taksonów flory polskiej wraz z synonimami oraz unikalnymi kodami i numerami.

W niniejszej pracy omawiane są „listy" oraz wybrane programy służące do wpisywania, przechowywania, selekcjonowania (TURBOVEG, INTAKE / =OPNAME/, CEDIT), porządkowania i analizy (TWINSPAN, CANOCO, DECORANA, DENDRO, CLUTER, CLUTAB, ELLEN, ORDIPLOT) zdjęć fitosocjologicznych, a także materiałów florystycznych oraz, w dalszej przyszłości, geokompleksów. Przedstawiono sposób konstruowania „list" oraz źródła taksonomiczne.