Additions to chromosome numbers of Polish Angiosperms (Fifth contribution)

by

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In the present paper we give a further contribution to the knowledge of the chromosome numbers of Polish Angiosperms. As previously, the plant material studied in the course of this work originated exclusively from natural habitats. The determination of the chromosome numbers was based chiefly on the study of root-tip mitoses.

DICOTYLEDONS

Caryophyllaceae

Dianthus L. ($x=15$). Studied by M. Skalińska.

Dianthus glacialis Haenke ($2n=30$).

This oreophytic species of the eastern Alps occurs also at higher altitudes in the Tatra Mts. Hitherto this evidently old species has been studied in respect of its chromosome number only from the western part of its area of distribution. Rohweder (1934) was the first to establish its chromosome number ($2n=30$) on plants collected in the locus classicus for this species: Carinthia, near the Glockner glacier. Carolin (1957) confirmed recently this number on plants from the Alps. In addition, Gentscheff (1937) studied specimens from botanical gardens and stated also the diploid number. The same result has been obtained in the course of the present work (Fig. 1). The plant material originated from the Western Tatra; it has been collected on rocks in the glacial cirque "Piekło" (c. 1600 m.a.s.l.) on the south-eastern slope of Giewont (zone of *Pinus montana*) and on a limestone rock, pass Małolacka (c. 1930 m.a.s.l., alpine zone). The available data concerning the cytology of this species suggest that it is uniform in respect of its chromosome number within its area of distribution.

Honckenya Ehrh. ($x=17$). Studied by M. Piotrowicz.

Honckenya peploides (L.) Ehrh. ($2n=68$).

This species is rather common on sand dunes of the Baltic coast. The plant material for the present study originated from sand dunes of the

Hel peninsula (Jastarnia, Kuźnice, N. lat. $54^{\circ}45'$, E. long. $18^{\circ}20'$) and from Mikoszewo at the estuary of river Vistula, near Gdańsk.

The chromosome number $2n=68$ (Fig. 2) established in the course of the present study agrees with that reported by Malling (1957) for plants from Denmark, Germany, Greenland and Alaska. Contrary to some previous reports, this author regards *Honckenya peploides* as a species which is karyologically uniform. The present result gives a further support to his opinion.

Arenaria L. ($x=10$). Studied by M. Skalińska.

Arenaria ciliata L. ssp. *tenella* Br. Bl. ($2n=40$).

The study of this species in the Tatra Mts has been undertaken in view of the highly interesting results obtained recently by Favarger (1960), as well as Duckert and Favarger (1960) on plants from the Alps. According to the results of their studies, *Arenaria ciliata* ssp. *moeringioides* Murr seems to be karyologically uniform, with the tetraploid chromosome number ($2n=40$). On the other hand, in ssp. *tenella* (Kit.) Br. Bl. the authors revealed an interesting differentiation in respect of the chromosome numbers of its various biotypes: octoploids, dodecaploids and also the still higher 24-ploid number have been found in the course of their study. The first of the two subspecies is well distributed in the western Alps in the north and southern parts, whereas ssp. *tenella* occurs more eastwards in the central part. It is considered as an eastern race.

In agreement with the regional differentiation occurring within this species, the representatives of *A. ciliata* in the Tatra Mts belong exclusively to ssp. *tenella* (Pawłowski 1956). This oreophytic subspecies is rather common in the Western Tatra on limestone; its vertical distribution extends to 2460 m a.s.l. It occurs in cracks of rocks, on scree and

Figs 1—3. Root-tip metaphases: 1 — *Dianthus glacialis* ($\times 5000$); 2 — *Honckenya peploides* ($\times 3700$); 3 — *Arenaria ciliata*, ssp. *tenella* ($\times 5000$).

in open places with low vegetation. Of the specimens collected for the present study reliable results have been obtained hitherto only for plants from three habitats. They originated from the south-eastern slope of Giewont, near the glacial cirque "Piekło" (c. 1600 m a.s.l., zone of *Pinus montana*), and were collected on rocks scattered in a mountain meadow. Two further habitats are: valley Jaworzynka, the stony bed of the torrent (c. 950 m), and a slope above the pass Między Kopami (c. 1500 m). In these plants the tetraploid chromosome number ($2n=40$, Fig. 3) could be established with certainty. This number is lower than that found in the biotypes from the Swiss Alps. The study will be continued on a larger plant material from a variety of habitats in the Tatra Mts. Our first result, however, seems to be particularly interesting, since it is in good accordance with the concept of eastern origin of the ssp. *tenella*. This subspecies could have persisted the glaciations in an eastern refuge and subsequently could have increased its degree of polyploidy in its advance to the west.

It is interesting to note that, according to Graebner, representatives of this subspecies which occur in the Austrian Alps, have notably larger flowers than those from the Tatra Mts, a detail suggesting the possibility of a higher degree of polyploidy.

Ranunculaceae

Ranunculus L. ($x=7,8$). Studied by R. Izmailow and A. Jan kun.

Ranunculus cassubicus L. ($2n=32,40,44,48$).

Studies in Polish biotypes of *Ranunculus cassubicus* were started by Kalita (in Skalińska *et al.* 1961) who revealed the occurrence of a karyological differentiation within this apomictic collective species. Of the various forms described by Jasiewicz (1956) only ssp. *marginicolus* and ssp. *Pawłowskii* have been studied by her. Therefore it was advisable to continue this investigation on biotypes from various parts of Poland. The material for the present study was collected in 12 natural habitats (Table 1); it comprised plants belonging to 7 subspecies from southern Poland described (as species) by Jasiewicz; they were collected in the localities where from the specimens of Jasiewicz originated. In addition, some other representatives of this collective species, not involved in the taxonomical study of this author, were investigated. The latter plants did not correspond exactly with any of the forms described and named by Jasiewicz.

Like in the course of the study of Kalita, a considerable karyological differentiation could be stated in the biotypes investigated by us. According to the results of Häfliger (1943), Rutishauser (1954) and Rousi (1956), in Switzerland and Finland the strictly tetraploid

Table 1

<i>R. cassubicus</i> coll.	2n	Locality and habitats	N. lat.	E. long.
Subspecies				
Undefined	32	primeval forest of Białowieża (Querceto — Carpinetum)	52°44'	23°53'
<i>digitatifolius</i>	32	near Tunel (Querceto — Carpinetum)	50°26'	19°59'
<i>Hannae</i>	40	near Tunel (Querceto — Carpinetum)	50°26'	19°59'
<i>kalinensis</i>	32	near Kalina (Querceto — Carpinetum)	50°23'	20°9'
Undefined	40	near Kalina (Querceto — Carpinetum)	50°23'	20°9'
<i>Szaferi</i>	32	near Klonów (Querceto — Carpinetum)	50°20'	20°11'
Undefined	32	Budy Głogowskie near Rzeszów (Querceto — Carpinetum)	50°11'	21°54'
Undefined	40	Jurassic Valley Kluczowa (Querceto — Carpinetum)	50°5'	19°50'
Form near to <i>Pawłowski</i>	32, 40	the forest Las Wolski near Cracow	50°4'	19°52'
<i>Żmudae</i>	32	Grodkowice (Szarów) border of the primeval forest of Niepołomice (Cariceto elongatae — Alnetum glutinosae)	50°1'	20°17'
<i>niepołomicensis</i>	40	Grodkowice (Szarów) border of the primeval forest of Niepołomice (Cariceto elongatae — Alnetum glutinosae)	50°1'	20°17'
Undefined	32	Krasiczyn near Przemyśl	49°47'	22°40'
Undefined	44	scrub near Maków Podhalański	49°44'	19°41'
Undefined	48	Pieniny range — scrub near Niedzica (c. 500 m. o.s.l.)	49°25'	20°18'
Undefined	48	Tatraska Lomnica — in a wood (c. 1350 m. o.s.l.)	49°10'	20°18'

type with $2n = 32$ is the most common, whereas higher numbers seem to occur only rarely within the apomictic complex *Ranunculus auricomus-cassubicus*. The pentaploid number ($2n = 40$) was found by Häfliger in *R. stricticaulis* and by Rousi in *R. cassubicus* ssp. *dispar*, while the hexaploid number ($2n = 48$) has been reported by Häfliger for *R. Allemanii*. On the other hand, the present study led to reveal

Figs 4—6. Root-tip metaphases: 4 — *Ranunculus cassubicus*, pentaploid type; 5 — *Ranunculus cassubicus*, hexaploid type ($\times 3200$); 6 — *Adonis vernalis* ($\times 2600$).

in the Polish biotypes a relatively higher frequency of pentaploids and hexaploids. Our results are compiled on Table 1. In addition to the most common tetraploids, the pentaploids have been found in five localities (ssp. *Hannae*, ssp. *niepolomicensis*, as well as some undefined forms) (Fig. 4). In two mountain habitats in the south: Niedzica in the range of Pieniny and Tatranska Lomnica in the Slovakian Tatra (coll. Dr. Z. Radwańska-Paryska), only hexaploids were detected (Fig. 5). It should be added that not all populations studied proved to be uniform in respect of their chromosome numbers; in some habitats tetraploids and pentaploids were found growing side by side. In addition to the strictly euploid numbers, also the aneuploid number 44 which has been reported for plants from several localities by Kalita (1961), has been found by us once in plants from Maków Podhalański.

A detailed account of the results obtained will be published in due time.

Adonis L. ($x = 8$). Studied by H. Jaworska*.

Adonis vernalis L. ($2n = 16$).

Adonis vernalis belongs to the Pontic element of the Polish flora. It is a rare species occurring in western and southern Poland in dispersed habitats with steppe vegetation. It grows on sunny grassy limestone slopes together with some other xerothermic species.

The first study of the chromosome number of *Adonis vernalis* was done by Langlet (1927, 1932) who reported $2n = 16$ for plants of unknown origin. This number was confirmed by Turesson (1938);

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this author studied a large plant material originating from various parts of the vast geographic area of this species: Öland (Sweden) and Munich in Europe, as well as Omsk in Siberia; the above specimens proved to be uniform in respect of their chromosome number. The same number has been found also in the course of the present study dealing with root-tip mitoses of plants collected in natural habitats in Płutowo nr Chełmno on Vistula and in Nakło.

The chromosomes of *Adonis vernalis* are large; their length ranges from $4.6\ \mu$ to $8.8\ \mu$. One pair of long chromosomes with trabants could be observed (Fig. 6).

It has been already emphasized by Turesson (1938) that *Adonis vernalis* like numerous other Linnean species, shows a remarkable stability in respect of chromosome number within its vast area of distribution.

Cruciferae

Draba L. ($x = 8$). Studied by M. Skalińska

Draba aizoides L. ($2n = 16$).

This collective species which belongs to the European mountain element of the Polish flora, is represented in the Tatra Mts by a number of minor forms; the most frequent there seems to be *D. aizoides* var. *carpatica* Deg. (syn. ssp. *Zmudae* Zap.). In other mountain ranges of Europe this species is differentiated, likewise, into some distinct varieties. Some of them, native in the Alps and the Jura Mts, have been recently studied by Duckert and Favarger (1960). These authors found invariably the diploid chromosome number ($2n = 16$) both in *D. aizoides typica* and in var. *montana* Koch, var. *microcarpa* Schulz and var. *minor* D. C. (*alpina* Koch). The same number has been stated for plants of var. *carpatica* from the Western Tatra studied in the course of the present work. Our plants were collected on the south-eastern slope of Giewont (c. 1600 m a.s.l.) where they were found in cracks of rocks. Mitoses were rather scarce in the tiny rootlets developed by adult plants brought from the natural habitat to the laboratory; however the metaphase plates were remarkably well spaced (Fig. 7). The chromosomes are small. With the exception of one larger pair the length of which attains $2.2\ \mu$ their length ranges from 1.2 to $1.5\ \mu$. A similar length differentiation occurs also in the taxa studied by Duckert and Favarger.

As pointed out by the Swiss authors, *Draba aizoides* should be regarded as a very old species of the European mountains. Its diploid chromosome number is in favour of this opinion. The occurrence in the Tatra Mts of a similar evidently old diploid type has been established in the course of the present study.

Thlaspi L. ($x=7$). Studied by H. Jaworska.

Thlaspi arvense L. ($2n=14$).

A common field weed, chiefly in the plain, growing also in ruderal places. The plants for the present study were collected in Toruń and in Piłtowo nr Chełmno on Vistula.

In accordance with previous results of Manton (1932), Jaretsky (1932), Vaarama (1943), Löve and Löve (1944), Heiser and

Figs. 7—9. Root-tip metaphases: 7— *Draba aizoides*, var. *carpatica* ($\times 5000$); 8 — *Thlaspi arvense* ($\times 4160$); 9 — *Sarothamnus scoparius* ($\times 4600$).

Whitaker (1948) in the Polish material also the chromosome number $2n=14$ has been found. The chromosomes are small and they show only slight length differences within the somatic plate (Fig. 8).

Saxifragaceae

Saxifraga L. Studied by M. Skalińska.

Saxifraga perdurans Kit. ($2n=66$).

This endemic oreophytic species is limited to the Western Carpathians. In Poland it occurs exclusively in the Tatra Mts, being frequent chiefly in higher mountain habitats (zone of *Pinus montana* and alpine zone).

Saxifraga perdurans is a representative of the section *Dactyloides* Tausch. Most taxonomists assign it to the group *Axilliflorae* Willk. together with *S. ajugifolia* Lap., another endemic species occurring only in Pyrenees. Recently however, S. Pawłowska (1953) expressed the opinion that *S. perdurans* should be treated within the section rather as a representative of a separate monotypic group, called by her *Perdurantes*, in view of notable differences concerning the structure of glandular hairs born on vegetative parts. Already Engler (1916) regarded *S. ajugifolia* and *S. perdurans* as old tertiary species. The isolated taxonomic position of *S. perdurans* favours the assumption that it represents a paleo-endemic species.

The chromosome number of this species was not studied hitherto. It has been established on root-top mitoses of plants originating from the slopes of Małolączniak in the massif of Czerwone Wierchy at the altitude of c. 1800 m (coll. Dr Z. Radwańska-Paryska). The species pro-

ved to be a hexaploid with $2n=66$ (basic number 11). It is interesting to note that the same number ($n=33$) has been found by Skovsted (1934) for *S. ajugifolia* L. p. The rather high polyploid number found in this paleo-endemic species is in sharp contrast with that of numerous diploid old species frequently occurring in the Tatra Mts (e.g. *Draba aizoides*, *Dianthus glacialis*). It is well known, however, that some paleo-endemic species could have attained a high degree of polyploidy. According to Favarger (1961) such paleo-polyploids belong to very ancient groups which have accomplished already their cytological differentiation. In the Polish flora, *Chrysanthemum Zawadzki*, var. *pieninicum* is likewise such an old endemic hexaploid ($2n=54$, Piotrowicz, in Skalińska et al., 1959) which should be also regarded as a paleo-polyploid.

Papilionaceae

Sarothamnus Wimm. ($x=12$). Studied by J. Małecka.

Sarothamnus scoparius (L.) Wimm. ($2n=46$).

This species is common over all Poland, both in the plain and in hilly regions. It is particularly frequent on sunny slopes along the Baltic coast.

Cytological studies of this species were performed by Tschchow (1931, cited from Tischler 1950), de Castro (1949), Morton (1955) and some other authors; they reported the number $2n=48$. Morton whose investigations dealt with plants of British origin, found in addition to the tetraploid number also the diploid number $2n=24$ for the ssp. *prostratus*.

On the other hand Maude (1940) found only 46 chromosomes. Böcher and Larsen who gave first (1955) the number 48, corrected two years later their previous report. On the basis of a renewed study of an extensive plant material from various parts of the European continent, they confirmed the number 46 previously established by Maude. According to the Danish authors plants with 48 chromosomes represent primary tetraploids which are probably not common; the secondary tetraploids with 46 chromosomes possess one pair with large trabants which may be easily mistaken for two small chromosomes.

In view of this, it seemed interesting to investigate the chromosome number of plants from Polish populations. The material for this study originated from five well separated habitats: Baltic coast — Reda and Swarzewo; south-eastern Poland: Tomaszów Lubelski; south-western Poland: Żarnowiec; Western Carpathians near Babia Góra. It should be added that the plants collected in two habitats situated along the Baltic coast correspond in their morphological features with the ssp. *maritimus*, according to Hegi (Vol. IV). The results of the present investigation are in accordance with those reported by Böcher and Larsen. In

the metaphase plates of all plants studied 46 chromosomes were counted and one pair of chromosomes with large trabants could be invariably observed (Fig. 9). This suggests that in Poland the species is represented by the secondary tetraploids found by Böcher and Larsen in other parts of the European continent.

Umbelliferae

Eryngium L. ($x=7, 8$). Studied by H. Jaworska.

Eryngium campestre L. ($2n=14$).

This species has its main area of distribution in central and southern Europe. In Poland it occurs chiefly in the south in the lowland, but it is found also, as introduced, in some northern localities. The plants were collected in Owczary nr Busk (a meadow near salty springs) and at the estuary of river Vistula, nr Gdańsk, on a railway track (coll. mgr Z. Schwarz). *E. campestre* is one of the few species with the basic number 7, the number 8 being more frequent within this genus. The chromosome number $2n=14$ found in the plants studied (Fig. 10) agrees with the results of Tamamschjan (1933) who was the first to investigate this species. It should be added, however, that some further studies have revealed the occurrence of a polyploid differentiation: tetraploids with 28 chromosomes were found by Gardé and Malheiros-Gardé (1949) in Portugal and Spain, and by Pólya (1950) in Hungary. In addition to these data which concern plants from the south, also Reese (1953) reported the occurrence of tetraploids near the northern limit of the area of distribution of this species (near Cuxhaven). According to Håkansson (1953) who studied chromosome numbers in the *Umbelliferae*, polyploidy is rare in this family and *Eryngium* belongs to the few genera where it seems to be rather frequent.

Eryngium planum L. ($2n=16$).

A rather common species in the Polish plain, except the south-west. The plants were collected near Toruń, Piwnice, Rzęczkowo nr Rypin (coll. mgr T. Korniak), Inowrocław, Ciechocinek, Płutowo nr Chełmno on Vistula, Kozienice. According to the results of previous studies (Wan-

Figs 10—12. Root-tip metaphases: 10 — *Eryngium campestre*; 11 — *E. planum*; 12 — *E. maritimum* ($\times 4160$).

scher, 1932, cit. from Tischler 1950, Tamamschjan 1933, Gardé and Malheiros-Gardé, 1949), this species seems to be uniform in respect of its chromosome number. All the above authors reported only the number $2n=16$, and the same result has been obtained in the course of the present study (Fig. 11).

Eryngium maritimum L. ($2n=16$).

In Poland this is a characteristic representative of the flora of sand-dunes along the Baltic coast. The material was collected in the form of seeds from the Hel peninsula near Jastarnia (coll. M. Skalińska) and from Górkki Wschodnie nr Gdańsk.

In previous studies the chromosome number $2n=16$ has been invariably found in various parts of the large area of distribution of this species. It has been reported by Wulff (1937), Bowden (1945), Malheiros-Gardé and Gardé (1951), as well as by Larsen (1956) for plants from Montpellier and from Coimbra and Tarnavski (1948, cit. from Löve and Löve 1956) for plants from Romania. The same number has been found also in plants investigated in the course of the present study (Fig. 12).

Primulaceae

Lysimachia L. ($x=9$). Studied by R. Czapiński.

Lysimachia nummularia L. ($2n=36$).

Lysimachia nemorum L. ($2n=18$).

Lysimachia nummularia is a common species in the lowland of Poland as well as in lower mountain habitats. It occurs in damp places: in scrubs and meadows, in ditches and at water borders. *L. nemorum* grows in similar ecological conditions, especially in damp woods and scrubs, but it is rare in the lowland and more common in lower mountain habitats.

The studied plants originated from the following habitats: *L. nummularia* (five habitats): Baltic coast, Wiselka on the isle of Wolin (scrub); Kołobrzeg (scrub). Central Poland: Lubiaszów nr Piotrków Trybunalski (border of a wood). Eastern Poland, Dorohuczka (a meadow at the river Wieprz). Southern Poland: Przegorzały nr Cracow (scrub).

L. nemorum (three habitats): Western Sudetic Mts, Świeradów (border of a stream in a wood). Western Carpathians (Beskid Śląski), Wisła (scrub). Central Carpathians (Beskid Niski), Krynica (wood).

The two species have the same basic number $x=9$, but they differ in respect of the degree of ploidy as well as of the chromosome size (Figs 13, 14). *L. nummularia* is tetraploid. Its chromosomes are smaller than those of *L. nemorum* which is diploid. The number of chromosomes of the Polish specimens agrees with the results of Wulff (1938) who also emphasized the difference of the chromosome size between the two species.

Rubiaceae

Sherardia L. ($x=11$). Studied by M. Piotrowicz.

Sherardia arvensis L. ($2n=22$).

This annual species is the only representative of the monotypic genus *Sherardia*. It grows chiefly as a weed in corn fields. According to Hegi (Vol. VI), it is a species of Mediterranean origin which spread afterwards over various parts of the world.

The chromosome number $2n=22$ has been already determined on plants from various parts of the unusually wide area of distribution of this species; in the north from Scandinavia (Fagerlind 1934, 1937) and from Iceland (Löve and Löve 1956), and in the south from California (Heiser and Whitaker 1948) as well as from northern Sahara (Reese 1957). Data from France (Poucqes 1949) and from Germany (Hömeier 1933, 1936) are also available.

The same diploid number (Fig. 15) has been confirmed also on plants originating from two habitats in Poland: Zubrzyca near Babia Góra (Western Carpathians) and Kudowa (Sudetic Mts).

It is interesting to note that this cosmopolitan species is karyologically perfectly uniform within its vast area of distribution. Already Tureson (1938) has emphasized the occurrence of constant chromosome numbers in numerous Linnean species with a large geographic area, e.g. *Adonis vernalis*, *Lamium album*. *Sherardia arvensis* is a further example of such a behaviour. Its karyological uniformity is the more interesting, as it contrasts sharply with the related genus *Galium*, some species of which show a distinct differentiation in respect of the degree of polyploidy in connection with ecological conditions.

Asperula L. ($x=11$). Studied by M. Piotrowicz.

Asperula cynanchica ($2n=44$).

In Poland this species occurs in the south and south-west, chiefly in the plain and on dry hills. The material for the present study originated from a habitat north of Cracow, Plateau of Little Poland, near Klonów. All plants proved to be tetraploid ($2n=44$) (Fig. 16), in agreement with the results of Hömeier (1932, 1936) and Fagerlind (1934, 1937); the same number has been found also by Baksay (1957) for *A. montana* W. et K. (*Asperula cynanchica* L. p.p.).

Galium L. ($x=11, 12$). Studied by M. Piotrowicz.

Galium anisophyllum Vill. ($2n=44$).

In our previous studies on this species (Piotrowicz 1958, Skalińska, Czapik, Piotrowicz et al., 1959) the somatic number 44 has been reported for plants from the Western Carpathians, the Tatra Mts and the range of Pieniny. In view of the complex differentiation of

this species found by Ehrendorfer (1949, 1955, 1956, 1958) in his extensive studies concerning the Sect. *Leptogalium*, it was advisable to investigate specimens from some new habitats. In the course of the present work plants from the following habitats were studied: Kuźnice nr Zakopane (coll. M. Skalińska), as well as six well separated habitats in the Central Carpathians (Beskid Niski, Mymoń, near Besko). The plants from the latter habitats were kindly put at our disposal by Dr. I. Kucowa who has studied the taxonomy and morphology of Polish representatives of the Sect. *Leptogalium* (1962). The material studied, however, proved to be cytologically uniform; in accordance with our previous results all plants studied were tetraploid ($2n=44$). Thus, this renewed study failed to reveal any karyological differentiation in Polish representatives of this species.

Galium hercynicum Weig. (*G. saxatile* L.) ($2n=44$).

This subatlantic species occurs in western, northern and central Europe. In Poland, according to the recent report of Kucowa (1962) it is found only in the range of Karkonosze in the Sudetic Mts, in the Pomeranian and Masovian lake district, as well as in one isolated centre far more eastwards in the forest of Mielnik on river Bug (district of Biała Podlaska, N. lat. c. $52^{\circ} 20'$, E. long. c. $23^{\circ} 5'$).

The plant material for the present study was collected in the Pomeranian lake district (Sianowa Huta, near Kartuzy, Smolne Błota; N. lat. $54^{\circ} 23'$, E. long. $18^{\circ} 11'$). The tetraploid number ($2n=44$, Fig. 17) agrees with the previous results of Fagerlind (1937) and of Ehrendorfer (1956).

Galium rotundifolium L. ($2n=22$).

In a previous paper (Piotrowicz, 1958) the diploid chromosome number has been reported for this species. It should be added that *G. rotundifolium* has been studied cytologically hitherto only on plants from Poland. The report of Tischler (1950) who quotes the number $2n=44$ as found by Fagerlind, is erroneous. The present results supplement our previous study; they concern plants from new habitats, partially in other parts of Poland: Western Carpathians, valley Dolina Białej Wisłki (coll. R. Czapik); Zubrzyca Górna, on the slopes of Babia Góra; slopes of Mt. Tarasówka over Bukowina Tatrzańska, 1000—1100 m a.s.l. (coll. M. Skalińska and I. Kucowa); western Poland: Foreland of the Sudetic Mts, peak of the hill Radunia; central Poland: Promno near Poznań. In accordance with our previous results, all plants from the above habitats were diploid.

Galium valdepilosum H. Braun ($2n=22$, 44).

In our previous paper (Skalińska, Piotrowicz, Sokołowska-Kulczycka et al., 1961) the diploid number $2n=22$ has been

Figs 13—19. Root-tip metaphases: 13 — *Lysimachia nemorum*; 14 — *L. nummularia* ($\times 2800$); 15 — *Sherardia arvensis* ($\times 3700$); 16 — *Asperula cynanchica* ($\times 3700$); 17 — *Galium hercynicum* ($\times 3700$); 18 — *G. valdepilosum* ($\times 3700$); 19 — *Linnaea borealis* ($\times 4000$).

reported by the author for plants originating from the Plateau of Little Poland.

In addition to the habitats mentioned previously, a new centre of occurrence of this species in Poland has been discovered recently by prof. J. Małdański in south-western Poland in the foreland of the Sudetic Mts; the plants grew on serpentine ground. Subsequently a taxonomical investigation has been performed by this author in collaboration with Dr I. Kucowa (Kucowa and Małdański 1963). The plant material for the present cytological study has been collected in this new habitat by I. Kucowa, J. Małdański and M. Piotrowicz. It originated from seven well separate stands situated at various altitudes

on the slopes of the hill Radunia, as well as near its top (573 m. a.s.l.). The chromosome number of these plants proved to be different than that found in the course of our previous work; the latter are diploid ($2n=22$) while in all plants from the new habitats the tetraploid chromosome number was invariably found (Fig. 18).

Already Ehrendorfer (1956) has revealed the occurrence of two cytotypes in specimens of *Galium valdepilosum* originating from Lower Austria, Moravia and Bohemia, as well as from Upper Austria to eastern Bavaria. The present study supplements our previous report and corroborates the results of this author.

Caprifoliaceae

Linnaea L. ($x=8$). Studied by R. Czapik.

Linnaea borealis L. ($2n=32$).

Linnaea borealis which belongs to the boreal elements of the European flora has a discontinuous area of distribution with a main centre in the north and dispersed isolated stands in central Europe. In Poland this rare species occurs in the north, in the central part of the country as well as in the Tatra Mts in spruce, pine and fir forests, in the alliance *Vaccinio-Piceion* (Pawłowski, in Szafer 1959).

The chromosome number $2n=32$ (Fig. 19) was established for three specimens collected in a forest at Rogów near Łódź (c. $51^{\circ} 50' N$. Lat.). This result agrees with the data previously obtained for plants originating from the northern part of the area of distribution of this species: by Löve and Löve (1944) for plants collected at Abisko and Ehrendberg (1945) for plants from southern Sweden. The same number has been reported also by Hagerup (1944) for *L. americana* Forbes considered by some taxonomists as a subspecies of *L. borealis* (ssp. *americana* (Forbes) (Hultén).

The present study brings a confirmation of the above results on plants from the southern part of the area of distribution of this species.

Dipsacaceae

Dipsacus L. ($x=8, 9$). Studied by H. Jaworska.

Dipsacus silvester Huds. ($2n=18$).

This species is well distributed over nearly all Europe, in the Caucasus, in Persia as well as in North Africa and the Canary Islands. In Poland it is a common plant which grows on road sides, scrubs and banks of rivers. The plants for the present study originated from the following habitats: Toruń, Ciechocinek, Płutowo near Chełmno on Vistula and Owczary near Busk.

According to the available data, two different chromosome numbers have been reported for this species. In a detailed study dealing with

the karyology of the *Dipsacaceae* Kachidze (1929) has found in *D. silvester* $2n=18$; this number has been confirmed by Sugiyura (1942, cit. from Tischler 1950). These results are in accordance with those obtained in the course of the present study. On the other hand, Poucques (1949) reported for this species (as well as for *D. laciniatus*) the number 16. This suggests that in the genus *Dipsacus* there are two basic numbers 8 and 9.

Within the somatic plate some length differences may be observed in the chromosomes. One pair of chromosomes with trabants could be found.

Gentianaceae

Gentiana L. Studied by M. Skalińska.

Gentiana nivalis L. ($2n=14$).

According to Hultén (1950) this annual species has an amphiatlantic, arctic-montane area of distribution. In Europe it occurs in two centres, the first in the north and the second in the mountains of central Europe. Chromosome counts of this species have been performed already on plant material originating from these different geographic regions; the first record was given by Favarger (1949, 1952) who found the number $2n=14$ in plants from two localities in the Swiss Alps. Knaben (1950, cited from D. Löve 1953) confirmed this number for plants from the Norwegian mountains while D. Löve (1953) found the same number in plants from Iceland.

In the course of the present study plants of *G. nivalis* from the Western Tatra have been investigated. They occur there on sunny limestone rocks and in dry mountain meadows, chiefly in the zone of *Pinus montana* and in the alpine zone. The plants investigated were found in the glacial cirque "Piekło" on the south-eastern slope of Giewont, on rocks (1600 m a.s.l.). Metaphase plates in the flower region were used for chromosome counts. In agreement with the previous results, the plants were diploid ($2n=14$).

Solanaceae

Solanum L. ($x=12$). Studied by K. Turała and K. Urbańska-Worytkiewicz.

Solanum nigrum L. ($2n=72$).

This species occurs over all Poland as a common ruderal plant. The somatic chromosome number $2n=72$ was established in plants from the vicinity of Bochnia. This number was confirmed also in meiosis of P.M.C.'s; 36 bivalents could be counted (Figs 20, 21).

Within the coll. species *Solanum nigrum* L. the occurrence of a karyological differentiation was reported by several authors (Nakamura

Figs 20—21. *Solanum nigrum*: 20 — I meiotic metaphase in a PMC; 21 — root-tip metaphase ($\times 3000$). Figs 22—25: root-tip metaphases: 22 — *Veronica alpina*; 23 — *V. aphylla*; 24, 25 — *V. beccabunga*, diploid and tetraploid type ($\times 3900$).

1935, Bhaduri 1935, cited from Magoon, Ramanujam and Cooper 1962). The resp. chromosome races showed $2n=24, 48, 72$ chromosomes. In view of these results as well as of those of Nakamura (1937), Magoon, Ramanujam and Cooper (1962) expressed the opinion that the diploid and tetraploid forms ought to be regarded as separate species, while the name *Solanum nigrum* L. should be retained for the hexaploid form only. This opinion seems to be the more justified as, according to numerous authors, in the European flora only the hexaploid type is represented. The chromosome number $2n=72$ found in the course of the present study agrees with the results obtained previously e.g. by Wulff (1950), Löve (1954) as well as Magoon, Ramanujam and Cooper (1962).

Scrophulariaceae

Veronica L. ($x=7, 8, 9$). Studied by A. Sokołowska-Kulczycka.

Veronica alpina L. ($2n=18$).

This eurasiatic arctic-montane species occurs in Poland in higher mountain habitats in the Tatra Mts and in the Sudetic Mts (range of Karkonosze). For the present study adult plants have been collected by M. Skalińska in two habitats in the Western Tatra: on rocks in the glacial cirque "Piekło" on the south-eastern slope of Giewont (c. 1600 m

a.s.l.) — zone of *Pinus montana*; and at the bottom of rocks of Ratusz near the path to Wielka Turnia (c. 1600 m a.s.l.) in the massif of Czerwone Wierchy. Plants from the High Tatra (slope of Rysy, c. 2000 m) were also studied. The plants were rooted in laboratory conditions. Their diploid number ($2n=18$, Fig. 22) agrees with the results of previous studies. It should be added, that representatives of this arctic-montane species were studied chiefly on plant material originating from its North-European centre of distribution: Greenland (Böcher 1938, Böcher and Larsen 1950, Jørgensen, Sørensen and Westergaard 1958); Iceland (Maude 1939, according to Favarger 1949, Löve and Löve 1956) and its var. *australis* from Sweden, Jämtland, was studied by Löve and Löve (1944). On the other hand, plants from Central Europe have been studied hitherto only from the Alps (Favarger 1949).

The present study adds further data concerning the chromosome number of this species in another part of its southern area, viz. in the Tatra Mts. The above results suggest that *V. alpina* is karyologically uniform over all its large area of distribution.

Veronica aphylla L. ($2n=18$)

The geographic distribution of *V. aphylla* is confined in Europe to the mountain ranges in the southern and central parts of the continent. In Poland its occurrence is limited to the Tatra Mts and the Western Carpathians (range of Babia Góra); it is found there chiefly in the zone of *Pinus montana* and in the alpine zone.

Plants for the present investigation were collected by M. Skalińska in the same two habitats as *V. alpina*. They proved to be, likewise, diploid with the same basic number ($2n=18$, Fig. 23). Prior to the present study *A. aphylla* has been investigated only by Brandt (1952, cited from Löve and Löve 1961) whose plant material originated from the Swiss Alps. The chromosome number obtained in the course of the present study is in accordance with the result of this author.

Veronica beccabunga L. ($2n=18, 36$).

A species widely distributed in Poland, both in the lowland and in the mountains, attaining in its vertical distribution the zone of *Pinus montana*. It occurs on borders of streams and ditches, frequently at least partially submerged. In previous studies, only the diploid number ($2n=18$) was found by several authors in representatives of this species originating from different geographic areas: by Huber (1927), and Schlenker (1937) (cited from Tischler 1950) presumably from Germany, by Simonet (1934) from France, by Ehrenberg (1945) from Scandinavia, by Mattick (in Tischler 1950) probably from the Tyrol.

The plant material for the present study has been collected in 19 habitats in southern and central Poland (Table 2). Some degree of karyological differentiation seems to occur in this species. In the majority of the habitats listed on the table, plants with the diploid chromosome number (Fig. 24) have been found, in accordance with the previous results. In two habitats, however, (Dolina Będkowska, a Jurassic valley north-east of Cracow, and Pychowice near Cracow) the occurrence of tetraploids with 36 chromosomes (Fig. 25) was stated.

Table 2

Habitats of *Veronica beccabunga*

Southern Poland

Surroundings of Cracow (Pleszów, Pychowice, Kostrze, Mydlniki-Wapiennik),
Janowice near Wieliczka,
Jurassic valleys: Dolina Będkowska and Dolina Raclawki,
Foreland of the Tatra Mts (Witów, Dzianisz, Bukowina Tatrzańska),
Tatra Mts. Valley Kościeliska,
Pieniny Mts, road from Folsztyn to Niedzica,
Western Carpathians: Zubrzyca Górna (2 habitats), Zubrzyca Dolna,

Central Poland

Lublin, Rury Jezuickie,
Lublin, border of river Bystrzyca,
Kobiela, near Piotrków Trybunalski.

Campanulaceae

Phyteuma L. ($x = ?$). Studied by M. Ochlewska.

Phyteuma belongs to genera the cytology of which is not yet adequately investigated. The available results suggest that several basic numbers occur within this genus.

In the flora of Poland only two species of this genus are known: *Ph. spicatum* L., a representative of the section *Spicata* (R. Schulz 1904) and *Ph. orbiculare* L. of the section *Capitata* (Schulz 1904).

Phyteuma orbiculare L. ($2n = 22$).

The distribution of this species in Poland is limited to the southern part of the country where it is common in the mountains, chiefly on limestone. The plant material for the present study has been collected in the range of Pieniny (ssp. *pratense* R. Schulz) and in the Western Tatra (ssp. *flexuosum* R. Schultz) in the following habitats: Valley Strążyska (c. 1000 m a.s.l.), slope of Krokiew (950 m a.s.l.), gorge "Kraków" on limestone rocks, glacial cirque "Piekło" in cracks of solid rocks (coll. M. Skalińska).

In all plants invariably the number $2n = 22$ could be found in well spaced root-tip metaphases. Two chromosomes with trabants could be observed (Fig. 26). It should be noted that this number is not in accordance with results published hitherto for this species: Mattick

(in Tischler 1950) found $n=12$ and Sugiura (cited from Tischler 1950) $2n=26$. The number $n=12$ (but occasionally also $2n=26$) has been reported by Baksay (1956) for plants from Hungary. Recently also Contandriopoulos (1962) has found the number $n=12$ and $2n=24$ in plants originating from various parts of the Alps and from the Swiss Jura. In view of these results, our observations were critically re-examined on a larger material comprising numerous metaphase plates; however, our previous counts could be confirmed for all plants studied. It should be added that the number $2n=22$ has been found in a single plant of *Ph. humile* by Contandriopoulos, while in other plants this author counted $2n=28$.

Phyteuma spicatum L. ($2n=22+0-3B$).

In Poland only *ssp. ochroleuca* occurs as a widely distributed plant in the plain; it is common in deciduous woods and in meadows, and is found also in the Carpathians, where it ascends to the altitude of 1300 m. The material for the present study consisted of 56 plants originating from 20 habitats: surroundings of Cracow; Plateau of Little Poland; Western Carpathians — range of Babia Góra; Tatra Mts; range of Pieniny; south-western Poland near Przemyśl; north-eastern Poland near Białowieża. The collected plants proved to be not quite uniform in respect of their chromosome numbers. In some plants in the root-tip mitoses the number comported $2n=22$ (Fig. 27), and two chromosomes with trabants could be discerned. In others, however, a frequent

Figs 26—30. Root-tip metaphases: 26 — *Phyteuma orbiculare*; 27—30. *Phyteuma spicatum*, plates with 22, 23, 24 and 25 chromosomes. ($\times 3200$).

deviation with an excess of one or two, in one case of three small chromosomes, was observed. Plants with two chromosomes in excess, thus with 24 chromosomes, were particularly numerous (29 out of 56 studied). However, $2n=22$ could be established with certainty in a number of plants, and within the tissues of the individual plants in all cases the chromosome numbers proved to be constant; in the somatic plates of plants with 23 and 24 chromosomes always one, resp. two smaller chromosomes could be discerned (Figs 28, 29); and the single plant with 25 chromosomes had in its plates three such small chromosomes (Fig. 30). In view of the above, the somatic chromosome number of *Phyteuma spicatum*, ssp. *ochroleuca* should be probably estimated as $2n=22$ (thus the same as in the Polish biotypes of *Ph. orbiculare*), with a frequent occurrence of plants with accessory chromosomes.

Previous studies in the chromosome number of *Ph. spicatum* are very scarce. The number $n=18$ reported for this species by Armand (1912) has not been confirmed by any other author. Recently Contandriopoulos (1962) who studied this species on plants from the Swiss Jura and H-te Savoie, found the number $n=12$ and $2n=24$. It should be noted, however, that in the somatic metaphase reproduced by this author (Fig. 11, p. 267) not 24, but only 23 chromosomes are seen; one (top right) which is somewhat smaller, may represent an accessory occurring in addition to the normal set of 22 chromosomes.

Compositae

Galinsoga Ruiz. et Pav. ($x=8$). Studied by H. Jaworska.

Galinsoga parviflora Cav. ($2n=16$).

Galinsoga quadriradiata Ruiz. et Pav. ($2n=32$).

Of the above two species introduced to Europe from South America, *G. parviflora* is widely spread in Poland, as an aggressive weed. On the other hand, *G. quadriradiata* appeared in Poland rather recently. According to Majdecka-Zdziarska (1929 cited from Kornaś 1949/50) this species was found in Poland in 1926 only in three regions: near Warsaw, Płock and Puławy. Since that time it extended considerably its area of distribution; it appeared in the surroundings of Cracow about 1940 (Kornaś 1949/50). It is, however, rarer than *G. parviflora*.

The plant material of *G. parviflora* originated from the following ten localities: Toruń and Piwnice near Toruń, Bydgoszcz, Inowrocław, Kórnik near Poznań, Kielce, Owczary near Busk, Kozienice, Dębiany near Rypin (coll. mgr T. Korniak), Grzybek near Świecie (coll. Prof. J. Zabłocki).

The chromosome number of this species has been established first by Covas and Schnack (1946, cited from Löve and Löve

1961), on plants from Argentina, then by Pólya (1950) on Hungarian plants and by Haskell and Marks (1952) on British material. All these authors have reported the diploid number $2n=16$. The same number has been found in the course of the present study (Fig. 31). In view of the above results, the number $n=18$ quoted by Tischler (1950) according to M. Navashin (in litt.) 1926 seems to be erroneous.

Figs 31—35. Root-tip metaphases: 31 — *Gallinsoga parviflora*. 32 — *G. quadriradiata* ($\times 4160$); 33 — *Achillea millefolium* ssp. *sudetica* ($\times 2800$); 34 — *Cichorium intybus* ($\times 4160$); 35 — *Leontodon hispidus*, var. *glabratus* ($\times 3000$).

The length of the chromosomes of *G. parviflora* ranges from 2 to $c. 3\mu$; like in the British material of Haskell and Marks, one pair of chromosomes with trabants could be observed.

Gallinsoga quadriradiata Ruiz et Pav. (*G. hispida* Benth., *G. quadriradiata* ssp. *hispida* (DC) Thellung, *G. ciliata* (Raf.) Blake).

The plant material of this species originated from three localities in northern and western Poland: Gdańsk-Wrzeszcz, Toruń and Poznań.

Prior to our study, this species was investigated by Haskell and Marks (1952) as well as by Reese (1952). The British authors reported the tetraploid chromosome number ($2n=32$) and the same number has been found in the course of the present study (Fig. 32). On the other hand, Reese reported the number $n=18$ and $2n=36$ for plants from Kiel. Therefore the possibility of an intraspecific

differentiation connected with a difference in the basic chromosome number should be taken into consideration.

Achillea L. ($x=9$). Studied by R. Czapik.

Achillea millefolium ssp. *sudetica* (Opiz) Weiss. ($2n=54$).

The initial plant material, in the form of seeds, originated from the pass Czerwona Glinka, foot-hills of the Belan Tatra (c. 1350 m a.s.l.). The plants grew in a glade in a mixed wood, on limestone. The seeds were collected in this habitat by Dr Z. Radwańska-Paryska, and young plants germinated in the experimental garden of the Scientific Station of Tatra, Zakopane, were kindly put by her at our disposal.

The hexaploid chromosome number ($2n=54$) (Fig. 33) was established from the study of root-tip mitoses of these plants, in accordance with the results of Ehrendorfer (in Janchen 1958, cited from Löve and Löve 1961).

Chrysanthemum L. ($x=9$). Studied by E. Gacek.

Chrysanthemum leucanthemum L. ($2n=18, 36, 54$).

The author's first report (in Skalińska *et al.* 1961) concerned the karyological differentiation of this collective species in connection with ecology and geographic distribution. Further studies have confirmed the occurrence of the hexaploid type which has been found again in some new habitats at lower elevations in the Western Tatra, as well as on slopes of the foot hills of the main range, over Bukowina Tatrzńska. In addition, a new centre of the rare diploid type, represented by ssp. *alpicola* has been detected in the Tatra Mts at a higher altitude (1750 m) on the Pass pod Kopą, zone of *Pinus montana* (coll. Dr K. Szczepanek). The morphology of these plants is similar to that of the specimens found previously in the Western Carpathians (Babia Góra); they seem to correspond with the plants from mountain habitats in Switzerland assigned by Favarger (1959) to ssp. *alpicola*. The study of herbarium specimens of plants from higher altitudes in the Tatra Mts and the estimation of their pollen size suggests, likewise, the occurrence of diploids in some other high-mountain habitats. The study is being continued.

Cichorium L. ($x=9$). Studied by H. Jaworska.

Cichorium intybus L. ($2n=18$).

This is a perennial species widely distributed in Poland along road sides, on pastures, both in the plain and in lower mountain habitats.

The chromosome number of this species $2n=18$ has been established first by Makovetsky (1929, in Tischler 1950) for plants of unknown origin, and later by Heiser and Whitaker (1948) in their studies on Californian weeds. The same number was found in the

plant material from Poland. It originated from the following habitats: Toruń, Bydgoszcz, Inowrocław, Płutowo near Chełmno on Vistula, Owczary near Busk, Kozienice, Nakło, Poznań, Wrocław, Warsaw, Gdańsk-Wrzeszcz.

The chromosomes in the somatic plates show some differences in respect of their length (from 2 to 3.6μ). One pair with trabants could be observed (Fig. 34).

It should be added that Stebbins, Jenkins and Walters (1953) who investigated the phylogeny of the tribe *Cichorieae*, consider the basic number 9 as the original number in this group, in view of the fact that it occurs in apparently primitive members of this tribe. A phylogenetical decrease in the basic number which occurred repeatedly in other genera of this tribe, gave rise to the numbers 8, 7 and others.

Leontodon L. ($x=4, 5, 6, 7$). Studied by M. Skalińska.

Leontodon hispidus L. var. *glabratus* (Koch) Bischoff (= *L. hastilis* L.) ($2n=14$).

This variety is in Poland notably rarer than the forma *typica* which is a very common plant. The material originated from the High Tatra; the plants grew among rock debris on a south-eastern slope over the lake Morskie Oko (c. 1450 m a.s.l.).

The chromosome complement of *L. hispidus* f. *typica* has been studied by Bergman (1935) who established the somatic numbers of several species of the genus. According to this author, *L. hispidus* has 14 chromosomes which show differences in respect of their length. Three size-classes: large, medium and small chromosomes, have been discerned. In var. *glabratus* from the High Tatra the chromosome number is the same ($2n=14$) and a differentiation of their length has been likewise observed. In the chromosome set chromosomes with subterminal centromeres prevail; their shorter arm is reduced to a small head. The largest two pairs are c. 5 and 4.5μ long; the length of the medium chromosomes (4 pairs) ranges from 2.5 to 3.5μ , while the smallest pair attains the length of 2μ . Thus, the size-classes seem to be less sharply delimited than in f. *typica*, according to Bergman. Two pairs of medium chromosomes of unequal size bear trabants on their shorter arm (Fig. 35).

Scorzonera L. ($x=6, 7$). Studied by H. Jaworska.

Scorzonera hispanica L. ($2n=14$).

In Poland this species is extremely rare in natural habitats; most frequently the resp. plants are garden escapes. The plants for the present study were collected near Solec Kujawski. Their chromosome number $2n=14$ agrees with the results of Poddubnaja-Arnoldi, Steschina and Sosnovetz (1935). Recently Sosnovetz (1960)

reported the occurrence of two chromosome numbers ($2n=14$ and 28) in cultivated forms of *Scorzonera hispanica* from western Europe and in wild plants from southern Russia and Ukraine; it is, however, not clear from this short report whether the tetraploid number is confined to cultivated forms or occurs likewise in plants from natural habitats.

Within the somatic set of *S. hispanica* some differences in the length of the chromosomes which ranges from 4.3 to 6μ could be observed.

MONOCOTYLEDONS

Liliaceae

Anthericum L. ($x=8$). Studied by H. J a w o r s k a.

Anthericum ramosum L. ($2n=32$).

In Poland this species is rather common chiefly in the plain, in meadows and light woods. The plants studied were collected in Płutowo near Chełmno on Vistula and in Nakło.

Figs 36—38. Root-tip metaphases: 36 — *Anthericum ramosum* ($\times 4160$); 37 — *Lilium bulbiferum* ($\times 3000$); 38 — *Gladiolus imbricatus* ($\times 5000$).

The chromosome number of this species has been studied hitherto only on meioses. Two Swedish authors: Stenar (1828) and Elvers (1932) have established the haploid number $n=16$. Recently Baksay (1956) confirmed this number for specimens from Hungary. In accordance with the above results, in root-tip metaphases 32 chromosomes were counted in the course of the present study. The chromosomes show some degree of differentiation in respect of length. Two pairs with trabants could be observed (Fig. 36).

Lilium L. ($x=12$). Studied by A. Sokołowska-Kulczycka.
Lilium bulbiferum L. ($2n=24$).

This species has in Poland only two centres of occurrence: in Lower Silesia where it is rather rare and around the village Witów at the foot hills of the Tatra Mts. It grows in meadows, on wood borders and in fields, as a weed.

Flower buds and root tips were fixed for the present cytological investigation in the natural habitat of this species near the hamlet Dzianisz in the vicinity of Witów. The chromosome number $2n=24$ (Fig. 37) has been confirmed also on meioses in PMC's ($n=12$). This number has been established for the first time by Strasburger (1888, cited from Löve and Löve 1961).

As it is well known, *Lilium bulbiferum* reproduces by means of bulbils formed in the axils of leaves. Plants belonging to the population studied by us seem to be unable of seed formation, both in their natural habitat and after transplanting into the experimental garden.

Iridaceae

Gladiolus L. ($x=15$). Studied by M. Skalińska.
Gladiolus imbricatus L. ($2n=60$).

A common species occurring both in the lowland and in lower mountain habitats in meadows and fields.

Cytological studies on this species are scanty. The only chromosome number reported hitherto $2n=14$ was given by Sokolovskaya and Strelkova (1948, cited from Löve and Löve 1961, where this number is quoted with a point of interrogation). As a matter of fact, this number disagrees with the results of most authors who studied various species and commercial varieties of *Gladiolus*. According to Bamford (1936) the basic chromosome number of this genus is 15; most species of Cape and Tropical Africa are diploid ($2n=30$) whereas the few species of Europe and of western Asia investigated by this

author have notably higher numbers (e.g. *G. byzantinus* Mill. $2n=90$, *G. segetum* Ker. $2n=120$).

In the light of these results, a re-examination of the chromosome number of *Gladiolus imbricatus* seemed advisable. The plant material for the present study has been collected in spring 1961 in a meadow on the hill Antałówka near Zakopane where plants of this species grow abundantly. The fixation of the root tips proved to be remarkably good; the tetraploid chromosome number ($2n=60$) (Fig. 38) could be established with certainty in numerous metaphase plates with well spaced chromosomes. On the whole, the morphology of the rather small chromosomes agrees fairly well with the drawings in Bamford's paper.

Gramineae

Calamagrostis Adans. ($x=7$).

Ammophila Host. ($x=7$). Studied by E. Kubień.

This is a continuation of the investigation started by A. Szwabowicz (1957 in Skalińska et al.) on *Ammophila baltica* Link which is considered as an intergeneric hybrid between *Calamagrostis epigeios* and *Ammophila arenaria*.

Westergaard (1943) distinguished within *A. baltica* three varieties, on the basis of morphological, anatomical and karyological criteria:

- A. baltica* var. *subarenaria* — $2n=42$,
- var. *intermedia* — $2n=28$,
- var. *epigeoidea* — $2n=42$.

In the Polish material, however, Szwabowicz found only the following chromosomic types:

- Calamagrostis epigeios* — $2n=56$,
- Ammophila arenaria* — $2n=28$,
- Ammophila baltica* — $2n=42$.

The present investigation has been carried out on a more extensive plant material collected in six habitats along the Baltic coast; four in the region of Gdańsk, one on the Hel peninsula and one more westwards, between Jastrzębia Góra and Karwia. In accordance with the previous results of A. Szwabowicz, in the course of the present study the occurrence of the three chromosomic types found by her could be stated in most habitats. In addition, however, other notably rarer chromosomic types were found, namely: *C. epigeios* $2n=28$, and *A. baltica*, var. *intermedia* (acc. to Westergaard's classification) $2n=28$ and c. 28.

Morphological and anatomical studies were carried out in the course of this work to supplement the cytological results. They permit to identify the type of *A. baltica* with 28 chromosomes as var. *intermedia*, and the type with 42 chromosomes (found previously also by Szwabowicz) as var. *subarenaria*. On the other hand, var. *epigeoidea* which has, likewise, 42 chromosomes, could not be detected in the material studied. According to the opinion of Westergaard however, this is the rarest type in Denmark. Further studies are in progress.

SUMMARY

The present paper gives chromosome numbers of 42 species of Polish Angiosperms. Most of our results are in accordance with the results of previous investigations done on plants from other geographic areas. Some new numbers have been also obtained.

The following results concerning species from the Tatra Mts are of interest:

1. Some ancient oreophytic species proved to be diploid: *Dianthus glacialis* ($2n = 30$), *Draba aizoides*, var. *carpatica* ($2n = 16$), *Gentiana nivalis* ($2n = 14$), *Veronica alpina* ($2n = 18$), *Veronica aphylla* ($2n = 18$), *Chrysanthemum leucanthemum* ssp. *alpicola* ($2n = 18$).

2. In *Arenaria ciliata* ssp. *tenella* a lower chromosomic type ($2n = 40$) thus, apparently more ancient than those occurring in the Alps (cf. Favarger 1960) has been found.

3. For *Saxifraga perdurans*, an ancient oreophytic endemic species, the chromosome number $2n = 66$ has been established. This species should be regarded as a paleo-polyploid.

In addition, in some of the species studied the occurrence of a karyological differentiation has been stated: *Galium valdepiosum* ($2n = 44$ in addition to 22); *Veronica beccabunga* ($2n = 36$ in addition to 18); in *Ranunculus cassubicus* two chromosomic types new for Poland have been found in the course of the present study: $2n = 40$ and 48, in addition to 32 and 44, reported by us previously (1961).

Some of our results differ from those of previous authors: for *Phyteuma orbiculare* the number $2n = 22$ (not 24), and for *Ph. spicatum* $2n = 22 + 0 - 3B$ (not 24) has been found.

For *Gladiolus imbricatus* the number $2n = 60$ which is in accordance with the basic number 15 of the genus, has been stated. The only available record for this species, $2n = 14$, seems to be erroneous.

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Dalsze badania nad kariologią roślin okrytonasiennych flory polskiej

Streszczenie

Praca niniejsza jest kontynuacją zespołowych badań Katedry Anatomii i Cytologii Roślin Uniwersytetu Jagiellońskiego. Podajemy w niej liczby chromosomów 42 gatunków roślin okrytonasiennych. Najważniejsze wyniki dotyczą flory Tatr: liczne stare oreofity (*Dianthus glacialis*, *Draba aizoides*, var. *carpatica*, *Gentiana nivalis*, *Veronica alpina*, *V. aphylla*, *Chrysanthemum laucanthemum* ssp. *alpicola*) są

diploidami; *Arenaria ciliata* ssp. *tenella*, która w Alpach jest wysokim poliploidem, reprezentowana jest w Tatrach przez niższy, a zatem starszy filogenetycznie typ chromosomowy: endemiczny trzeciorzędowy gatunek *Saxifraga perdurans*, który w ogóle nie był dotąd badany, okazał się wysokim poliploidem; jest to tzw. paleo-poliploid.

Ponadto w obrębie pewnych gatunków zostało wykryte w toku niniejszych badań zróżnicowanie kariologiczne (*Galium valdepilosum*, *Veronica beccabunga*). U *Ranunculus cassubicus* znaleziono oprócz podanych poprzednio typów o 32 i 44 chromosomach, dwa dalsze typy o 40 i 48 chromosomach. Dla niektórych gatunków (np. *Gladiolus imbricatus*) została skorygowana podawana poprzednio liczba chromosomów.