Further additions to chromosome numbers of Polish Angiosperms

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The present paper gives further additions to the knowledge of the chromosome numbers of Polish Angiosperms, carried out by the research workers of the Institute of Plant Anatomy and Cytology, University of Krakow. The plant material for our studies has been collected only in natural habitats. Like in our previous work (1950, 1957, 1959) the determination of the chromosome numbers was based chiefly on the study of root-tip mitoses.

DICOTYLEDONS

Ranunculaceae

Clematis L. ($x=8$). Studied by A. Sokołowska-Kulczycka.
Clematis alpina (L.) Mill. ($2n=16$).

This species occurs in Poland chiefly in lower mountain habitats in woods and in scrubs. It is particularly frequent in the Tatra Mts. Plants for the present study have been collected by Dr. Z. Radwańska-Paryska in the valley of the lake Morskie Oko. The chromosome number $2n=16$ agrees with the results of previous investigations (Sakai 1935, Meurman and Therman 1939, Gregory 1941, as well as Mattick, in Tischler 1950).

Details of the chromosome morphology of several other species of the genus *Clematis* have been studied by Meurman and Therman; according to the present results, the chromosome set of *C. alpina* seems to be similar to that of *C. viticella* analysed by these authors. It consists of five pairs of large chromosomes with a median or submedian centromere (corresponding to the chromosomes A, B, C, D, E of Meurman and Therman), one pair of large chromosomes with a subterminal centromere (chromosomes F), one pair of large chromosomes with trabants (chromosomes G) and one pair of small chromosomes with a terminal centromere (chromosomes H). In *C. alpina* trabants could be observed only in the chromosomes G (Fig. 1).

Ranunculus L. ($x = 7, 8$).

Ranunculus polyanthemus L. ($2n = 16$). Studied by M. Skalińska.

A species occurring in Poland both in the lowland and in lower mountain habitats, at wood borders, in meadows as well as on dry slopes. The plants for the present study have been collected on sunny hills in Grzybów, near Krakow and in damp meadows near Mokrzyska (N. lat. $50^{\circ} 2'$, E. long. $20^{\circ} 38'$). The number $2n = 16$ agrees with the results of Larter (1932), of Mattick (in Tischler 1950) and of Reese (1953), whereas Felföldy (1947 cited from Tischler 1950) reported the number $2n = 14$.

Ranunculus oreophilus M. B. ($2n = 16$). Studied by A. Sokołowska-Kulczycka.

This is an oreophytic species which in Poland is limited to the Carpathian range where it occurs in mountain meadows and on limestone

Fig. 1—3. Root-tip metaphases: 1 — *Clematis alpina* ($2n = 16$); 2 — *Ranunculus oreophilus* ($2n = 16$); 3 — *Ranunculus sceleratus* ($2n = 32$) ($\times 3500$)

rocks. The plant material for the present study has been collected in the Tatra Mts by Dr. Z. Radwańska-Paryska. The chromosome number of this species which is related to *R. montanus* L. has not been reported hitherto. It should be added that the specific name of *R. oreophilus* has been given by various authors as a synonyme of several different species (cf. Gregory 1941); none of these species however does correspond with the specimens from the Tatra Mts studied in the course

of the present study. The plants investigated were diploid ($2n=16$). (Fig. 2).

Ranunculus sceleratus L. ($2n=32$). Studied by A. Sokołowska-Kulczycka.

This species is common in Poland both in the plain and in lower mountain habitats; it occurs in swamps and on water borders. Plants for the present study originated from two habitats in south-eastern Poland near Lublin, bank of the river Bystrzyca (N. lat. $51^{\circ}20'$, E. long. $22^{\circ}35'$) and bank of the canal joining the rivers Wieprz and Krzna (N. lat. $51^{\circ}45'$, E. long. $22^{\circ}30'$). The tetraploid chromosome number (Fig. 3) agrees with that reported previously by Langlet (1936), Gregory (1941), Felföldy (1947) and by other authors. The chromosomes of this species are notably smaller than those of other *Ranunculus*-species.

Ranunculus auricomus L. ($2n=32$). Studied by A. Kleczkowska.

Ranunculus cassubicus L. ($2n=24, 32, 44, 64$). Studied by J. Kalita.

The huge apomictic complex *Ranunculus auricomus-cassubicus* is split up into a great number of constant biotypes (microspecies) occurring in various parts of its large area of distribution. Some taxonomists give to the various forms the rank of species (W. Koch), while others regard them as subspecies (Marklund) or agamospecies (Gustafsson). In our study we follow Marklund's taxonomical treatment.

The morphological differentiation within this apomictic complex in Poland has been studied by Jasiewicz (1956) who described 11 forms as separate species. Two belong to *R. auricomus* and 9 to *R. cassubicus*. The karyological studies started in the course of the present work deal with a total of 22 populations of *R. auricomus*; 15 could be assigned to *ssp. binatus* (*R. binatus* Kit. em. Jas.) and comprised 7 lowland populations as well as 8 populations from lower mountain habitats; *ssp. subatriticus* (*R. subatriticus* Jas.) was represented by 7 populations originating from lower mountain habitats in the Tatra Mts (940 to 1250 m o.s.l.). All plants studied were tetraploid ($2n=32$) (Fig. 4).

R. cassubicus has been studied on plants belonging to 27 separate populations from southern and central Poland. 13 populations contained forms similar to the *ssp. marginicolus* (*R. marginicolus* Jas.) and 8 could be identified as *ssp. Pawlowskii* (*R. Pawlowskii* Jas.); on the other hand, the remaining six populations could not be assigned with certainty to any of the forms described by Jasiewicz. Contrasting with *R. auricomus* which in Poland seems to be uniform in respect of the chromosome number, *R. cassubicus* shows a remarkable karyological differentiation. The most frequent type occurring here is also the tetraploid; *ssp. Pawlowskii* as well as most undefined populations seem to consist only of tetraploids.

Fig. 4—7. Root-tip metaphases: 4 — *Ranunculus auricomus* ssp. *binatus* ($2n = 32$); 5—7. *Ranunculus cassubicus*, biotypes near to ssp. *marginicolus*; 5 — a triploid biotype ($2n = 24$); 6 — a tetraploid biotype ($2n = 32$), 7 — an aneuploid biotype ($2n = 44$) ($\times 2500$)

On the other hand, in biotypes near to ssp. *marginicolus* several chromosomic types could be found, sometimes in the same population: besides the tetraploids also plants with the aneuploid number $2n = 44$ have been found repeatedly (Figs 6, 7). It should be added that this type has been detected also in some of the populations which could not be assigned to any of the forms described by Jasiewicz. Other cytotypes occurring among biotypes near to ssp. *marginicolus* seem to represent very rare exceptions: in one habitat a single octoploid ($2n = 64$) as well as a triploid plant ($2n = 24$) growing in close neighbourhood of the tetraploid and the aneuploid were found (Fig. 5).

The occurrence of the aneuploid type is the more interesting, as in studies of previous authors dealing with the cytology of the *Ranunculus auricomus-cassubicus* complex only strictly euploid numbers have been reported. Rutishauser (1954) has found exclusively tetraploids in the Swiss populations. In addition, occasionally pentaploids with 40 somatic chromosomes and hexaploids with 48 chromosomes have been found by Häfliger (1943) in Switzerland and by Rousi (1956) in Finland.

Another unexpected type, the origin of which is difficult to elucidate is represented by the single triploid plant. On the other hand, the octoploid which has been found also only once, might have arisen spontaneously in the way of chromosome doubling in some vegetative parts of a plant; this higher degree of polyploidy could have been fixed subsequently by apomixis.

In view of the results obtained, the study is being continued.

Rosaceae

Comarum L. ($x = 7$). Studied by A. Sokołowska-Kulczycka.
Comarum palustre L. ($2n = 42$).

This species which has a wide general area of distribution, is rather frequent in Poland in the plain but is relatively rare in lower mountain habitats. It grows on moist ground in peat-moors and at borders of stagnant waters. The plant material for the present study has been collected in the following six habitats: Jastrzębia Góra, Baltic coast (N. lat. $54^{\circ}45'$, E. long. $18^{\circ}20'$), coll. Dr. E. Pogan; swampy ground at the border of the lake Wygoda, south of Wejherowo, Pomeranian Lake district (N. lat. $54^{\circ}32'$, E. long. $18^{\circ}15'$) coll. Prof. M. Skalińska; border of the

Fig. 8—13. Root-tip metaphases: 8 — *Comarum palustre* ($2n = 42$) ($\times 3500$); 9 — *Cakile maritima* ($2n = 18$); 10 — *Spergularia salina* ($2n = 36$) ($\times 3700$); 11 — *Salicornia herbacea* ($2n = 18$); 12 — *Hottonia palustris* ($2n = 20$); 13 — *Samolus Valerandi* ($2n = 26$) ($\times 3600$)

lake Podkówka, near Olsztyn, Masovian lake district (N. lat. $53^{\circ}45'$, E. long. $20^{\circ}30'$) coll. Dr. E. Pogan; borders of the lakes Czarne and Białe in the Lublin lake district (N. lat. $51^{\circ}20'$, E. long. $23^{\circ}30'$); swampy ground in the vicinity of Wieluń (N. lat. $51^{\circ}15'$, E. long. $18^{\circ}45'$).

In all the above habitats exclusively plants with the hexaploid chromosome number ($2n=42$) have been found (Fig. 8). It should be emphasized that previous investigations in this species revealed the occurrence of a polyploid differentiation: the lowest number corresponding with the tetraploid type ($2n=28$) has been reported from Germany (Wulff 1937), from Scandinavia (Ehrenberg 1945) as well as from Iceland (Löve a. Löve 1956); the occurrence of hexaploids has been reported from SW-Greenland by Jørgensen, Sørensen and Westergaard (1958) and by Sokolovskaja and Strelkova (1941) from the district of Leningrad; the latter authors have found in addition biotypes with a still higher number, viz. $2n=64$, in the arctic (isle of Kolguyev).

Papilionaceae

Lathyrus L. ($x=7$). Studied by M. Piotrowicz.

Lathyrus maritimus (L.) Big. ($2n=14$).

A common species occurring on sand dunes of the Baltic coast. The plants studied originated from two habitats on the Hel peninsula (Jastarnia and Kuźnica). Their chromosome number $2n=14$ agrees with that reported by Senn (1938) and by other authors, e.g. by Wulff (1950).

Cruciferae

Cakile Mill. ($x=9$). Studied by M. Piotrowicz.

Cakile maritima Scop. ($2n=18$).

This species occurs in Poland only at the Baltic coast on sandy soil. The specimens for the present study originated from the Hel peninsula (Jastarnia, Kuźnica). The number $2n=18$ (Fig. 9) agrees with that previously reported by Jaretsky (1932), by Manton (1932) and other authors.

Caryophyllaceae

Spergularia Presl. ($x=9$). Studied by M. Piotrowicz.

Spergularia salina Presl. ($2n=36$).

In Poland this halophytic species is a rather common component of the flora of salines in various parts of the country. The specimens studied have been collected in salt marshes along the Baltic coast (Wielka Wieś

and Swarzewo). The tetraploid number ($2n=36$) (Fig. 10) is in accordance with the results of previous authors quoted by Tischler (1950).

Chenopodiaceae

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

Salicornia herbacea L. (*S. europaea* L.). ($2n=18$).

This halophytic species is the only representative of the genus in the flora of Poland. It occurs in salt marshes along the Baltic coast as well as in inland salines. The plants for the present study originated from the inland salines in central Poland (Ciechocinek and Inowrocław, south of Toruń); they have been collected on banks of a ditch and in meadows overflowed by water from salt-works; in these habitats they occur together with some other halophytic species.

In all plants from the above habitats the number $2n=18$ could be established. One pair of chromosomes bears trabants (Fig. 11).

According to results of previous studies *S. herbacea* shows some degree of intraspecific karyological differentiation. Tarnavski (1938) reported likewise $2n=18$ for specimens from Rumania, whereas Wulff (1937a) found in plants from Schleswig-Holstein a higher number ($2n=38$) considered by him as hypertetraploid. On the other hand König (1939, cited from Tischler 1950) has found two different types, the diploid as well as the tetraploid one ($2n=36$). In view of this differentiation, further studies of specimens from the salines along the Baltic coast should supplement the present results.

Umbelliferae

Hydrocotyle L. ($x=12$). Studied by A. Sokołowska-Kulczycka.

Hydrocotyle vulgaris L. ($2n=c. 96$).

This species which is rare in Poland occurs in peat-bogs and swamps chiefly in the western part of the country, while more eastwards it is found only in dispersed habitats. The plants for the present study originated from the south-eastern part of Poland in the Lublin lake district (N. lat. $51^{\circ}20'$, E. long. $23^{\circ}30'$), a large area with many lakes and an abundant watering of the soil.

The chromosome number of this species was estimated previously by Wanscher (1932, 1933, cited from Tischler 1950) as $2n=c. 96$, and the same result has been obtained by Håkansson (1953) and by

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Löve and Löve (1956). In view of this high number of chromosomes and their approximately uniform size, it proved difficult also in the course of the present study to obtain more exact results; the chromosome number of the Polish plants however seems to correspond with that found by Wanscher and by Håkansson.

Primulaceae

Hottonia L. ($x=10$). Studied by A. Sokołowska-Kulczycka.

Hottonia palustris L. ($2n=20$).

This species is widely distributed in Poland in stagnant waters. The plants for the present study originated from two habitats in the north of Poland: in peat moors Błota Bielańskie near Puck (coll. Dr. E. Pogan) and Błota Karwińskie (coll. J. Małecka).

The chromosome number $2n=20$ (Fig. 12) agrees with that previously reported by Wulff (1938) and by Ehrenberg (1945).

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

Glaux maritima L. ($2n=30$).

This halophytic species is very common in Poland in salt marshes along the Baltic coast; it occurs also in inland salines. The plants for the present study have been collected in three habitats: in salt marshes at the Baltic coast in Wielka Wieś near the bay of Puck; on the Hel peninsula near Jastarnia; and near Swarzewo, somewhat farther from the coast.

The chromosome number $2n=30$ agrees with that previously reported by Wulff (1937) for plants from Schleswig-Holstein and by Tarnavski (1938) from Rumania, as well as by Löve and Löve (1956) from Iceland.

Samolus L. ($x=13$). Studied by M. Skalińska.

Samolus Valerandi L. ($2n=26$).

In the flora of Poland *Samolus Valerandi* represents a very rare halophytic species, the occurrence of which is limited only to some isolated habitats at the Baltic coast in salt marshes; it appears also, as a rarity, in some inland salines. The plants for the present study have been collected in salt marshes near the Baltic coast in the vicinity of Wielka Wieś at the Bay of Puck, where they grow abundantly.

The chromosome number of this species has been studied first by Wulff (1937) who found $2n=c.24$. The same number has been reported recently by Larsen (1960) for representatives of this species from the Canary Islands. Some other authors however have determined the chromosome number of this species as $2n=26$ (Tarnavski 1948,

Rodrigues 1953). The same number has been found also for plants from Poland studied in the course of the present work. The chromosomes show distinct size differences. One pair of chromosomes bears trabants (Fig. 13).

Rubiaceae

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

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

This species occurs in central Europe in dispersed habitats from north-western Lower Austria to Moravia and Bohemia; and along the Danube through Upper Austria to eastern Bavaria (Ehrendorfer 1956). The studies of this author who regards it as an endemical subspecies (*ssp. valdepilosum*) revealed some degree of karyological differentiation in the above area: in Moravia and north-western Austria chiefly diploids were found by him, whereas in Bohemia and eastern Bavaria only tetraploid types seem to occur.

In Poland this species has been found on the Plateau of Little Poland where it occurs on sunny calcareous slopes in grassland among thermophilous plants. The material for the present study has been collected on hills near Miechów; Zarogów near Pojałowice (coll. B. Pawłowski) as well as in the steppe reservation Sterczów-Ścianka and on the slope of hill Grodzisko (coll. I. Kucowa). All plants investigated proved to be diploid ($2n=22$). This result is interesting in view of the details concerning the distribution of diploid biotypes of the *ssp. valdepilosum* reported by Ehrendorfer (l.c.).

Galium boreale L. ($2n=44, 55, 66$).

In a previous paper (Skalińska, Czapik, Piotrowicz 1959) the hexaploid number ($2n=66$) has been reported by the author for plants from two habitats in Poland. Further studies have revealed some degree of karyological differentiation within this species in Poland. In addition to that number, two other numbers, viz. $2n=44$ (Fig. 14) and $2n=55$ (Fig. 15) have been found.

Biotypes with $2n=44$ were found in Izabelin near Warsaw; they grew in wood clearings, whereas in rather shady habitats in the same wood biotypes with $2n=66$ have been found. The pentaploid type ($2n=55$) has been detected in Iznota, near Olsztyn, NE Poland (coll. K. Bijok) in a mixed population together with hexaploid plants.

The number $2n=44$ agrees with that previously reported from other areas of Europe by Fagerlind (1934, 1937), Poucques (1949), Böcher and Larsen (1950) as well as by Löve (1954) and by

Fig. 14—19. Root-tip metaphases: 14, 15 — *Galium boreale* ($2n = 44$ and 55); 16, 17 — *Galium palustre* ($2n = 24$ and 88) ($\times 3700$); 18 — *Lobelia Dortmanna* ($2n = 14$); 19 — *Centaurea montana* ssp. *mollis* ($2n = 44$) ($\times 3000$)

Löve and Löve 1954, 1956). On the other hand, the pentaploid number is given here for the first time.

It should be added that the occurrence in Europe of the hexaploid *G. boreale* has been queried by some authors. Therefore it seems important to note that this number ($2n = 66$) has been found again in the course of the present study in three new well separated habitats: central Poland near Warsaw, NE Poland near Olsztyn and N Poland at the Baltic coast near Karwia (N. lat. $54^{\circ}48'$, E. long. $18^{\circ}7'$). These data supplement our previous results (1959) based of the study of two habitats: N. Poland and S. Poland in the vicinity of Krakow. Thus, the hexaploid biotypes seem to be rather common in Poland.

Galium palustre L. ($2n = 24$, 88).

This species is common in all parts of Poland in damp meadows, in marshes and banks of ditches. In the course of the present study plants from seven habitats have been investigated. The results have shown the occurrence of two different chromosomic types. The first is represented by plants with the number $2n = 24$ (Fig. 16); they originated from

a single habitat near Jastarnia on the Hel peninsula. This chromosome number has been reported previously by Fagerlind (1934, 1937), Hagerup (1941), and by Hancock (1942, cited from Darlington and Wylie, 1955). The second chromosomic type was $2n = 88$ (Fig. 17). Plants belonging to the latter type have been collected in six habitats: near Karwia at the Baltic coast (three separate habitats), near Jastarnia on the Hel peninsula, Izabelin near Warsaw and Sosnowica near Lublin.

Previous studies in *G. palustre* led to establish a rather complex intraspecific karyological differentiation. The following numbers have been reported in addition to 24: $2n = 48$ (Fagerlind 1937, Hancock 1942), $2n = 66$ ($n = 33$, Homeyer 1936); for *var. elongatum* G. Beck $2n = 95?$ (Fagerlind 1934, 1937) $2n = 96$ (Hancock 1942); and for *var. aparinoides* $2n = c. 100$ (Fagerlind 1937). These cytotypes however have not been found in the course of the present study. On the other hand, the type with 88 somatic chromosomes has been detected for the first time in plants from natural habitats in Poland.

The available data concerning the karyological differentiation of *G. palustre* suggest the occurrence of two basic numbers, $x = 11$ and 12, within this species. In view of the present results a more detailed cytological study of this species in Poland has been undertaken.

Plantaginaceae

Plantago L. ($x = 6$) Studied by D. Czapska.

Plantago maritima L. ($2n = 12, 18$).

In Poland this species is confined only to salt marshes along the Baltic coast. The plant material for the present study has been collected in various natural habitats extending from the isles of Uznam and Wolin in the western parts of Pomerania along the Baltic coast — to the Bay of Puck.

The chromosome number of *P. maritima* has been studied hitherto on plants originating from various parts of its area of distribution. Previous counts were done by McCullagh on plants from NW Greenland (in Gregor, 1939), by Löve and Löve (1956) from Iceland, by Jørgensen, Sørensen and Westergaard (1958) for SW Greenland, by Wulff (1937) from Sylt and by Tarnavski (1938) from the Black Sea coast in Rumania. All these authors have reported exclusively the diploid chromosome number $2n = 12$. The majority of the plants studied in the course of the present work proved to be, likewise, diploid. In one habitat however, on the Hel peninsula in the vicinity of Jastarnia in a salt marsh at the border of the Bay of Puck, triploid plants

Fig. 20—23. Root-tip metaphases: 20,21 — *Plantago maritima* ($2n=12$ and 18) ($\times 2800$); 22 — *Tragopogon orientalis* ($2n=12$); 23 — *Tragopogon pratensis* ($2n=12$) ($\times 2880$)

with $2n=18$ could be found in two successive years (Fig. 20, 21). The occurrence of this chromosomal type is interesting in view of the ability of a vegetative propagation which may contribute to establish these rare triploids in their natural habitats. The study is being continued.

Lobeliaceae

Lobelia L. ($x=7$). Studied by M. Skalińska.

Lobelia Dortmanna L. ($2n=14$).

In Poland the occurrence of this amphiatlantic species is limited to the district of postglacial lakes in western Pomerania. It grows there abundantly in shallow oligotrophic waters. Plants for the present study originated from their native habitat in the lake Wygoda south of Wejherowo (N. lat. $54^{\circ}32'$, E. long. $18^{\circ}15'$); they were collected by Dr. K. Miąrowska and M. Skalińska.

The chromosome number $2n=14$ agrees with the recent reports of Reese (1952) and of Bowden (1958). Two chromosomes have distinct trabants (Fig. 18). According to Bowden, species of the genus *Lobelia* show a polyploid differentiation. In his studies dealing with the phylogeny of the genus this author expresses the opinion that *L. Dortmanna* belongs to the oldest species within this genus.

Compositae

Centaurea L. Studied by R. Czapik.

Centaurea montana L. ssp. *mollis* (W. et K.) Gugler ($2n=44$).

C. montana ssp. *mollis* occurs in lower as well as higher mountain habitats in the Carpathians. It grows on calcareous soil only, in scrubs on grassy slopes and at banks of streams. For the present study plants from three habitats have been collected by Dr. Z. Radwańska-Paryska on the slopes of Podskalki (c. 1200 m.o.s.l.) in the Bélian Tatra (CSR). Their somatic number $2n=44$ (Fig. 19) agrees with the results of Baksaý (1957) dealing with specimens from Hungary. This species belongs to the group of *Centaurea* species with the basic number $x=11$.

Tragopogon L. ($x=6$). Studied by H. Jaworska.

Tragopogon maior Jacq. (*T. dubius* Scop.) ($2n=12$).

A species occurring in southern and central Poland in rather dry habitats. The plant material for the present study has been collected by M. Skalińska near Warsaw on a dry grassy slope on the right bank of river Vistula. The chromosome number $2n=12$ agrees with that previously reported by Pólya (1950) for plants from Hungary, as well as by Mulligan (1957) for specimens from Canada.

Tragopogon pratensis L. ($2n=12$).

This species is widespread in Poland chiefly in the lowland in meadows and along roadsides; it occurs also in lower mountain habitats. Plants for the present study originated from two habitats in the vicinity of Warsaw: dry meadows on hills in Bielany, on the left bank of river Vistula, and a roadside along the right bank of Vistula.

The chromosome number $2n=12$ (Fig. 23) is in accordance with the results of Winge (1938) and of Wulff (1950), as well as those of Mulligan (1957) who studied this species in Canada.

Tragopogon orientalis L. ($2n=12$).

T. orientalis, regarded by some taxonomists as a subspecies of *T. pratensis*, occurs in Poland in the lowland in meadows and on roadsides while in the Carpathians it ascends to the zone of *Pinus montana*.

The plants for this study originated from two habitats: Starogród near Chełmno on Vistula (N. lat. $53^{\circ}20'$, E. long. $18^{\circ}30'$), roadside along fields, and Piwnice near Toruń.

The number $2n=12$ (Fig. 22) found in the plants studied is the same as that recently reported by Mulligan (1957).

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

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

According to the results obtained by Böcher and Larsen (1957), by Baksaý (1957) and by Favarger (1959), this species shows a well

marked karyological differentiation in connection with ecology and geographic distribution. The present study deals with 30 populations originating from various parts of Poland. The most frequent type is represented by tetraploids (24 populations) which are widespread over all Poland, both in the plain and in lower mountain habitats. On the other hand, diploid populations are notably rarer. They are represented by two different ecological types. The first has been found, in accordance with the report of Böcher and Larsen (1957), in the vicinity of Puszczykowo; they occur there very locally on a sunny slope of Osowa Góra. In addition, in the same region a second habitat has been found in Luboń near Poznań. This type seems to correspond with the *ssp. praecox* of Horvatič. Another diploid type quite different in respect of ecology has been detected in the range of Babia Góra (Western Carpathians) in two habitats at the altitude of c. 1500 m o.s.l. on stony slopes bearing only a very scanty vegetation. It represents the *ssp. alpicola*, recently studied by Favarger (1959) in mountain habitats in Switzerland. In addition, a third chromosomic type has been found hitherto only in four habitats in the Western Tatra at altitudes ranging from c. 950 to 1250 m o.s.l. The plants grew in mountain meadows and in pastures. Their chromosome number is c. 54, thus they correspond presumably with the hexaploid types reported by Baksay for the Tatra Mts of Slovakia and by Favarger from the Swiss Alps and the Jura Mts.

Further studies are in progress.

MONOCOTYLEDONS

Alismataceae

Alisma L. ($x=7$). Studied by E. Banach-Pogan.

Alisma plantago-aquatica L. ($2n=14$).

Alisma lanceolatum With. ($2n=26$).

Of the three representatives of the genus *Alisma* in the flora of Poland, viz. *A. plantago-aquatica*, *A. lanceolatum* and *A. gramineum* Gmel. the two former have been investigated in the course of the present study. *A. plantago-aquatica* is very common and occurs over all Poland; by contrast, *A. lanceolatum* is rather rare in our flora.

Plant specimens of *A. plantago-aquatica* were collected in 61 natural habitats distributed over the whole area from the Baltic coast to the foreland of the Tatra Mts. In 10 of these habitats *A. lanceolatum* occurred together with *A. plantago-aquatica*; the two species grew there in close neighbourhood, not unfrequently in the same tufts.

The genus *Alisma* shows some degree of karyological differentiation. Previous studies led to establish the following chromosome numbers: *Alisma plantago-aquatica*: $2n = 10$ (Wulff 1939); $2n = 12$ (Liehr 1916, Löve and Löve 1942, Palmgren 1943, Blomstrand, in Löve and Löve 1944); $2n = 14$ (Heppel, in Maude 1939, Blomstrand, in Löve and Löve 1944, Hagerup 1944, Erlandsson 1946, Löve and Löve 1948, Tschermak-Woess 1948, Pólya 1949, Wulff 1950, Holzer 1952, Löve 1954, Hendricks 1957); $2n = 16$ (Wulff 1950); $2n = 28$ (Wulff 1950).

Alisma lanceolatum: $2n = 26$ (Löve and Löve 1944, Tschermak-Woess 1948); $2n = 28$ (Hagerup 1944, Erlandsson 1946, Löve and Löve 1948).

In the course of the present investigation only one chromosome number was invariably found for each species in all specimens studied, namely $2n = 14$ for *A. plantago-aquatica* and $2n = 26$ for *A. lanceolatum*. Further studies, now in progress, will presumably throw light upon the type of karyological differentiation within this genus.

Butomaceae

Butomus L. ($x = 13$). Studied by M. Skalińska.

Butomus umbellatus L. ($2n = 26$).

This species which is a member of the swamp-flora, is rather common in the lowland of Poland where it grows particularly in shallow water near the borders of lakes and ponds. Plants for the present study originated from two habitats: in southern Poland — Jadowniki Mokre (N. lat. $50^{\circ}15'$, E. long. $20^{\circ}40'$) in a lake formed in the ancient bed of river Vistula; in northern Poland — Fordon on Vistula (N. lat. $53^{\circ}15'$, E. long. $18^{\circ}15'$) in swampy ground at the edge of a pond.

The chromosome number $2n = 26$ agrees with one of the two numbers found by Lohammár (in Löve and Löve 1948). The triploid number $2n = 39$ has been also reported by this author. Within the somatic plate distinct size differences of the chromosomes are observable (Fig. 24). Three pairs of large heterobrachial chromosomes (5.5 to 7μ), a pair of somewhat smaller chromosomes (c. 5μ), one pair of small (c. 2.5μ) and eight pairs of very small chromosomes (1 to 1.6μ) could be discerned.

Hydrocharitaceae

Hydrocharis L. ($x = 14$). Studied by A. Sokołowska-Kulczycka.

Hydrocharis morsus-ranae L. ($2n = 28$).

This is a common species occurring in stagnant waters over all the

Fig. 24—30. Root-tip metaphases: 24 — *Butomus umbellatus* ($2n = 26$) ($\times 3000$); 25 — *Triglochin palustre* ($2n = 24$) ($\times 3700$); 26, 27, 28 — *Triglochin maritimum* ($2n = 24$, 30, 48) ($\times 3700$); 29 — *Hydrocharis morsus-ranae* ($2n = 28$); 30 — *Acorus calamus* ($2n = 36$) ($\times 3500$)

Polish plain. The material for the present study has been collected by Z. Trela in lakes near Jadowniki Mokre (southern Poland).

The chromosome number $2n = 28$ agrees with the previous results of Tuschniakova (1929), of Hoare (in Maude 1939) and of Ehrenberg (1945). It should be added that within the somatic plates the chromosomes are distinctly differentiated in respect of their length; the following types may be discerned: two pairs of larger chromosomes

(c. 4μ and 3μ resp.), two pairs of smaller chromosomes (c. 1.7μ) and eight pairs of very small chromosomes attaining hardly the length of 0.8μ (Fig. 29).

Juncaginaceae

Triglochin L. ($x=6$). Studied by M. Piotrowicz.

Triglochin palustre ($2n=24$).

This species is rather common in Poland and occurs in damp meadows and at borders of stagnant waters. The material for the present study originated from one habitat in the vicinity of Kraków and from 5 habitats in northern Poland at the Baltic coast; Karwia (two habitats), Swarzewo, as well as Jastarnia and Jurata on the Hel peninsula.

In all specimens studied invariably the chromosome number $2n=24$ (Fig. 25) was found. The same number has been reported previously by Wulff (1939), Löve and Löve (1944, 1956) as well as by Jørgensen, Sørensen and Westergaard (1958). It should be added that in the metaphase plates a pair of chromosomes with distinct secondary constrictions has been observed; it may be easily mistaken for two pairs.

Triglochin maritimum L. ($2n=24, 30, 48$).

A species occurring frequently in damp meadows and salt marshes along the Baltic coast and notably rarer in some inland salines. Plants for the present study have been collected in 8 habitats situated near the Baltic coast. In this material three different chromosome numbers have been found, viz. $2n=24, 30$, and 48 . The number 24 (Fig. 26) has been found in plants from a single habitat near Kołobrzeg at the Baltic coast; the same number has been reported by Tarnavski (1948) for plants from Transsylvania. The chromosome number $2n=48$ (Fig. 28) seems to be the most common at the Baltic coast; it has been found in specimens originating from Wielka Wieś (coll. M. Skalińska), as well as from Karwia, and from Jastarnia and Jurata on the Hel Peninsula. This chromosomal type seems to be widespread also in other parts of Europe; it was reported by Winge (1925), Wulff (1939), Tarnavski (1948), as well as by Löve and Löve (1944, 1956). On the other hand, the number 30 (Fig. 27) found in plants originating from two further habitats on the Hel peninsula (Jastarnia and Jurata) as well as from Swarzewo, is given here for the first time. It represents evidently the pentaploid type. On the whole, *T. maritimum* is a species which shows a high degree of karyological differentiation; in addition to the chromosome numbers quoted above, also the following numbers, not detected hitherto in the habitats from Poland, have been reported previously by

Tarnavski (1938, 1948): $2n = 12$ from Rumania and $2n = 36$ from Portugal. It should be added that in Japan and in North America notably higher degrees of polyploidy have been attained by this species (cf. Löve and Löve 1958a, b).

Araceae

Acorus L. ($x = 12$). Studied A. Sokołowska-Kulczycka.

Acorus calamus L. ($2n = 36$).

This species is widespread over all Poland growing in swampy ground at banks of stagnant waters. The material for the present study has been collected in 20 habitats from various parts of Poland (map of habitats,

Fig. 31. Map of habitats of *Acorus calamus*

Fig. 31). All plants studied had the triploid chromosome number, $2n = 36$ (Fig. 30).

The studies of Wulff (1954) concerning the chromosome number and the geographic distribution of various chromosomic types led to establish the occurrence in well separated areas of the diploid, the triploid and the tetraploid types. According to this author, the diploid form ($2n = 24$) occurs in North America, whereas in central Europe hitherto only the sterile triploid form has been found. The same type occurs in India. On the other hand, in Asia from western Siberia to Japan *Acorus calamus* is represented by the tetraploid form ($2n = 48$), var. *spurius* (Schott) Engl.

In the course of the present study the possibility of detecting in the south-eastern part of the country a different chromosomic type has been taken into consideration in view of the occurrence of var. *angustifolius* in Galicia (Zapałowicz 1906). According to Wein (cited from Wulff 1954), this variety may possibly correspond with the tetraploid var. *spurius*, native in Asia. However, all biotypes originating from the southern and south-eastern parts of Poland within her present boundaries proved to be triploid in agreement with the results of Wulff.

Liliaceae

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

Ornithogalum Gussonei Ten. (*O. tenuifolium* Guss.) ($2n = 18$).

According to Szafer, Kulczyński and Pawłowski (1953) natural habitats of this species in Poland are found only in the south: in Silesia, in the district of Miechów and along the lower course of the river Nida. The plants for karyological studies originated from the latter habitat; they have been collected in the steppe reservation "Skorocice" near Busko (N. lat. $50^{\circ}30'$, E. long. $20^{\circ}40'$). The plant associations of this reservation have been studied recently by Medwecka-Kornaś (1949).

All plants studied proved to be diploid ($2n = 18$) (Fig. 32). The same chromosome number has been found in plants from Hungary by Pólya (1949).

Ornithogalum umbellatum L. ($2n = 27$).

This species grows chiefly as a weed in corn-fields and in gardens in southern Poland. According to Kornaś (1950) it may be regarded as a species characteristic of the corn-field association *Arnosereto-Scleranthetum*.

The chromosome number has been established for plants collected in two habitats in the vicinity of Krakow: Batowice and Brzostkwinia

Fig. 32—34. Root-tip metaphases: 32 — *Ornithogalum Gussonei* ($2n = 18$); 33 — *Ornithogalum umbellatum* ($2n = 27$) ($\times 2260$); 34 — *Listera cordata* ($2n = 38$) ($\times 3000$)

(coll. M. Ochlewska) as well as near Dąbrowa Tarnowska (N. lat. $50^{\circ}10'$, E. long. 21°) (coll. D. Tumidajowicz). All these specimens were triploid ($2n = 27$) (Fig. 33). Within this species a polyploid differentiation has been already reported; the following numbers are known: $2n = 18, 27, 36, 45, 54, 72$ (Sprumont 1928, Matsuura and Sutô 1935, cited from Sutô 1936, Nakajima 1936, Pólya 1950, Holzer 1952, Neves 1952, 1956a, b). In addition, aneuploid numbers ($2n = 43, 52$) and accessory chromosomes have been found by Neves (1952). In the Polish material however a karyological differentiation was not detected hitherto.

Iridaceae

Iris L. Studied by H. Wcisło.

Iris aphylla L. ssp. *bohemica* (Schmidt) Dostal ($2n = 48$).

In the Polish flora *I. aphylla* ssp. *bohemica* is a representative of the pontic element; it occurs only in a few isolated habitats on the Plateau of Little Poland. The plants for the present study have been collected in the steppe reservation "Biała Góra" near Tunel, district Miechów;

an isolated habitat of this ssp. has been found there by Medwecka-Kornaś (1953) in the steppe association *Inuletum ensifoliae*.

The chromosome number of *Iris aphylla* ssp. *bohémica* has not been reported hitherto. In the course of the present study the number $2n=48$ has been established. It is the same as that found previously by Pólya (1950) for ssp. *hungarica*. Other authors who studied this species (e.g. Simonet) did not give any information about the ssp. taken for their investigations.

Iris sibirica L. ($2n=28$).

This species is rather rare in the flora of Poland. Its area of distribution is restricted to the lowland where it grows only in swampy meadows. The plants studied originated from two habitats, in Pychowice and Kostrze, in the vicinity of Krakow. Their chromosome number $2n=28$ is in accordance with the results of previous authors: Kazao (1929, cit. from Tischler 1950) and Simonet (1932).

Thus, this species seems to be uniform in respect of its chromosome number.

Iris pseudacorus L. ($2n=24, 32, 34$).

This is the continuation of the author's investigation started some years ago. The first report (1957) concerned the occurrence of a cytotype with 24 somatic chromosomes in southern Poland. In addition to this number, plants with $2n=32$ and 34 have been detected in the course of the present work. The material collected hitherto originated from 40 natural habitats ranging from the Baltic coast in the north to the south of Poland (Leńcze near Kalwaria, N. lat. $49^{\circ}54'$). It has been pointed out previously (l. c.) that according to the results of other authors, this species manifests a well marked intraspecific differentiation. Further studies are in progress.

Gramineae

Poa L. ($x=7$). Studied by M. Skalińska.

Poa Chaixii Vill. ($2n=14$).

The occurrence of this grass in Poland is confined to mountains; in the Carpathian range it grows in plant communities consisting of tall grasses and herbs, on rather gentle slopes with a relatively high content of moisture in the soil. The plants for the present study originated from the range of Beskid Śląski near Żywiec (880 m o.s.l.) and from the range of Babia Góra (1020 to 1320 m o.s.l.) in the Western Carpathians (coll. Dr. S. Myszowski). The chromosome number $2n=14$ agrees with that previously reported by Stählin (1929) and by Avdulov (1931).

Poa bulbosa L. ($2n = 42$).

Our previous results concerning the chromosome number of this species in Poland (1957) have been supplemented by the study of plants collected in two further habitats: Grochów on the outskirts of Warsaw and Rembertów, north of Warsaw (coll. M. Piotrowicz). The two populations studied recently differ in respect of their chromosome number from our plants studied previously (aneuploids with 39 somatic chromosomes). In the two populations the hexaploid number ($2n = 42$) has been found. The same number has been reported by Hartung (1946) for specimens from North America.

Avenastrum (Koch) Jessen ($x = 7$). Studied by M. Skalińska.

Avenastrum planiculme (Schrad.) Opiz (*Avena planiculmis* Schrad.) ($2n = c. 120$).

This species is very rare in Poland. Its occurrence is confined to the mountains (Tatra Mts and the Sudetic Mts) where it is found in rare and isolated habitats. The plants for the present study have been collected by Dr. Z. Radwańska-Paryska on grassy slopes of Kominy Tylkowe in the Western Tatra at the altitude of about 1600 m.

A cytological study of this species has been performed by Reese (1953) on seedlings from the Botanical Garden in Göttingen; this study has revealed a chromosome number which is unusually high in grasses ($2n = c. 126$). Approximately the same number ($c. 120$) has been observed in root-tip mitoses of adult plants from the above mentioned natural habitat in the Western Tatra. It should be added that a similar chromosome number has been reported (evidently erroneously) by Katterman (in Tischler 1950) for the related species *Avena versicolor* (*Avenastrum versicolor*) of unknown origin. However a renewed study done on specimens from several natural habitats in the High Tatra led to establish for this species the diploid number ($2n = 14$) (Skalińska 1956).

Sieglingia Bernh. ($x = 6$). Studied by E. Banach-Pogan.

Sieglingia decumbens (L.) Bernh. ($2n = 36$).

This species occurs in barren meadows, in woods and in peatbogs. It is common in Poland both in the plain and in lower mountain regions. The specimens investigated have been collected in a pine wood near Maków Podhalański (foreland of the Carpathian range).

The chromosome number of this species ($2n = 36$) found in the Polish material agrees with the previous results of Wulff (1939) as well as those of Löve and Löve (1956). It should be added that according to Maude (1939) the chromosome number of this species is very high ($2n = 124$). This number however has not been confirmed hitherto by later studies.

Orchidaceae

Epipactis Zinn. em. Sw. Studied by E. Banach-Pogan and H. Weisło.

Epipactis latifolia (L.) All. ($2n=40$).

Epipactis latifolia represents an interesting example of intraspecific karyological differentiation ($2n=38$, Barber 1942, Hagerup 1947; $2n=40$, Hagerup 1947, Weijer 1952). In addition to the number $2n=38$ reported previously from Poland (Skalińska, Banach-Pogan, Weisło 1957), a further type, $2n=40$ has been found in the course of the present study in two habitats: road from Rabka to Poręba, in the Carpathian range, and Valley of Biały in the Western Tatra.

Listera R. Br. Studied by E. Banach-Pogan and H. Weisło.

Listera cordata (L.) R. Br. ($2n=38$).

This is a rare species in Poland occurring in shady woods chiefly in lower mountain habitats. The plant material originated from three habitats in the Tatra Mts: the slope of Kopieniec (c. 1300 m o.s.l.), the common "Polana pod Wołoszynem" (c. 1254 m o.s.l.) and the Valley of Roztoka near the cascades "Wodogrzmoty Mickiewicza" (c. 970 m o.s.l.). In all plants studied only the number $2n=38$ has been found. A detailed study of the chromosome morphology led to establish the occurrence of two pairs of long bi-armed chromosomes, one pair of somewhat smaller chromosomes and 16 pairs of small ones (Fig. 34). The somatic number 38 agrees with that given by Sokolovskaja and Strelkova (1940, cited from Tischler 1950), while neither the number 42 reported by Harding (in Tischler L. C.) nor any deviation towards the lower number 36 observed by Löve and Löve in specimens from Iceland (1956), could be found in the material from Poland.

SUMMARY

The present study deals with the karyology of 43 species of Dicotyledons and Monocotyledons from natural habitats in Poland, compared with the results obtained by previous authors for plants from other geographic areas.

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