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Further studies in chromosome numbers of Polish Angiosperms (Dicotyledons)

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This paper gives the results of further studies in the chromosome numbers of Polish Angiosperms carried out by the research workers of the Institute of Plant Anatomy and Cytology, University of Krakow. The present part deals only with Dicotyledons. Like in our previous work the plant material originated exclusively from natural habitats in various parts of Poland. The determination of the chromosome numbers was based chiefly on the study of root-tip mitoses.

Betulaceae

Betula L. (x = 7)

Betula verrucosa Ehrh. (2n = 28)

Betula oycoviensis Bess. (2n = 28)

Betula pubescens Ehrh. (2n = 56)

B. pubescens ssp. *carpatica* (W. K.) Jav. *(B. carpatica* W. K.) (2n = 56)

B. verrucosa, studied by M. Piotrowicz. The plant material has been brought in early spring 1956 in the form of twigs cut from adult trees growing in the forest reservation of Białowieża. The twigs were kept in the laboratory in jars with water and the study was performed on acetic orcein smears of very young leaves. The chromosome number agrees with that reported previously for this species by most authors; the higher number (viz. 42) found by Johnsson (1944, cited from Tischler 1950) and by Löve (1944) has not been detected in the material studied.

B. oycoviensis Bess. studied by J. Małecka. This is an endemic species known only from a few habitats in the vicinity of Ojców. The specimens were collected in the valley of Prądnik near Hamernia, the type locality from which this species was originally described by Besser and in the neighbouring valley Bolechowicka. The material was collected in the form of seeds, subsequently germinated on Petri dishes and of young plants. This species (considered by some taxonomists as a subspecies of *B. verrucosa)* has not been investigated cytologically till now. Its chromosome number 2n = 28 is given here for the first time.

B. pubescens Ehrh. studied by M. Piotrowicz. The origin of the material is the same as that of *B. verrucosa*: the forest reservation in Białowieża, and the

material was treated in the same way. The number 2n = 56 established in the course of this study agrees with previous results.

B. pubescens Ehrh. ssp. *carpatica* (W.K.) Jav. studied by M. Skalińska. In the Tatra Mts this species is rather frequent in higher mountain habitats where it ascends to the layer of *Pinus montana*. The material was collected on the slopes of Opalone in a very rich habitat. Young plants 3 to 4 years old were transplanted from this habitat into the experimental field of the institute and fixed after rooting. The chromosome number of this subspecies has not been studied hitherto. It is the same as that of the typical *B. pubescens* (2n = 56) to which it is closely related.

Polygonaceae

Oxyria Hill (x = 7)

Oxyria digyna (L.) Hill. (2n = 14) studied by H. Wcisło.

In the flora of Poland this species is a representative of the arctic-alpine eurasiatic element. It occurs in the Tatra Mts in higher mountain habitats, chiefly in the layer of *Pinus montana* and in the alpine layer. The specimens studied were collected in eleven habitats. Western Tatra: higher parts of the gorge Kraków (valley Kościeliska), c. 1400 m o.s.l.; Zadnie Kamienne below Gładkie Upłaziańskie, c. 1450 m o.s.l.; path near Wielka Turnia, c. 1700 m o.s.l. High Tatra: higher parts of the path from the lake Morskie Oko to pass Szpiglasowa, c. 1700 m o.s.l.; valley Za Mnichem, c. 1750 m o.s.l.; near the path to pass Zawrat, above the lake Zmarzły Staw, c. 1800 m o.s.l.; slope of Mała Kosista, c. 2000 m o.s.l.; higher parts of the path from valley Pańszczyca to pass Krzyżne, c. 2100 m o.s.l.; Wołoszyn Wielki, c. 2130 m o.s.l.; higher part of the path to Rysy, c. 2300 m o.s.l.; Rysy, below the peak, c. 2450 m o.s.l.

The number 2n = 14 found in plants from all the above habitats is in accordance with the results of previous investigations. They concerned chiefly plants from the north and the arctic (Sweden, Norway, Spitsbergen, Kola peninsula, Greenland, Faeroes Islands and Iceland). On the other hand data dealing with plants from mountains of central Europe are rather scarce. Larsen (1954) studied plants from two habitats in the Alps while specimens of Mattick (Tischler 1950) originated probably from Tyrol. The present study which deals with plants from a variety of habitats in the Tatra Mts gives a further evidence that *Oxyria digyna* is cytologically uniform within its wide and discontinuous area of distribution.

Ranunculaceae

Caltha L. (x = 8,7) Studied by K. Satczek.

The taxonomy of this genus presents serious difficulties; the morphologicat characters seem to be highly variable in natural habitats. Further difficulties result from the complex karyological differentiation occurring within the genus. Therefore

various authors differ in respect of the taxonomical groupment of the forms. In the flora of Poland three main taxa may be distinguished on the basis of purely morphological criteria: *palustris* L., *cornuta* Schott and *laeta* Schott. They are considered by most taxonomists as separate species; some other authors however give to *cornuta* the rank of a subspecies of *C. palustris* (cf. Pawłowski 1956). The material from Poland has not been investigated cytologically hitherto. The present study carried out on a very limited number of specimens yielded the following results:

Caltha palustris L. 2n = 32. The plants originated from southern Poland and were collected in the vicinity of Gliwice (Silesia) and in Bieżanów near Krakow on damp meadows.

Caltha cornuta Sch. N.K. 2n = 56. Plants were collected in northern Poland in a single habitat: Jelitkowo at the Baltic coast.

Caltha laeta Sch. N.K. 2n = 56. This species occurs in mountain habitats and in the Tatra Mts it ascends sometimes to the alpine layer. The specimens for the present study were collected in one habitat in the Pieniny Mts (slope of Orlica).

All specimens from Poland studied till now had euploid chromosome numbers, whereas some authors (Reese 1954) have found frequent deviations: the occurrence of additional A-chromosomes and of small B-chromosomes. The present report gives only a very preliminary information about the cytological differentiation within the genus. In view of the complexity of the problem the investigation of a notably larger plant material is required.

Trollius L. (x = 8) studied by K. Satczek.

Trollius europaeus L. (2n = 16)

Trollius europaeus L. ssp. *transsilvanicus* (Schur) Bł. (2n = 16).

This perennial species occurs in damp meadows over all Poland. In the Tatra Mts it is represented by the ssp. *transsilvanicus*.

The material originated from the following habitats: Bieżanów near Krakow; Kulin Kłodzki in the Sudetic Mts; High Tatra: path to pass Zawrat above the lake Zmarzły Staw (c. 1980 m o.s.l.) (ssp. *transsilvanicus)*. In all plants investigated 16 somatic chromosomes were found, in accordance with previous results (Langlet 1927, Levitsky 1931 and others).

Delphinium L. (x = 8). Studied by K. Satczek.

Delphinium elatum L. 2n = 32

Delphinium oxysepalum Borb. et Pax (2n = 32)

The first of these two species is represented in the Tatra Mts only by the ssp. *intermedium* (Sol.) Fleisch. et Lind. (cf. Pawłowski 1956); which is well distributed chiefly in lower mountain habitats. The material investigated originated from the following habitats in the Western Tatra: Valley of Mała Łąka (c. 950 m o.s.l.), slopes of Krokiew (c. 1100 m o.s.l.) and Hruby Regiel (c. 1300 m o.s.l.). All plants investigated had the tetraploid chromosome number 2n = 32. For plants collected in the two first habitats this number was confirmed in the study of meioses

in P.M.C's. The species *Delphinium elatum* was investigated previously by Levitsky (1931), Gregory (1941) as well as by Propach (cited from Tischler 1950); all these authors give the same chromosome number as that established in the present study; it should be added however that for ssp. *intermedia* the chromosome number is reported here for the first time. *Delphinium oxysepalum,* the second species investigated, occurs at higher altitudes frequently on limestone rocks and on scree. The tetraploid chromosome number of this dwarf mountain species was first reported by Skalińska (1950). It has been confirmed on plants from a different habitat: rocky slopes over the gorge Krakow, Kościeliska valley.

Actaea L. (x = 8). Studied by M. Skalińska.

Actaea spicata L. (2n = 16).

A common species occurring in deciduous woods over all Poland both in the plain and in lower mountain habitats. The material originated from beech woods in lower parts of the Western Tatra: from the slopes of Krokiew (c. 1100 m o.s.l.) and from woody slopes over the road „pod Reglami" (c. 1000 m o.s.l.). The plants were diploid in accordance with Langlet (1927) who first established the correct chromosome number of this species.

Isopyrum L. (x = 7). Studied by M. Skalińska.

Isopyrum thalictroides L. (2n = 14)

This species occurs in Poland in shady deciduous woods. Plants for studies were collected in the vicinity of Krakow in the wood Las Wolski where they grow abundantly. Among the *Ranunculaceae* the genus *Isopyrum* belongs together with *Aquilegia* and *Thalictrum* to the group with very small chromosomes (Gregory 1941) and with the basic number 7. Accordingly the somatic number of *Isopyrum thalictroides* is 14 (Fig. 1). Within the set one pair of nucleolar chromosomes may be discerned.

Thalictrum L. (x = 7). Studied by E. Pogan.

Thalictrum aquilegiifolium L. (2n = 14).

A perennial species occurring in wood clearings and scrubs over all Poland. The plants investigated were collected from two habitats in the limestone part of the Tatra Mts (slopes of Łysanki, c. 1350 m o.s.l.; lower part of the gorge Kraków, c. 1100 m o.s.l.). The diploid chromosome number 2n = 14 (Fig. 2) found for the Polish material agrees with the previous results (Langlet, 1927; Kuhn, 1928, 1930; Matsuura and Sutô, 1935, cited from Tischler, 1950). According to Kuhn (1928) *Thalictrum aquilegiifolium* var. *atropurpureum* has the same chromosome number. On the other hand *T. aquilegiifolium* var. *hybridum* Hort. is tetraploid (Langlet, 1927).

Anemone L. (x = 7, 8). Studied by K. Satczek.

Anemone nemorosa L. (2n = 30).

A perennial plant occurring over all Poland chiefly in deciduous woods. The plant material for the present study has been collected in the south of Poland in

the following habitats: Tomisław (Lower Silesia); Chorynkowice near Gliwice (Upper Silesia); Lipowiec (distr. Krakow); Las Wolski near Krakow; Pieniny Mts, way to Czertezik (c. 700 m o.s.l.); Pieniny Mts, way to Przehyba (c. 500 m o.s.l.); Krynica, Central Carpathians (c. 650 m o.s.l.). The study of the somatic plates led to establish in all investigated plants the number 2n = 30. The chromosomes are large and notable differences of their length are observable within the set.

The cytology of *A. nemorosa* has been investigated already by a number of authors and various numbers have been reported: 16 (Guinochet 1935), 24 (Winge 1917), 30 (Langlet 1932), 28—32 (Böcher 1932), 32 and 39 (Moffett 1932). The most detailed study has been done by Bernström (1946); his results point to the occurrence of aneuploidy within this species. The numbers found by this author are: 29—30, 30, 30—31, 37, 43, 45, 45—46. On the whole however it is the number 30 as well as some numbers close to it which are the most frequent. It should be added that the related species *A. ranunculoides* has 2n = 32 and is regarded as a tetraploid with the basic number 8. Thus, the number 30 found in numerous biotypes of *A. nemorosa* seems to be aneuploid. Further studies concerning this problem are required and they should be based on a larger plant material from various parts of Poland. The investigation is being continued by Z. Trela.

Hepatica Mill. (x = 7). Studied by K. Satczek.

Hepatica nobilis Garsault *(H. triloba* Gilib.) (2n = 14).

This perennial plant occurs in Poland chiefly in the plain, in shady deciduous woods and in scrubs. Plants from the following habitats were investigated: Baltic coast near Gdańsk-Wrzeszcz; valley Będkowska and valley of Kluczwoda — two Jurassic valleys NW of Krakow; Rymanów-Zdrój — foreland of the Carpathian range. All plants had 14 somatic chromosomes. This number has been reported previously by Langlet (1927), Böcher (1932), Moffett (1932), Nakajima (1933) and Gregory (1941). Some degree of cytological differentiation however seems to occur within this species: Langlet (l.c.) gives for var. *multiloba* n = 14, while Sugiura (1931) found in a Japanese variety (var. *acuta)* 2n = 16.

Batrachium S.F. Gray (x = 8). Studied by K. Turała

Batrachium circinatum (Sibth.) Fr. *(Ranunculus circinatus* Sibth.) (2n = 16).

In Poland this species occurs in stagnant waters, in dispersed habitats both in the plain and in lower mountain regions. The material studied originated from two habitats from the south of Poland: Mydlniki near Kraków and Maków Podhalański (foreland of the Carpathian range). The number 2n = 16 (Fig. 3) established in the course of the present study is in accordance with the results of Scheerer (1939, cited from Tischler 1950).

Batrachium aquatile (L.) Dum. *(B. peltatum* Schrank. *Ranunculus heterophyllus* Web.) (2n = 32).

occurs in Poland in the plain and in lower mountain regions in stagnant waters. For this species a number of authors (Böcher 1932, 1938, Larter 1932, Ehrenberg 1945) reported the tetraploid chromosome number 2n = 32. The same number

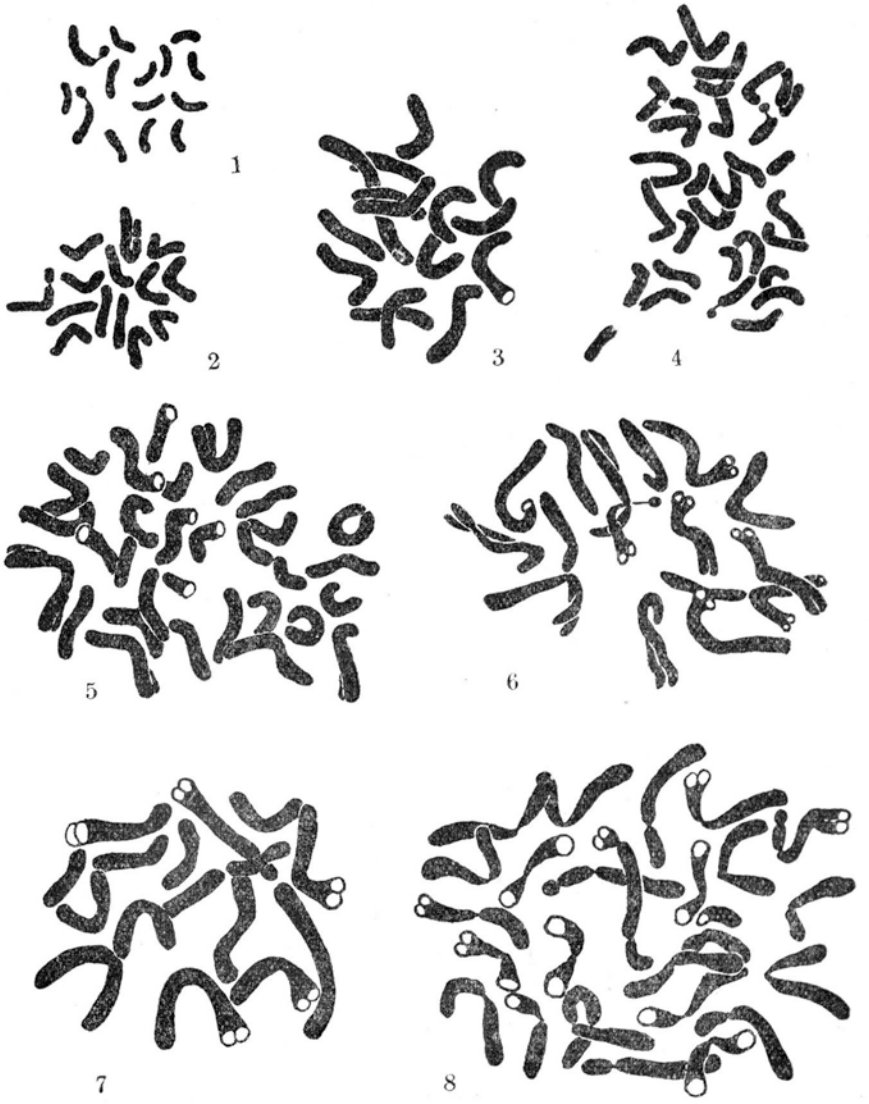

Fig. 1—8. Root-tip metaphases: *1 — Isopyrum thalictroides* (2n = 14). *2 — Thalictrum aquilegiifolium* (2n = 14). *3 — Batrachium circinatum* (2n = 16). *4 — Batrachium aquatile* (2n = 32). *5 — Ranunculus flammula* (2n = 32). *6 — Ranunculus montanus* (2n = 16). (× 3000). *7 — Callianthemum coriandrifolium* (2n = 16) (× 2300). *8 — Asarum europaeum* (2n = 26) (× 3000)

has been found also in the material originating from ten habitats in Poland (Fig. 4): Surrounding of Kraków (N. Lat. c. 50°, E. Long. c. 20° 15′): Staniątki; Pychowice; Spytkowice, surrounding of Rzeszów (N. Lat. c. 50° 3′, E. Long. c. 22°); Huta Komorowska; Krzątka; Brzostowa Góra; Wilcza Wola, Swoły near Stalowa Wola

(N. Lat. 50° 30′, E. Long. 22° 15′), Baranów near Sandomierz (N. Lat. 50° 30′, E. Long. 21° 35′), Wisełka near Międzyzdroje, Isle of Wolin (N. Lat. 53° 55′, E. Long. 14° 28′).

On the other hand Barros Neves (1944, cited from Tischler 1950) found the diploid chromosome number 2n = 16 in specimens presumably originating from the south-western part of Europe.

Ranunculus L. (x = 7,8).

Ranunculus flammula L. (2n = 32). Studied by K. Turała

The specimens studied were collected in swampy meadows. They originated from three habitats: Marcyporęba SW of Kraków (N. Lat. 49° 50′, E. Long. 19°35′), Niepołomicka Forest near Szarów (N. Lat. 50°, E. Long. 20° 15′), Jadowniki Mokre (N. Lat. 50° 15′, E. Long. 20° 40′). The number 2n = 32 (Fig. 5) found in all plants studied is in accordance with the results of previous authors (Tischler 1950).

Ranunculus montanus Willd. (2n = 16). Studied by R. Trafas.

This perennial species occurs in mountains of southern and central Europe. In Poland the distribution of this species is restricted to the Tatra Mts, chiefly to its granitic part where it occurs on grass patches on slopes and on rocks (Szafer, Kulczyński and Pawłowski 1953).

The plants studied originated from six habitats in the High Tatra: Higher part of the path to pass Karb (c. 1730 m o.s.l.); slope of Opalone (c. 1700 m o.s.l.); border of the lake Czarny Staw over Morskie Oko (c. 1580 m o.s.l.); bottom of the ravine Żabi Żleb (c. 1650 m o.s.l.); lower part of the path to Rysy (c. 1650 m o.s.l.); slope of Rysy, higher part (c. 1800 m o.s.l.). In all plants studied the somatic chromosome number 16 was found (Fig. 6). This number is in accordance with the results of Langlet (1932) who investigated plants from Copenhagen. On the other hand, triploid and tetraploid plants found in addition to the diploid type by Mattick (Tischler 1950) in specimens probably originating from Tyrol have not been found in the High Tatra.

Ficaria Adans. (x = 8) Studied by K. Satczek.

Ficaria verna Huds. (*Ranunculus ficaria* L.) (2n = 32).

Cytological and embryological studies carried out hitherto on this collective species (Langlet 1927, Larter 1932, Böcher 1938 and others) have revealed the occurrence of diploid, triploid and tetraploid biotypes; only the former are sexual while the latter propagate by means of bulbils (Gustafsson 1947). In view of this karyological differentiation it was advisable to investigate the chromosome numbers of biotypes occurring in Poland. Plants originating from the following habitats have been studied till now: SE. Poland, vicinity of Rzeszów, foreland of the Carpathian range; S. Poland, vicinity of Chrzanów (distr. of Krakow); SW. Poland, Tomisław, Lower Silesia; N. Poland, near Gdańsk-Wrzeszcz, Baltic coast. All plants from the above habitats were tetraploid (2n = 32). It is possible that

the karyological differentiation within this collective species is connected with geographical distribution. This problem deserves a more thorough study.

Callianthemum C.A., Mey. (x = 8). Studied by Z. Trela.

Callianthemum coriandrifolium Rchb. (2n = 16).

The occurrence of this species in Poland is restricted to the higher mountain habitats of the Tatra Mts. The specimens studied were collected on the slopes of Żabi (1800—1950 m o.s.l.) on granitic rocks and in the Valley Litworowa nr Gerlach, Č.S.R. (1800 m o.s.l.) by Dr Z. Radwańska-Paryska. The chromosome number 2n = 16 (Fig. 7) established in the course of the present study is in accordance with the results of Langlet (1932) and of Mattick (in Tischler 1950).

Aristolochiaceae

Asarum L. Studied by J. Małecka.

Asarum europaeum L. (2n = 26).

Asarum europaeum is a species common over all Poland in shady woods and scrubs both in the plain and in lower mountain habitats.

Cytological studies dealing with the genus *Asarum* are rather scanty. The first investigation concerning the species *A. europaeum* is that of Taeckholm and Söderberg (1918); on the basis of studies of meioses in P. M.C's these authors reported the number n = c.12. The same number (2n = 24) was given by Tanaka (1935) for the species *A. dimidiatum* Meakawa. On the other hand Ehrenberg (1945) found in specimens of *A. europaeum* from Sweden a higher number, viz. 2n = 40. In view of the above results it seemed interesting to study the chromosome number in plants from natural habitats in Poland. Biotypes from 12 various habitats well distributed in southern, western and northern Poland, both in the plain and in the Carpathians, were collected for this study. In all specimens the somatic number was 26 (Fig. 8). In addition to the somatic plates in root tips, meiotic metaphases in P.M.C's were studied in plants from one habitat (vicinity of Krakow); 13 bivalents could be counted. It should be noted that within the somatic plates considerable differences concerning the length and the morphology of the chromosomes were observed.

Cruciferae

Arabis L. (x = 8). Studied by M. Skalińska.

Arabis pieninica Woł. (2n = 16).

This perennial species occurring endemically in the Pieniny Mts, is related to *A. alpina* L. according to the opinion of taxonomists. The chromosome number of this species has not been studied previously.

The plants were collected in 1953 by Dr Z. Radwańska-Paryska who detected in the Pieniny Mts a new abundant habitat of this species along the walls of the castle of Niedzica. The chromosome number 2n = 16 has been established on root-tip mitoses in the course of the present study.

Violaceae

Viola L.

Section *Dischidium* Ging.

Viola biflora L. (2n = 12). Studied by H. Wcisło.

This alpine-arctic circumpolar species occurs in Poland in woods and on wet rocks of the Carpathians and of the Sudetic Mts. The plants studied originated from the following habitats in the Tatra Mts where they occur both on limestone and on granite: 1. A spruce forest on Hruby Regiel (c. 1300 m o.s.l.); 2. Peak of Łysanki (c. 1440 m o.s.l.); 3. Szeroki Piarg, above the lake Morskie Oko (c. 1450 m o.s.l.); 4. Slope of Opalone (c. 1700 m o.s.l.).

All plants investigated had 2n = 12, in accordance with previous results of Clausen (1927) and of Gershoy (1928) for specimens from North America.

Section *Melanium* Ging.

Viola alpina Jacq. (2n = 22). Studied by M. Skalińska.

In Poland the occurrence of this species is restricted to higher elevations of the Carpathian range where it grows chiefly on limestone rocks. According to Zabłocki (1947) the Carpathian specimens belong to var. *tatrensis* Zapał. They occur in the layer of *Pinus montana* and in the alpine layer. Plants for the present study have been collected by Dr. Z. Radwańska-Paryska in the Western Tatra on calcareous rocks in the massif of Czerwone Wierchy. This species has not been studied cytologically hitherto. The number 2n = 22 (Fig. 9) which is rather rare in this genus, is the same as that of *Viola cornuta* L. belonging to the same section (Clausen 1927).

Crassulaceae

Sedum L. Studied by E. Pogan.

Sedum alpestre Vill. (2n = 16).

This perennial species occurs in Poland in the Sudetic Mts and the Carpathians on granitic rocks and on shingle. In the Western Tatra it is found only on soils depleted of lime. The vertical distribution of this species in the Tatra Mts extends from the higher mountain layer upwards to the alpine layer, but it is of a very common occurrence only in the layer of *Pinus montana* and in the alpine layer.

The specimens studied originated from four habitats:

Sudetic Mts: higher part of the path from the tourist house over Śnieżne Kotły to Mały Kocioł Śnieżny in the range of Karkonosze (c. 1490 m o.s.l.).

Tatra Mts: near the path from Hala Gąsienicowa to Świnica (c. 1600 m o.s.l.); bank of the lake Czarny Staw Gąsienicowy, near the path to Granaty (c. 1620 m o.s.l.); Valley of Stawy Gąsienicowe (c. 1600 m o.s.l.).

The diploid chromosome number 2n = 16 found in the Polish material (Fig. 10) has been established previously by Mattick (cited from Tischler 1950) and was confirmed on meioses in P.M.C.'s by Favarger (1953) for the material from the Alps.

Rosaceae

Fragaria L. (x = 7). Studied by R. Czapik.

Fragaria vesca L. (2n = 14).

Fragaria viridis Duch. (= *F. collina* Ehrh.) (2n = 14).

The two species were studied cytologically by various authors in connexion with their genetics and phylogeny. The chromosome numbers of plants from the area of Poland however have not been investigated hitherto.

In Poland *F. vesca* is common in woods in the lowland and it ascends in the mountains up to the layer of *Pinus montana*. The specimens for the present study originated from 11 habitats extending from Babia Góra (Western Carpathians) in the south to the Baltic coast in the north (N. Lat. is given in brackets): Babia Góra (49° 35′); Besko (49° 36′); Krynica (49° 25′); Mt. Góra Zbylutowa and Lipowiec near Chrzanów (50° 05′); Januszowice near Krakow (50° 10′); Chorenkowice near Gliwice (50° 20′); Tunel (50° 25′); Ciebłowice near Tomaszów Mazowiecki (51° 31′); Baltic coast (54° 24′): Gdańsk-Wrzeszcz and Łysica.

The specimens of *F. viridis* originated from the following 5 habitats on sunny slopes: Swoszowice near Krakow (50° 00′); Podgórki near Krakow (50°01′); Krakow, Skały Twardowskiego (50° 04′); Tomisław, Lower Silesia (51° 10′); Choceń near Włocławek (52° 40′).

The two species are cytologically uniform; the diploid number (2n = 14) reported by previous investigators (Tischler 1950) has been confirmed also in the course of the present study. The same number was given recently by Staudt (1952) for *F. vesca* and *F. viridis* from Central Europe, and by Löve and Löve (1956) for *F. vesca* from Iceland.

Dryas L. (x = 9). Studied by H. Wcisło.

Dryas octopetala L. (2n = 18).

Dryas octopetala is an old circumpolar species of northern origin widely distributed in the alpine flora of Europe. In the Tatra Mts it is fairly common in the western part on limestone while in the High Tatra it is very rare. The material for the present study has been collected in the following habitats of the Western Tatra: 1. Valley of Biały, higher part of the valley, c. 1000 m o.s.l. 2. Gładkie Upłaziańskie, c. 1500 m o.s.l. 3. Kopa Magóry, higher part of the slope, c. 1500 m o.s.l. 4. The Common Karczmisko, above the road, c. 1560 m o.s.l. 5. Slope of Kominy Tylkowe, c. 1800 m o.s.l. 6. Peak of Kominy Tylkowe, c. 1820 m o.s.l.

Prior to the present study *D. octopetala* has been cytologically investigated both from its northern centres of distribution (Flovik 1940, Böcher and Larsen 1950, Löve and Löve 1956) and from the European mountains (Böcher and Larsen 1955). On the whole, this species is cytologically uniform within its wide and discontinuous area of distribution. The number 2n = 18 has been found also in the course of the present study for plants of the Tatra Mts. It should be added that a tetraploid strain (2n = 36) has been detected exceptionally by Böcher and Larsen (1955) at Col du Pillon in the Alps.

Agrimonia L. (x = 7). Studied by R. Czapik.

Agrimonia eupatoria L. (2n = 28).

The material for cytological studies has been collected in two habitats in the form of seeds (Marcyporęba near Brzeźnica, N. Lat. c. 49°55′, and Miechów, N. Lat. c. 50° 20′) and in two further habitats (Dębica, N. Lat. c. 50° 05′ and Sąspowska Valley in Ojców, N. Lat. c. 50° 10′) in the form of root tips of adult plants. All plants had 28 somatic chromosomes in root tips. The same number was found by Wulff (1938), Maude (1940, cit. from Darlington and Wylie 1955) as well as by Löve (1954a).

Papilionaceae

Anthyllis L. (x = 6). Studied by J. Małecka.

Anthyllis vulneraria L. var. *affinis* (Britt.) Wohlf. (*Anthyllis affinis* Britt.) (2n = 12)

This variety of the coll. species *A. vulneraria* is very common in lower situations in the Tatra Mts, where it grows on dry grassy slopes.

The cytological differentiation within the collective species does not concern the chromosome number, only some details of their morphology. Tschechow and Kartaschowa (1932) who investigated *A. alpestris* and *A. maritima,* have observed only slight size differences within the chromosome set of the former, while the latter has one pair of chromosomes notably longer than the others. Jalas (1950) studied the chromosome morphology of various races (incl. „*A. affinis*" Ljubljana) and found the same type of differentiation as in *A. maritima.* The present study on plants of *A. affinis* from the slopes of Krokiew has confirmed the occurrence of one pair of large chromosomes (c. 3 μ); among the smaller chromosomes however also size differences could be discerned; two pairs of minute chromosomes (c. 1 μ) could be identified in all investigated root-tip metaphases (Fig. 11).

Oxalidaceae

Oxalis L. Studied by R. Czapik.

Oxalis acetosella L. (2n = 22).

Oxalis stricta L. (2n = 24).

Of the three representatives of the genus in the flora of Poland: *Oxalis acetosella* L., *O. stricta* L. and *O. corniculata* L. (Szafer, Kulczyński, Pawłowski 1953) the two former were investigated in the course of the present study.

O. stricta is a North-American species introduced in Poland as a weed in gardens and fields. *O. acetosella* is a cosmopolitan species very common in Poland.

The genus shows a notable karyological differentiation and was therefore a subject of numerous investigations. For *O. acetosella* the chromosome number has been studied on plants from seven habitats: Świeradów and Szklarska Poręba in Sudetic Mts (N. Lat. c. 50° 50′), Mt Tuł near Cieszyn (N. Lat. c. 49° 50′), Mt Ćwilin (N. Lat. c. 49° 41′), Myślenice near Krakow (N. Lat. c. 49° 50′), Zabierzów near Krakow (N. Lat. c. 50° 10′), Ostromecko near Bydgoszcz (N. Lat. c. 53° 10′)

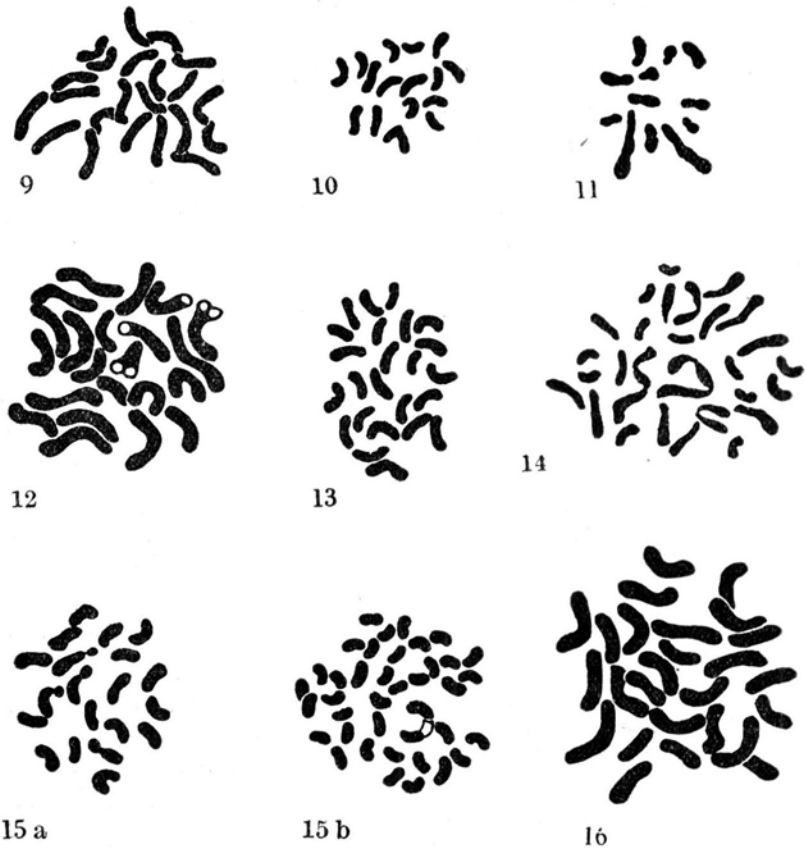

Fig. 9—16. Root-tip metaphases: *9 — Viola alpina* (2n = 22). *10 — Sedum alpestre* (2n = 16). *11 — Anthyllis vulneraria,* var. *affinis* (2n = 12). *12 — Oxalis acetosella* (2n = 22). *13 — Oxalis stricta* (2n = 24). (× 3000). *14 — Polygala amara,* ssp. *brachyptera* (2n = 28). (× 3600). *15 — Impatiens nolitangere,* (a — 2n = 20, b — 2n = 40). *16 — Impatiens parviflora* (2n = 26). (× 3000)

and Jastrzębia Góra on the Baltic coast (N. Lat. c. 54° 50′). The number 2n = 22 (Fig. 12) agrees with previous results of Heitz (1927, n = 11 — 12), Nakajima (1936), Löve (1954a), Löve and Löve (1956) and Marks (1956).

O. stricta studied from two habitats: Kołobrzeg on the Baltic coast and from the vicinity of Krakow, has 24 somatic chromosomes (Fig. 13). The same number has been found previously by Wulff (1937) and Marks (1956). The two species which are representatives of two separate sections within the genus differ in respect of the basic number and the morphology of their chromosomes.

Geraniaceae

Geranium L. (x = 7). Studied by M. Skalińska.
Geranium phaeum L. (2n = 28).
Geranium silvaticum L. (2n = 28).

Geranium phaeum is a perennial species rather common in the southern parts of Poland, in the lowland and in the Carpathians where it reaches the layer of *Pinus montana*. The material for the present study originated from the Jurassic valley Będkowska, NW of Krakow, as well as from two habitats in the Western Tatra: valley Jaworzynka (c. 1000 m o.s.l.) and the border of a wood near Wantule (c. 1200 m o.s.l.). All plants had 2n = 28, in accordance with the previous results of Warburg (1938) and of Mattick (Tischler 1950).

Geranium silvaticum occurs in scrubs and light woods and in meadows, it is particularly common in mountain habitats, and in the Tatra Mts it ascends to the alpine layer. Plants for the present study originated from the following habitats in the Western Tatra: valley Jaworzynka (c. 1000 m o.s.l.); a wood on the slopes of Kobylarz (layer of subalpine forests, c. 1300 m o.s.l.); lower parts of the path to the massif of Czerwone Wierchy (layer of *Pinus montana*, c. 1550 m o.s.l.): very tall plants, one group with sterile anthers, another group male fertile; higher parts of the same slope, c. 1650 m o.s.l. in more exposed habitats two separats colonies of dwarf plants; bottom of Wielka Turnia on scree, c. 1700 m o.s.l. a single dwarf albino plant with purely white flowers and without any trace of anthocyanin in the vegetative parts. The differences of height seem to be phaenotypic, but some other characters of these populations were evidently due to a genic differentiation.

All plants had the tetraploid chromosome number (2n = 28) in accordance with the previous results of Warburg (1938) and of Löve and Löve (1944, 1956).

Polygalaceae

Polygala L. studied by M. Skalińska

Polygala amara L. ssp. *brachyptera* (Chod.) Hay. (2n = 28).

This ssp. occurs in mountain regions and it is common in the Western Tatra on basic grassland. In spite of this, the studied material was rather scanty: plants with expanded flowers are required for a correct taxonomical determination (cf. Pawłowski 1958) and in this stage rooting is extremely difficult. Therefore, the plants for the present study originated from two habitats only: valley Kościeliska and Jaworzynka.

The chromosome number of this ssp. has not been reported hitherto. We have found 2n = 28, the same number as that established by Larsen (1956) for *P. comosa*. Within the set of *P. amara* ssp. *brachyptera* the chromosomes show distinct size differences: one pair with a submedian centromere and a secondary constriction is notably larger, another pair has a median centromere, while some of the smaller chromosomes seem to have terminal centromeres (Fig. 14).

Balsaminaceae

Impatiens L. Studied by R. Czapik.

Impatiens noli-tangere L. (2n = 20, 40).

Impatiens parviflora DC. (2n = 26).

These two annual species are very common in Poland. *I. noli-tangere* occurs in woods and scrubs, along banks of streams, as well as in lower mountain habitats. In the course of the present work plants from the following three habitats have been investigated: Sudetic Mts near Szklarska Poręba and Świeradów; Tatra Mts: valley Kościeliska, gorge Krakow (c. 1200 m o.s.l.). Plants from the two latter habitats had 2n = 20 (Fig. 15a), the same chromosome number as that established by Winge (1925); this is hitherto the only report concerning the cytology of this species. On the other hand, in the material collected from the first habitat the tetraploid number 2n = 40 has been found (Fig. 15b).

I. parviflora is an Asiatic species widely dispersed in Poland as a weed in gardens and along roads among ruderal plants. For this species three chromosome numbers have been reported: 2n = 20, 24, 26 ((Schürhoff 1926, Heitz 1926, Wulff 1934, Ehrenberg 1945). The material for the present study originated from a single habitat in the Sudetic Mts (scrub along a stream near Świeradów). The specimens investigated had 2n = 26 (Fig. 16), the same number as that found by Heitz and Resende (1936, cit. from Khoshoo 1957).

Trapaceae

Trapa L. studied by Z. Trela.

Trapa natans L. (2n = c. 48).

This very rare, perishing species occurs in Poland only in the southern part of the country in a few isolated habitats; it is found in ponds and lakes situated chiefly in the basins of the rivers Vistula and San. The plant material for the present study originated from the following habitats: Jadowniki Mokre (N. lat. 50° 15′, E. long. 20° 40′), a lake formed in the ancient bed of Vistula; Baranów (N. lat. 50° 30′. E. long. 21° 35′ and Dwikozy (N. lat. 50° 40′, E. long. 21° 45′) on Vistula; Malce. near Stalowa Wola (N. lat. 50° 30′, E. long. 22° 15′), in a pond; Rybnik-Paruszowiec (N. lat. 50° 05′), E. long. 18° 30′), in a pond.

The chromosome number studied in root-tip mitoses of adult plants is 2n = = c. 48. In the metaphase plates some size differences could be found within the set, four chromosomes being larger. The only available data concerning the chromosome number of *Trapa natans* have been given by Palmgren (1943) who reported for this species 2n = 36, thus a lower number than that found in the course of the present study.

Umbelliferae

Hacquetia Necker. (x = 8). Studied by Z. Trela.

Hacquetia epipactis (Scop.) D.C. (2n = 16).

This species is rare in Poland; it occurs in isolated habitats in deciduous woods in Silesia as well as the plateau of Lublin. The plants studied were collected in the neighbourhood of Cieszyn by K. Bijok and in Mogilany nr Krakow by D. Tumidajowicz. Their somatic chromosome number is 16 (Fig. 17). It agrees with the results obtained previously by Wanscher (1933).

Archangelica Hoffm. (x = 11). Studied by H. Wcisło.

Archangelica officinalis Hoffm. (2n = 22).

In Poland wild populations of this species occur exclusively in mountain regions of the Carpathians and of the Sudetic Mts. They are well distributed in the Tatra Mts, both on calcareous soil and on granite chiefly in the layer of *Pinus montana*. According to Pawłowski (1956) the specimens from the Tatra Mts belong probably to var. *norvegica* (Rupr.) Rikli. The plants studied were collected in the High Tatra on banks of a stream running from the lake Czarny Staw to the lake Morskie Oko (c. 1550 m o.s.l.). Their chromosome number is 2n = 22 (Fig. 18). The same results have been obtained by Schulz-Gaebel (1930), Wanscher (1931) Löve and Löve (1948, 1956), Vaarama (1949), Gardé and Malheiros-Gardé (1949) and Jörgensen, Sörensen and Westergaard (1958) for different subspecies within this species.

Primulaceae

Cortusa L. (x = 12). Studied by E. Pogan.

Cortusa Matthioli L. (2n = 24).

In the flora of Poland this perennial species is rather rare and its area of distribution is restricted to the Carpathians. It occurs there in scrubs and on moist rocky slopes. *Cortusa Matthioli* is a representative of the arctic-alpine flora with one centre in the north and others in mountain regions of Europe and Asia. It is regarded as a species of southern origin which presumably migrated from the mountain regions of Asia northwards to the arctic tundra (Kulczyński, 1924).

The specimens studied were collected in the Western Tatra (Valley of Mała Łąka; c. 1000 m o.s.l.). The somatic chromosome number 2n = 24 (Fig. 19) established on the Polish material is in accordance with the results of previous investigations (Bruun, 1932, List of chromosome numbers, Tischler 1950).

Androsace L. Studied by H. Wcisło.

Androsace chamaejasme Wulf. (2n = 20).

According to Szafer (1949), in the Polish flora *Androsace chamaejasme* is a representative of the alpine-arctic eurasiatic element. It is regarded as a species of mountain origin which presumably migrated northwards in the Diluvial period. In Poland it is common in the limestone part of the Tatra Mts, where its vertical distribution extends from the higher mountain layer to the layer of *Pinus montana*. The plants studied originated from the following habitats in the Western Tatra: Gładkie Upłaziańskie, a grassy slope (c. 1500 m o.s.l.); Twardy Upłaz (c. 1600 m o.s.l.); Ciemniak, below the peak (c. 2050 m o.s.l.).

In all specimens investigated, the chromosome number 2n = 20 could be established (Fig. 20). The same chromosome number (n = 10) has been found by Favarger (1954) for this species and by Dahlgren (1916) for *A. septentrionalis*.

On the other hand, higher numbers have been reported for *A. maxima* by Titova (n = 29—30, cited from Tischler 1950), and for *A. villosa* (n = 36—37) by

Sokolovskaja and Strelkova for plants from the Caucasus (1940, cited from Tischler 1950). This points to a well marked karyological differentiation within the genus *Androsace*.

Primula L. Studied by M. Skalińska
Primula auricula L. (2n = 62).

A mountain species occurring in Poland in the Pieniny and Tatra Mts on calcareous rocks. Its vertical distribution extends from lower mountain habitats to the alpine layer. The plants for the present study originated from rocks in higher parts of Krokiew (Western Tatra, c. 1300 m). Their chromosome number 2n = 62 agrees with that first determined by Wanner (1943) and confirmed by Larsen (1954) for plants from the Swiss Alps.

Menyanthaceae

Menyanthes L. Studied by R. Trafas.
Menyanthes trifoliata L. (2n = 54).

This species occurs in Poland in wet meadows, swamps and moist ditches. The specimens studied originated from two habitats in the north of Poland: Isle of Wolin and Jastrzębia Góra on the Baltic coast. The number 2n = 54 found in all plants studied (Fig. 24) is in accordance with the previous results of Palmgren (1943), Rork (1949) Löve (1954), Löve a. Löve (1956) and of Jörgensen, Sörensen and Westergaard (1958).

Gentianaceae

Swertia L. Studied by K. Satczek.
Swertia perennis L. ssp. *alpestris* (Bmg.) Jav. (2n = 28).

The ssp. *alpestris* is a rather common plant in higher parts of the Carpathian range, especially in the limestone part of the Tatra Mts. It grows on wet rocks and on shady slopes, frequently also on borders of streams. The material originated from four habitats in the Western Tatra 1. Valley of Biały (c. 940 m o.s.l.); 2. Valley of Mała Łąka (c. 950 m o.s.l.); 3. Valley Kościeliska (c. 930 m o.s.l.); Gorge Kraków (c. 1100 m o.s.l.). All plants had the somatic number 28 (Fig. 23). The same number has been reported by Favarger (1952) who studied plants of *Swertia perennis* from the Alps and from the Jura in Switzerland; on the other hand Woycicki (1937) counted in plants of var. typica of unknown origin only 24 chromosomes.

Gentiana L. Studied by M. Skalińska.
Gentiana ciliata L. (2n = 44).

This perennial species is common in the Western Tatra in lower habitats on dry grassy slopes and light scrubs. The specimens for the present study were collected in a scrub near the entrance to the Valley of Biały (c. 900 m o.s.l.) and on a sunny grassy slope over the Valley Jaworzynka (c. 1200 m o.s.l.). The chromosome number of this species is 2n = 44. The present results agree with those of Favarger (1949)

who counted 22 bivalents in the I Metaphase of the E.M.C.'s and 22 chromosomes in the pollen grain mitosis of plants from natural habitats in the Alps.

Boraginaceae

Cynoglossum L. (x = 12). Studied by R. Czapik.

Cynoglossum officinale L. (2n = 24).

The material of this species was collected in the form of seeds originating from plants growing in the following localities of Central Poland: near a road in Cie-

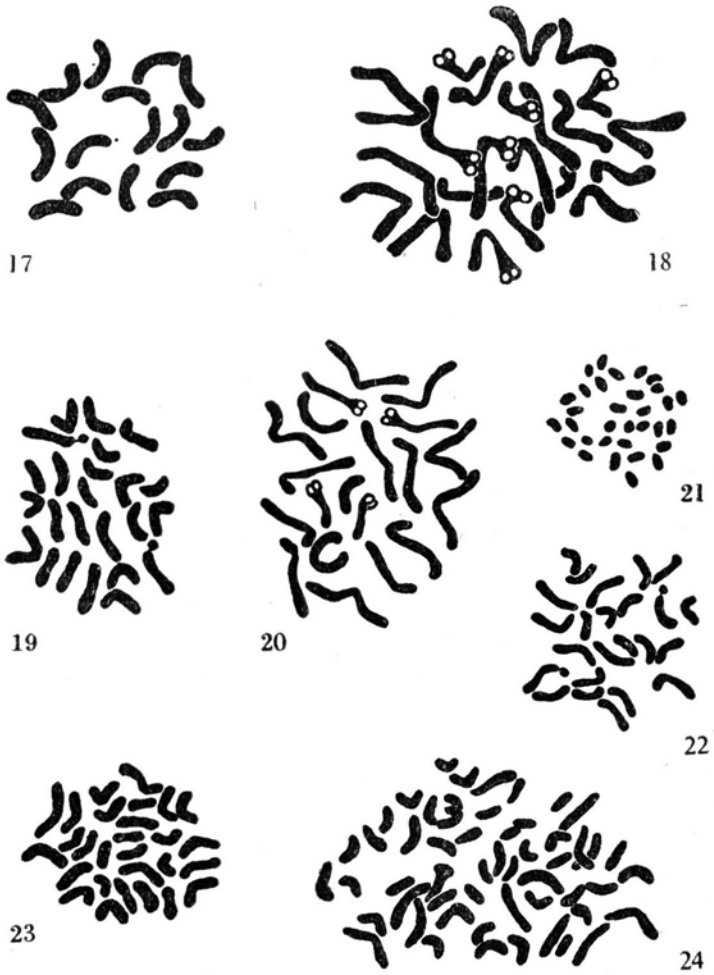

Fig. 17—24. Root-tip metaphases: *17 — Hacquetia epipactis* (2n = 16). *18 — Archangelica officinalis* (2n = 22). *19 — Cortusa Matthioli* (2n = 24). *20 — Androsace chamaejasme* (2n = 20). *21 — Pinguicula alpina* (2n = 32). *22 — Cynoglossum officinale* (2n = 24). *23 — Swertia perennis* ssp. *alpestris* (2n = 28) (× 3000). *24 — Menyanthes trifoliata* (2n = 54) (× 4000)

chocinek (N. Lat. 52° 53′), in Ząbinek near Włocławek (N. Lat. 52° 50′), on the road border of Zbocza Płutowsko-Starogrodzkie near Bydgoszcz (N. Lat. 53° 10′) and in the neighbourhood of the castle ruins in Inowłódz near Tomaszów Mazowiecki (N. Lat. 51° 10′).

The seeds germinated easily and abundantly on Petri dishes after careful taking off their pericarp and seed coat. All plants had 24 somatic chromosomes (Fig. 22). In the metaphase plates two chromosomes with trabants could be discerned. The same chromosome number had been found by Strey (1931) who investigated meioses of *C. officinale,* by Britton (1951, cit. acc. to Darlington and Wylie 1955) as well as by Löve and Löve (1956).

It should be added that among the plants germinated from seeds collected in Ząbinek a pair of twins has been found. One of these plants was lost in a very young stage before the fixation of root tips was possible while the second developed into a normal diploid plant.

Labiatae

Glechoma L. (x = 9) Studied by M. Skalińska.

Glechoma hederacea L. (2n = 36).

A common plant occurring in Poland in light scrubs, along road borders and frequent also as a garden weed. In the Carpathians it is found only in lower situations. The specimens for the present study originated from the following habitats: Kulikowo, near Warsaw, scrub on the right bank of the river Vistula; Zakopane, roadside; Antołówka over Zakopane, border of a meadow; Krakow, in a garden as a weed. The specimens studied have been identified as *Glechoma hederacea* L. which is common in Poland. The second species of the genus, *G. hirsuta* W.K. is notably rarer and occurs only in the south-eastern part of the country. All plants investigated had 2n = 36. Previous studies however have revealed a differentiation within this species. In addition to the number 36, also the diploid number 2n = 18 has been reported by some authors (e.g. Scheerer, 1940).

Scrophulariaceae

Digitalis L. (x = 7). Studied by H. Wcisło.

Digitalis grandiflora Mill. (*D. ambigua* Murr.). (2n = 26).

The genus *Digitalis* in Poland is represented by three species, *D. grandiflora* Mill., *D. purpurea* L., and *D. lutea* L. Only the first species is indigenous to the flora of Poland. It occurs in clearings, scrubs and in light woods both in the plain and in mountain regions, where it ascends from the lower mountain layer to the layer of *Pinus montana.* The plants for the present study were collected in the following habitats in southern Poland, in the range of Gorce and in the Tatra Mts.: Leńcze near Kalwaria, clearing of a wood (N. lat. 49° 54′, c. 650 m o.s.l.); Gorce: Poręba Wielka (N lat. 49° 48′, c. 800 m o.s.l.); Poronin near Zakopane, Galicowa Grapa (c. 950 m o.s.l.); Tatra Mts: Valley of Biały, border of a stream (c. 900 m o.s.l.); Łysanki, near the peak (c. 1440 m o.s.l.); Zadnie Kamienne (c. 1300 m o.s.l.).

The number 2n = 56 established in the course of the present study is in accordance with the results of all previous authors (Buxton and Newton 1928, Michaelis 1931, Haase-Bessel 1932, Buxton and Dark 1934).

Bartsia L. (x = 6,7). Studied by H. Wcisło.
Bartsia alpina L. 2n = 24.

This species has a discontinuous area of distribution, with separate centres in high mountains of Europe, Asia, North America and in the arctic. It is considered as a species of mountain origin (Szafer 1949). In Poland *B. alpina* occurs in the Sudetic Mts, Western Carpathians (Babia Góra), and in the Tatra Mts. Its vertical distribution extends from the layer of subalpine forests to the alpine layer. The specimens for the present study have been collected in the following habitats: Western Tatra: Ciemniak near the entrance to Grota Lodowa (c. 1710 m o.s.l.); higher part of Wielki Żleb below Ratusz (c. 1800 m o.s.l.); High Tatra: slope of Opalone (c. 1700 m o.s.l.); slope of Kosista (c. 2010 m o.s.l.).

In all plants studied the number 2n = 24 has been found. According to previous studies on plants from other geographical areas, *B. alpina* shows a high degree of karyological differentiation. It is represented by four different chromosomic types: 2n = 12 (Mattick, cited from Tischler 1950), 24 (v. Witsch 1932, Mattick, cited from Tischler 1950, Favarger 1953, Löve and Löve 1956, and the present study), 28 (Böcher and Larsen 1950), 36 (Doulat 1946, cited from Böcher and Larsen 1950).

Böcher and Larsen (1956) assume the occurrence of two different basic chromosome numbers: 7 in the arctic regions and 6 in Central Europe. The results of Löve and Löve (1956) obtained for plants from Iceland suggest that the forms with the basic number 6 have a wider geographic distribution.

Lentibulariaceae

Pinguicula L. (x = 8). Studied by M. Skalińska.
Pinguicula alpina L. (2n = 32).
Pinguicula vulgaris L. (2n = 64).

In the flora of Poland the genus *Pinguicula* is represented by three species: *P. alpina, P. vulgaris* and *P. bicolor* Woł., a species closely related to *P. vulgaris* and considered by some taxonomists as a subspecies of the latter. The correct chromosome numbers of *P. alpina* and *P. vulgaris* had been first reported by Löve and Löve 1944 (cited from 1948) for plants from Sweden. The same results were obtained by Doulat (1947) for plants from France, and recently the chromosome number of *P. vulgaris* has been confirmed for specimens from SW Greenland by Jörgensen, Sörensen and Westergaard (1958). According to the results of Zurzycki (1954) who studied in this Institute *P. vulgaris* and *P. biflora* from natural habitats in southern Poland, these two species have 2n = 64. On the other hand, the chromosome number of *P. alpina* was not studied hitherto in Poland.

Pinguicula alpina in the flora of Poland belongs to the Eurasiatic arctic-alpine element. It is very frequent at lower altitudes in the Tatra Mts. The plants for the present study originated from the following habitats in the Western Tatra: a shady slope over the valley of Biały (c. 930 m o.s.l.); on moist calcareous rocks in lower parts of Gorge Krakow, Valley Kościeliska (c. 1100 m o.s.l.); a slope over valley Jaworzynka (c. 1100 m o.s.l.); calcareous rocks of Skupniów Upłaz (c. 1400 m o.s.l.), Pass Między Kopami, a grassy slope over the road (c. 1500 m o.s.l.). All plants had 2n = 32 (Fig. 21) in accordance with the previous results.

Pinguicula vulgaris. A renewed study of this species has been undertaken in view of the fact that the plants studied previously by Zurzycki originated exclusively from lower altitudes in the Western Tatra. This species is very rare on higher elevations; according to Kotula (1890) it ascends only to c. 1200 m; however in 1955 a colony of small plants belonging to *P. vulgaris* has been detected in the High Tatra at the altitude of c. 1600 m (layer of *Pinus montana*), on a steep slope over the path from the lake Morskie Oko to Pass Szpiglasowa. These plants were found near a spring in swampy ground among *Sphagnum*. Their rosettes of leaves had hardly 4 cm in diameter, and their flowers were notably smaller and paler than those of typical plants of *P. vulgaris*. The resp. morphological differences however could be due to local modifications. The chromosome number of plants from this unusual habitat was exactly the same as that reported previously: 2n = 64.

Rubiaceae

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

Asperula odorata L. (2n = 44).

In Poland this species is rather common in lowland habitats in shady deciduous woods; in the mountains it ascends to the higher mountain layer. The material studied originated from seven habitats: northern Poland — Elbląg; southern Poland — Grabowiec, Myślenice, Cwilin, Zawoja; Western Carpathians (Babia Góra; Pieniny Mts (Trzy Korony).

In all specimens the number 2n = 44 was found (Fig. 25). The same number has been established previously by Fagerlind (1937), Homeyer (1933, 1937) and Poucques (1949).

Asperula tinctoria L. (2n = 44)

This species occurs in Poland in the lowland and only rarely in lower mountain habitats. The chromosome number 2n = 44 found in specimens originating from the vicinity of Kraków (Fig. 26) agrees with that previously established by Fagerlind (1934, 1937).

Galium L. Studied by M. Piotrowicz.

Galium verum L. (2n = 44)

This species is widely distributed over all Poland, both in the plain and at lower altitudes in mountains; it occurs in meadows, along field borders and in light scrubs.

The chromosome number 2n = 44 (Fig. 27) established on specimens originating from four separate habitats in the vicinity of Warsaw agrees with the number given for that species by Fagerlind (1934, 1937) and Homeyer (1933, 1936). In addition, the diploid number has been established previously by Poucques (1949), while Fagerlind reported the number 2n = 66 for a single specimen. These results suggest that the tetraploid type has a wider geographic distribution. In southern Europe it occurs together with the diploids which are absent from northern Europe.

Somewhat similar relations were noticed by Fagerlind (1937) for *Galium mollugo*. Within this species the tetraploid forms occupy a much wider area than the

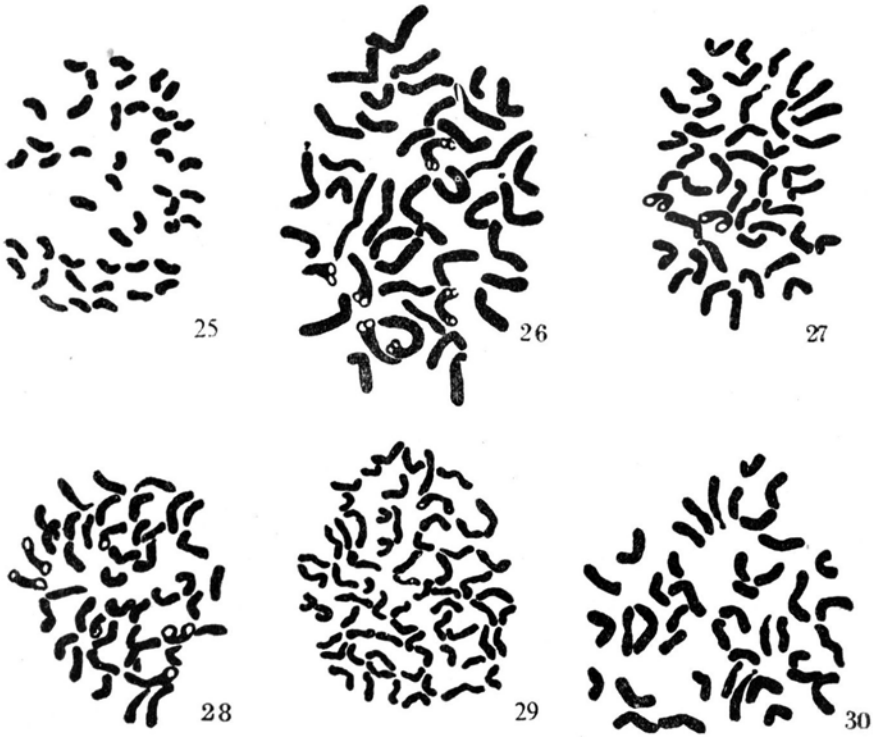

Fig. 25—30. Root-tip metaphases: *25* — *Asperula odorata* (2n = 44). *26* — *Asperula tinctoria* (2n = 44). *27* — *Galium verum* (2n = 44). *28* — *Galium anisophyllum* (2n = 44). *29* — *Galium boreale* (2n = 66). *30* — *Galium aparine* (2n = 42). (× 3700)

diploids, the habitats of the former extending more northwards. However according to recent studies on the Polish material of *G. mollugo* (Piotrowicz 1958), also the diploid type extends farther northwards than it could be anticipated from previous investigations. In connection with these results a more detailed study of the Polish representatives of *G. verum* has been started.

Galium anisophyllum Vill. (2n = 44). Studied by M. Piotrowicz.

In a previous paper on *Galium* Piotrowicz (1958) reported the tetraploid number for plants of *Galium anisophyllum* from the Western Carpathians (Babia Góra) and the Tatra Mts. Now these results have been supplemented by the study of specimens from the Pieniny Mts (N. lat. 49° 25′, E. long. 20° 25′). They proved to by likewise tetraploid. (Fig. 28).

The chromosome number 2n = 44 of *Galium anisophyllum* from Poland agrees with that previously reported for this species by Fagerlind (1934, 1937) and Ehrendorfer (1949). This author however reported also other numbers, viz. 2n = 22, 66, 88, 110 for plants from Tyrol and the Alps (1949, 1955, 1956, 1958)

Galium boreale L. 2n = 66

For *Galium boreale* two chromosomic types 2n = 44 and 66 have been reported by Löve (1954a, b), by Löve and Löve (1954, 1956), Poucques (1949), Turesson (1938), Homeyer (1933, 1936), Fagerlind (1934, 1937), as well as by Böcher and Larsen (1950). The former type occurs in Europe and Western and Central Asia, while the latter has been reported only from North America and Eastern Asia.

In the course of the present study the chromosome number 2n = 66 (Fig. 29) was established on plants from two habitats: Northern Poland — Baltic Coast (Dębki, N. Lat. 54° 50′, E. Long. 18° 8′); Southern Poland in the vicinity of Kraków (N. Lat. 50° 4′, E. Long. 19° 57′).

It should be emphasized that hitherto the hexaploid type was not reported from Europe. According to Löve and Löve (1954) the number 66 given by Homeyer (1933, 1936) originated probably from a botanical garden; the source of that material is unknown. In view of the present result a more detailed cytotaxonomical study of this species in Poland is in progress.

Galium aparine L. 2n = 42

This species is well distributed in Europe (in Scandinavia to N. Lat. 68° 56′), in parts of Asia and is introduced also in North and South Africa. It is of common occurrence in Poland in woods, scrubs and fields as well as in ruderal habitats. The material studied originated from 4 habitats: Vicinity of Wrocław (N. Lat. 51° 6′, E. Long. 17° 3′), Kraków (N. Lat. 50° 4′, E. Long. 19° 57′), Jordanów (N. Lat. 49° 38′, E. Long. 19° 47′), the Pieniny Mts (N. Lat. 49° 25′, E. Long. 20° 25′).

It should be emphasized that in all specimens the aneuploid number 2n = 42 has been found (Fig. 30). This number has not been reported hitherto. Previous studies have led to establish the following chromosome numbers: 2n = 22, 44 (Poucques 1949), 64 (Böcher, Larsen and Rahn 1955, Fagerlind 1934, 1937), c. 66 (Löve and Löve 1956) and 86 (Fagerlind 1934, 1937).

Thus, besides the number 42 found in the course of the present study, two other aneuploid numbers were found hitherto in *G. aparine*: 2n = 64 and 86. In each of

these numbers the deviation from the corresponding euploid types comports two missing chromosomes.

The occurrence of aneuploid numbers in *G. aparine* is in contrast with the results obtained for other *Galium* species. It should be added however that Fagerlind (1934, 1937) has also found an aneuploid number (2n = 45) in a single specimen of *G. mollugo*.

Valerianaceae

Valeriana L. (x = 7,8). Studied by M. Skalińska.

Valeriana sambucifolia Mikan. (2n = 56).

In Poland the main centre of distribution of this octoploid species is found in the mountain regions in the south. In the course of our previous work (Skalińska, 1951) the chromosome number of plants from the Western Carpathians (Babia Góra), the Pieniny and Tatra Mts has been investigated. Plants for the present study originated from an area not explored previously, namely the Eastern Carpathians, range of Bieszczady (N. Lat. 49° 00′, E. Long. 22° 45′), slope of Mały Halicz (1220 m o.s.l.) under *Alnus* trees. The resp. specimens could be identified without hesitation as *Valeriana sambucifolia* in view of the occurrence of overground runners and of the very low number of leaflets in stem-leaves (3 pairs, cf. Skalińska 1951, p. 163). The chromosome number of these plants (2n = 56) is in accordance with our previous results.

Campanulaceae

Campanula L. Studied by M. Skalińska

Campanula alpina Jacq. (2n = 34).

In Poland the occurrence of this species is limited to the Tatra Mts. It grows almost exclusively on granitic soil in the High Tatra, where its vertical distribution extends from the layer of *Pinus montana* to the alpine layer. The plants for the present study originated from three separate habitats in the High Tatra. Layer of *Pinus montana*: near the path to Świstówka over Hala Gładka, c. 1600 m o.s.l.; a grassy slope near the path from the valley of Stawy Gąsienicowe to the pass Liliowe, c. 1700 m o.s.l. Alpine layer: slope of Granaty, among rock debris, c. 2000 m o.s.l. The chromosome number of *Campanula alpina* has not been studied hitherto; according to the results obtained in the course of the present work, this species has 2n = 34 (Fig. 31), thus, within the genus it belongs to the group of species with the basic number 17.

Compositae

Bellis L. (x = 9). Studied by M. Piotrowicz.

Bellis perennis L. (2n = 18.).

This species is common in Poland in the plain and in the mountains where it ascends to the layer of *Pinus montana*.

The somatic chromosome number was studied in plants from the following habitats: Northern Poland: Prabuty (N. Lat. 53° 45′, E. Long. 19° 47′) as well

as from the southern parts of the country: from the vicinity of Kraków; Myślenice (N. Lat. 49° 50′, E. Long. 19° 57′); Jordanów (N. Lat. 49° 38′, E. Long. 19° 47′); Western Tatra, Sarnia Skała (1360 m o.s.l.). The number 2n = 18 found in all plants studied is in accordance with the results of the previous authors (list in: Tischler 1950, Darlington and Wylie 1955).

Bellidiastrum Cass. (x = 9). Studied by M. Skalińska.
Bellidiastrum Michelii Cass. (2n = 18).

This perennial species occurs in Poland only in mountain habitats. It is very common in the Tatra Mts from the higher mountain layer to the alpine layer, and

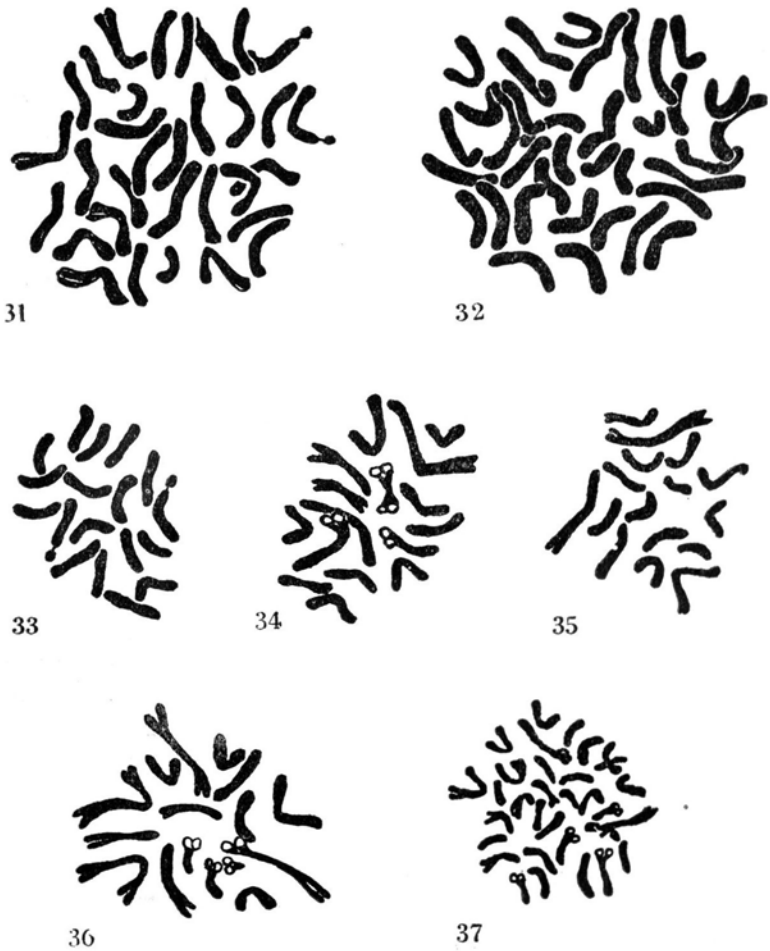

Fig. 31—37. Root-tip metaphases: *31 — Campanula alpina* (2n = 34). (× 3600). *32 — Aster alpinus* (2n = 36). *33 — Erigeron uniflorus* (2n = 18). *34 — Inula salicina* (2n = 16). *35 — Inula hirta* (2n = 16). *36 — Inula ensifolia* (2n = 16). *37 — Inula britannica* (2n = 32). (× 3000)

it occurs also in the Pieniny Mts. It is a calcicolous species which grows on limestone rocks.

The chromosome number of this species has been established recently by Larsen (1954) who reported the somatic number 18 for plants from two habitats in the Alps. The same number has been found in plants from the Western Tatra: calcareous rocks near the entrance to valley of Biały and over the road on the slope of valley Jaworzynka.

Aster L. (x = 9).

Aster tripolium L. (2n = 18). Studied by M. Piotrowicz.

This halophytic species occurs in Poland chiefly along the Baltic coast in salt marshes, but it is found rarely also in the inland salines.

The plant material originated from two habitats on the Hel peninsula (Baltic coast): Jurata and Jastarnia (N. Lat. 54° 45′, E. Long. 18° 20′).

The chromosome number of the plants investigated (2n = 18) is in accordance with the previous results (list in: Tischler 1950, Darlington and Wylie, 1955).

Aster alpinus L. (2n = 36). Studied by H. Wcisło.

In Poland the distribution of *Aster alpinus* is restricted to the Pieniny Mts and to the limestone part of the Tatra Mts. The specimens from the following habitats have been studied: Pieniny Mts: Limestone rocks near the bank of river Dunajec between Szczawnica and Krościenko (c. 700 m o.s.l.); Czerwone Skałki, near the path from Sokolica to Trzy Korony (750 m o.s.l.); Tatra Mts: Kościeliska Valley — limestone rocks over the entrance to Grota Mylna (c. 950 m o.s.l.); Zadnie Kamienne (c. 1300 m o.s.l.).

All plants investigated had 2n = 36 (Fig. 32). The same chromosome number has been found previously by Sokolovskaja and Strelkova in materials from Pamir and Altai (1938, cited from Darlington and Wylie 1955). On the other hand, a different chromosome number (2n = 18) has been reported by Sakai (1935) in his list of alpine plants, for materials of unknown origin. It should be added that the present study gives the first report concerning the chromosome number of *A. alpinus* in the montains of central Europe. It would be interesting to study specimens from the Alps.

Erigeron L. (x = 9). Studied by E. Pogan.

Erigeron uniflorus L. (2n = 18).

A perennial species occurring in Poland on moist mountain pastures and rocks in the Tatra Mts, chiefly in the alpine layer. It is a representative of the arctic-alpine flora with a putative centre of origin in the mountain regions (Kulczyński 1924).

The specimens studied were collected in the Western Tatra, on the slopes of Ciemniak (c. 1800 m o.s.l.; group of Czerwone Wierchy). The diploid number 2n = 18 (Fig. 33) established in the course of the present study is in accordance with that reported previously for plants from the north by Holmgren (1919,

cit. from Böcher and Larsen 1950), Böcher and Larsen (1950), Löve (1950) as well as Löve and Löve (1948, 1956) and recently by Jörgensen, Sörensen and Westergaard (1958).

Gnaphalium L. (x = 7). Studied by M. Skalińska.
Gnaphalium supinum L. (2n = 28).
Gnaphalium norvegicum Gunn. (2n = 56).

The occurrence of these two species is limited in Poland to the mountains; their vertical distribution extends from lower mountain habitats to the highest peaks. Hitherto the chromosome numbers of these two species have been studied on specimens from the north.

Plants of *G. supinum* have been collected in the Western Tatra in the glacial cirque „Piekło" (c. 1600 m o.s.l.) on the south-eastern slope of Giewont; they grew in shade among large blocks of rocks in humus-filled cracks. Their chromosome number agrees with that found by Löve and Löve (1948, 1956) for specimens from Scandinavia and Iceland, as well as with the results of Jörgensen, Sörensen and Westergaard for plants from SW Greenland.

The material of *G. norvegicum* originated from three habitats: the Sudetic Mts, range of Karkonosze (coll. Dr. I. Kucowa); Western Tatra: a slope over Hala Kondratowa; Mt. Czuby Goryczkowe, near the peak (c. 1900 m). All plants studied had 2n = 56 in accordance with the results of Löve and Löve (1944, cited from 1948, 1956); the same approximate number (54—57) has been reported by Jörgensen, Sörensen and Westergaard. Thus, in the two species of *Gnaphalium* the same numbers have been found in central-european mountains as in northern areas.

Inula L. Studied by Z. Bauer.
Inula ensifolia L. (2n = 16).
Inula salicina L. (2n = 16).
Inula hirta L. (2n = 16).
Inula britannica L. (2n = 32).

Inula ensifolia: According to Kozłowska (1931) *Inula ensifolia* represents in the Polish flora a steppe relict with a dispersed area of distribution; it occurs in a few isolated centres on loess layers of the Plateau of Little Poland and the Plateau of Lublin; in addition it grows in the Pieniny Mts. Plants from the following habitats have been studied: Plateau of Little Poland: lower course of the river Nida (N. Lat. 50° 20′); Tunel near Miechów, in a beech wood (N. Lat. 50° 27′); the jurassic Valley of Kluczwoda; the limestone Valley Kalina Mała near Kraków; Pieniny Mts: Sokolica, lower part of the slope; a meadow above the bank of river Dunajec.

The chromosome number of *I. ensifolia* 2n = 16 (Fig. 36) agrees with that previously established by Reese (1953).

I. salicina occurs chiefly in the southern part of Poland in the plain and in lower

mountain regions (Szafer, Kulczyński, Pawłowski 1953). The specimens studied were collected in the following habitats: Ojców near Kraków, beech wood in a jurassic valley; Pieniny Mts: way to Czertezik — in a beech wood; way from Szczawnica to Krościenko — in a meadow; Sokolica, lower part of the slope (together with *I. ensifolia*); Orlica, a spruce forest; Czerwone Skałki, on calcareous rocks in a beech wood.

All plants investigated had the diploid chromosome number 2n = 16 (Fig. 34). It should be added that the present study gives the first report of the chromosome number of this species.

It is worth while mentioning that in the lower part of the slope of Sokolica, where plants of *I. salicina* and *I. ensifolia* are growing together, numerous intergrading forms, probably of hybrid origin, were found; they had likewise 2n = 16.

I. hirta L. In the Polish flora *I. hirta* is a representative of the mediterranneanpontic element (Szafer 1949). This species is rare in northern Poland; on the other hand in lowland habitats of central and southern Poland as well as in calcareous parts of lower mountain regions it occurs rather frequently. The plants studied originated from four habitats in jurassic valleys north-west of Kraków, limestone rocks of Valleys of: Kluczwoda, Bolechowicka, Będkowska, Kalina Mała.

This species is, likewise, diploid; the chromosome number 2n = 16 (Fig. 35) was found. The same number has been previously reported for plants originating from southern Europe (Tongiorgi 1935, 1942, cited from Darlington and Wylie 1955).

I. britannica L. According to previous records, some degree of cytological differentiation occurs within this species. In the course of the study of *I. britannica subsp. japonica* Kitam., Okabe (1937) revealed the occurrence of two chromosome numbers: 2n = 16 and 24. On the other hand Pólya (cited from Soó 1947) found 2n = 32 for plants originating from Hungaria. In view on this, a large material has been collected for the present study from a variety of habitats in different parts of Poland: Bytyń near Poznań, a ditch along a road (N. Lat. 52° 28′); Izabelin near Warsaw — glade in a wood (N. Lat. 52° 16′); Spała — bank of the river Pilica (N. Lat. 51° 33′); Vicinity of Krakow: Przegorzały, meadows along the banks of the river Vistula; Podgórze, banks of Vistula; Olsza, a ditch along a road; Bieżanów, meadows along the bank of the river Drwinia; Szczawnica, meadows along the banks of the river Dunajec.

In all plants invariably the tetraploid chromosome number 2n = 32 (Fig. 37) could be established, in spite of well marked morphological differences among plants collected in various natural habitats; this suggests that the diploid type does not occur in Poland. The diploid subsp. *japonica* investigated by Okabe (1937) presumably represents a phylogenetically older type than that from the European continent.

Of the four species investigated, three: *I. ensifolia, I. salicina, I. hirta,* are diploid perennials occurring in Poland only in isolated habitats; this points to their putative

high age. By contrast, the tetraploid *I. britannica* is presumably a phylogenetically younger, usually biennial species with a wide area of distribution extending over almost all Poland.

Bidens L. (x = 12). Studied by E. Pogan.

Bidens cernuus L. (2n = 24).

Very few data concerning the chromosome numbers of the representatives of the genus *Bidens* are available. *Bidens cernuus* was studied karyologically only by Levitsky (in litt. 1934, 1940; cit. from Tischler, 1950) who found the number 2n = 24.

In Poland this annual species is rather common in the plain and in lower mountain habitats. It occurs there on borders of ponds and ditches and in peat-bogs.

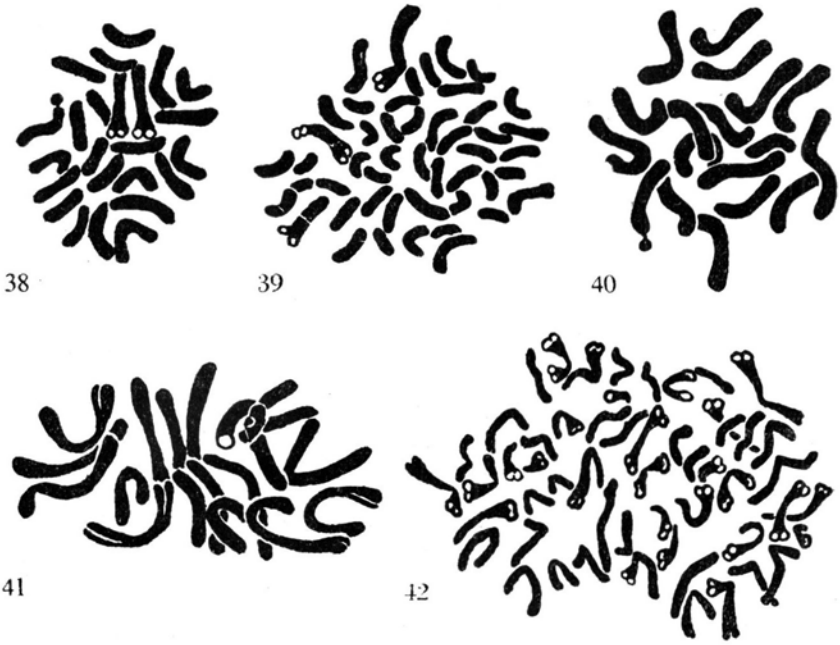

Fig. 38—42. Root-tip metaphases: *38* — *Bidens cernuus* (2n = 24). *39* — *Bidens tripartitus* (2n = = 48). *40* — *Achillea nobilis* (2n = 18). *41* — *Chrysanthemum alpinum*, f. *Tatrae* (2n = 18). (× 3000). *42* — *Chrysanthemum Zawadzkii* (2n = 54). (× 2800)

Specimens collected in Pychowice near Kraków proved to have 2n = 24, (Fig. 38) in accordance with the results of Levitsky (l.c.). This species is diploid, the basic number of the genus being x = 12.

Bidens tripartitus L. (2n = 48).

This annual species is very common on moist meadows, borders of ponds and ditches. It occurs over all Poland in the plain and in lower mountain habitats.

The specimens for the present study originated from three habitats: Swoszowice near Kraków — two separate habitats, borders of ditches; Kraków-Płaszów, bank of a pond. Their chromosome number was 2n = 48, (Fig. 39), thus this species is tetraploid. This result agrees with those of previous studies (Levitsky 1934, 1940; Tarnavschi 1943; cit. from Tischler 1950).

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

Achillea nobilis L. (2n = 18).

According to Hegi (VI, 2) *Achillea nobilis* L. in Central Europe is a species which belongs to the South-European pontic element with a very wide distribution. In Poland this species is very rare and occurs only on the plateau of Little Poland. The specimens for the present study were collected from a calcareous hill in Brzyszów near Częstochowa (N. Lat. c. 50° 50′), a habitat reported by H. Błaszczyk (1949). All investigated plants had 2n = 18 (Fig. 40). It should be added that the number of chromosomes of this species was not studied previously.

Chrysanthemum L. (x = 9).

Chrysanthemum rotundifolium W.K. (*Leucanthemum rotundifolium* (W.K.) D.C.) 2n = 18. Studied by H. Wcisło.

This species occurs in Poland in scrubs and woods both in the plain and in the mountains where it is found from the higher mountain layer up to the alpine layer. The material for the present study originated exclusively from the Tatra Mts; Western Tatra: Zadnie Kamienne (c. 1300 m o.s.l.); High Tatra: along the path from Valley of Morskie Oko to Czarny Staw (c. 1550 m o.s.l.); Slope of Miedziane — path from the Valley of the Lake Morskie Oko to Szpiglasowa Pass, among *Pinus montana* (c. 1750 m o.s.l.).

The chromosome number of *Ch. rotundifolium* 2n = 18 agrees with that previously established by Shimotomai (1937) for specimens from the Botanical Garden Berlin-Dahlem.

Chrysanthemum alpinum L. (2n = 18). Studied by A. Zielińska

Chrysanthemum alpinum is a common species in the granitic part of the Tatra Mts, where it occurs in the layer of *Pinus montana* and in the alpine layer. According to Vierhapper (1914), this species is represented in the High Tatra by two forms: forma *cuneifolium* Murr. and forma *Tatrae* Vierh. The plants collected for the present study originated from the following habitats: Forma *Tatrae* — slopes of Mt Granaty, alpine layer (c. 1950 m o.s.l.), two colonies; slope of Kasprowy Wierch, layer of *Pinus montana* (c. 1700 m o.s.l.); near the pass Sucha Przełęcz, alpine layer (c. 1900 m o.s.l.). Forma *cuneifolium* — valley Kozia Dolinka, alpine layer (c. 1930 m o.s.l.). All plants were diploid: 2n = 18 (Fig. 41).

The chromosome number of *Ch. alpinum* was studied hitherto by two authors only: Chiarugi (1927, cited from Tischler 1950) reported the somatic number 18; on the other hand Shimotomai (1937) found 18 haploid chromosomes in the II

meiotic metaphase of plants from Tyrol, thus, the specimens investigated by him were tetraploid. This higher chromosomic type has not been found hitherto in the Tatra Mts.

Chrysanthemum Zawadzkii Herb. (2n = 54) Studied by M. Piotrowicz (=*Chrysanthemum Zawadzkii Herb.* var. *pieninicum Koz-Polj.* =*Tanacetum Zawadzkii (Herb) Pawł.)*.

This endemic form occurs exclusively on limestone rocks in the central part of the Pieniny Mts. It is common on the two banks of the river Dunajec, both in Poland and in Czechoslovakia.

The plant material studied cytologically was collected in 14 habitats in the Polish part of the Pieniny Mts: along the road between Krościenko and Szczawnica; the gorge Soboczański; slope of Orlica; Biała Skała; Mt Czertezik; Mt Sokolica; Mt Zamkowa Góra; peak of Trzy Korony (982 m o.s.l.).

In all plants studied the number 2n = 54 has been found (Fig. 42). In view of the fact that the basic number of the genus is 9, this species is hexaploid. This number is different from that previously established by Shimotomai (1937). In the study of meiosis of specimens from the Botanical Garden Berlin-Dahlem this author reported n = 36; thus, the plants studied by him were octoploid (2n = 72).

As all plants studied in the course of the present work originated from their native habitats in the Pieniny Mts, they could be identified with certainty as true representatives of the species. Therefore it seems probable that the specimens studied by Shimotomai did not represent really *Chrysanthemum Zawadzkii.*

Tanacetum L. (x = 9). Studied by M. Piotrowicz.

Tanacetum vulgare L. (2n = 18).

Tanacetum vulgare is well distributed in Poland both in the plain and in lower mountain habitats. The specimens for the present study were collected in four habitats. Northern Poland: Prabuty, Masovian Lake district; Central Poland: Izabelin near Warsaw; Southern Poland: Myślenice; Jordanów. The chromosome number 2n = 18 agrees with that reported by all previous authors (list in Tischler, 1950, and in Darlington and Wylie, 1955).

Artemisia L. (x = 8,9). Studied by K. Urbańska

Artemisia vulgaris L. (2n = 16)

A very common species in Poland. The plants studied originated from 21 habitats in all the country. Their chromosome number 2n = 16 (Fig. 43) is in accordance with most previous results (e.g. Wulff 1950). For this species however also the chromosome number 2n = 18 was reported by Weinedel-Liebau (1928 cit. from Darlington a. Wylie 1955). Within the genus *Artemisia* two basic chromosome numbers: x = 8,9 and in addition the secondary number x = 17 are known. Thus, the Polish specimens of *A. vulgaris* studied in the course of the present work, are diploid with the basic number 8.

Artemisia austriaca Jacq. (2n = 16)

Artemisia austriaca is a rather rare species in the Polish flora known hitherto only from few habitats. The specimens originated from southern Poland: a sandy hill near Szczakowa. This species has not been studied cytologically hitherto. Its chromosome number reported here for the first time is 2n = 16 (Fig. 44). Thus, this species is diploid with the basic number 8, like the Polish biotypes of *A. vulgaris* studied hitherto.

Artemisia pontica L. (2n = 18)

A very rare species in Poland. The material originated from a single habitat near Huta Komorowska (south-eastern Poland). The chromosome number 2n = = 18 (Fig. 49) is in accordance with the results of Weinedel-Liebau (1928, cit. from Darlington a. Wylie 1955) and Pólya (1948, from Tischler 1950). This species has the basic chromosome number 9.

Artemisia absinthium L. (2n = 18)

A common species occurring over all Poland. The somatic chromosome number established only from two habitats: Bochnia, east of Krakow and Huta Komorowska, is 18 (Fig. 46); this number is this same, as that found previously by Weinedel-Liebau (1928, cit. from Darlington a. Wylie 1955). In the course of the present work also specimens of *A. absinthium* var. *calcigena* Rehm. were studied. This variety occurs in Poland only in the Pieniny Mts. The specimens have been collected there on an escarpment near the castle of St. Kinga. Their chromosome number is likewise 2n = 18 (Fig. 48).

Artemisia abrotanum L. (2n = 18)

This species has not been studied hitherto. The material originated from one habitat: Huta Komorowska. The chromosome number is 2n = 18 (Fig. 45). Like *A. absinthium* and *A. pontica, A. abrotanum* is a diploid species with the basic number x = 9.

Artemisia petrosa Baumg. *(A. Baumgartenii* Bess.) (2n = 18, 36 (?))

This mountain species is rather rare in the Tatra Mts, where it is found almost exclusively in the alpine layer. The material was collected both in the granitic and the limestone part of the Tatra Mts. The list of habitats is given below:

Jatki Bielskie, Belan Tatra (2024 m o.s.l.); E. slope of Krywań, High Tatra (c. 1900 m o.s.l.); E. slope of Gerlach, High Tatra (c. 1950 m o.s.l.); granitic rocks over the path from Pass Rakuska to Valley of Zielony Staw Kieżmarski, High Tatra (c. 1700 m o.s.l.); metamorphic rocks over the lakes Raczkowe Stawki, Western Tatra (c. 2000 m o.s.l.).

No cytological studies on this species have been carried out hitherto. In the course of the present studies the somatic chromosome number 2n = 18 (Fig. 47) from four habitats was established. In one habitat, however, (E. slope of Krywań) the tetraploid number 2n = 36 has been found.

According to previous results (Weinedel-Liebau 1928, Erlandsson 1939, cit. from Darlington a. Wylie 1955), some species within the genus *Artemisia*

show a cytological differentiation: they are represented by diploids and tetraploids (e.g. *Artemisia campestris*). Possibly *Artemisia petrosa* has a similar differentiation, however, more detailed studies, which are in progress now, are required.

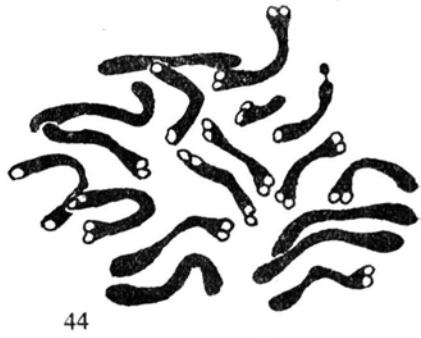

Fig. 43—49. Root-tip metaphases: *Artemisia* sp. *43* — *A. vulgaris* (2n = 16). *44* — *A. austriaca* (2n = 16). *45* — *A. abrotanum* (2n = 18). *46* — *A. absinthium* (2n = 18). *47* — *A. petrosa* (2n = 18). *48* — *A. absinthium*, var. *calcigena* (2n = 18). *49* — *A. pontica* (2n = 18). (× 4000)

Carlina L. (x = 10). Studied by R. Czapik.

Carlina onopordifolia Bess. (2n = 20).

C. onopordifolia Bess. is a very rare steppe species occurring only in three isolated habitats in south-eastern Poland, where the area of its distribution has the NW limit. The two habitats known long ago (Szafer 1923) are: Mt Stawska Góra near Chełmo on Lublin Plateau and Mt Pińczowska Góra in the distr. of Kielce. A third very abundant habitat has been found recently by prof. B. Pawłowski and A. Jasiewicz on slopes of the hill Wały near Racławice (vicinity of Miechów) in the association *Inuletum ensifoliae* (Jasiewicz and Pawłowski 1956). The present study was carried out on root tips of germinated seeds collected by Prof. Pawłowski in this habitat.

The number 2n = 20 (Fig. 50) is reported here for the first time, since hitherto this species has not been studied cytologically. The same number is known also in other representatives of the genus: *C. acaulis* (Poddubnaja-Arnoldi 1931), *C. vulgaris* and *C. acanthifolia* (Arata 1944, cit. from Darlington and Wylie 1955). The latter species is regarded as related to *C. onopordifolia* (Jasiewicz and Pawłowski 1956). Morphologically, the chromosomes of *C. onopordifolia* are similar to those of *C. acaulis* reproduced in the paper of Poddubnaja-Arnoldi (1931, fig. 100).

Silybum Adans. (x = 17). Studied by R. Czapik.

Silybum Marianum (L.) Gaertn. (2n = 34).

This species is indigenous in the Mediterranean area. In Poland it is introduced and grows as a weed in gardens and in waste places near gardens. The seeds for the present study have been collected from plants growing as weeds on field along the river Młynówka in Krakow. All seedlings had 34 somatic chromosomes (Fig. 51). The same number was established by Larsen (1956) on material from Italy as well as by Haiser and Whitaker (1948) in their studies of California weeds.

Cirsium L. (x = 17). Studied by R. Czapik.

Cirsium acaule (L.) Webb. (2n = 34).

In addition to the chromosome numbers of 10 species given in a previous paper (Czapik 1958) the chromosome number of *C. acaule* was investigated in the course of the present work. The plants were found on a calcareous slope of a hill in Mstów near Częstochowa (N. Lat. c. 50° 50′). The chromosome number studied only in one specimen was 2n = 34 (Fig. 54), thus, it was diploid with the basic number x = 17, like other European species of *Cirsium* investigated previously. The chromosome number established in the Polish material agrees with the results of Wulff (1937).

Serratula L. (x = 11). Studied by R. Czapik.

Serratula tinctoria L. subsp. *eu-tinctoria* Br-Bl. (2n = 22).

The species is common in Poland in the plain and in lower mountains habitats. The plants grow in meadows, in thickets and in light woods. The chromosome number

has been established on plants from two habitats in southern and central Poland: Kostrze near Krakow (bank of a draining ditch, one ♀ specimen) and Tomaszów Mazowiecki (seedlings of a plant growing on the border of a forest). The number 2n = 22 is in accordance with that found previously by Wulff (1939) and by Maude (1939). Two chromosomes with trabants could be occasionally discerned in the metaphase plates.

Onopordon L. (x = 17). Studied by R. Czapik.

Onopordon acanthium L. (2n = 34).

Onopordon acanthium is in Poland a very common ruderal plant occurring on road sides and waste places. The number of chromosomes was established on root-tip mitoses of young seedlings. The seeds were collected in four habitats: in Krakow (N. Lat. c. 50° 04′), Lublin (N. Lat. c. 51° 15′), Ząbinek near Włocławek (N. Lat. c. 52° 50′) and Ciechocinek (N. Lat. 52° 53′). All plants had 34 somatic chromosomes. The chromosome number agrees with that given by Poddubnaja-Arnoldi (1931) and their morphology corresponds to the fig. 27 of her paper.

Centaurea L. (x = 9, 10). Studied by R. Czapik.

Centaurea alpestris Heg. et Heer (2n = 20).

(= *C. scabiosa* L. ssp. *alpestris* (Hegetschw.) Hayek).

According to Szafer, Kulczyński and Pawłowski (1953) *C. alpestris* grows on limestone in the Pieniny and Tatra Mts where it ascends to the layer of *Pinus montana*. The number of chromosomes was established on root-tip mitoses of young plants cultivated from seeds collected by Dr. Z. Radwańska-Paryska; they originated from the southern slope of Mt Mały Murań (Tatra Mts, ČSR). The chromosomes are large, of the same type as in *Centaurea scabiosa* L. (Czapik 1954) and also the number of chromosomes (2n = 20, Fig. 52) is the same as that of this closely related species.

On the other hand in the western Alps tetraploid plants (2n = 40) determined as *Centaurea scabiosa* ssp. *alpestris* (Hegetschw.) Hayek have been found by Böcher and Larsen (1955). The chromosome number of *C. alpestris* from the Tatra Mts and the results of Böcher and Larsen point to the possibility of a karyological differentiation within this species.

Centaurea rhenana Bor. (2n = 18 + 0—2B).

(= *C. maculosa* Lam. ssp. *rhenana* (Bor.) Gugler).

Centaurea rhenana Bor. is common in the lowland of Poland. It grows on dry slopes, rocks and along road sides. The seeds for the present study were collected from the following localities in southern and central Poland: 1. Krzemionki and 2. Dębniki (Krakow, N. Lat. c. 50° 04′), 3. Tyniec near Krakow (N. Lat. c. 50° 01′), 4. Dębica (N. Lat. c. 50° 05′), 5. Tunel (N. Lat. c. 50° 25′), 6. Mstów near Częstochowa (N. Lat. c. 50° 50′), 7. Tomaszów Mazowiecki (N. Lat. c. 51° 30′), 8. Warsaw (N. Lat. c. 52° 15′).

In a previous paper (Czapik 1954) the erroneous basic number x = 10 has

been reported for plants of *Centaurea rhenana* from one habitat. More exact studies however showed that the correct number for this species is x = 9; in the P.M.C's meiosis of a plant from Dębniki nine bivalents could be discerned (Fig. 53c). On account of the frequent occurrence of accessory chromosomes in root tips, the diploid number of this species would be 2n = 18 + 0—2B (Fig. 53 a, b).

Three other species of *Centaurea* from Asia: *C. macrocephala* Muss., *C. ossica* and *C. ovina* Pall. (Poddubnaja-Arnoldi 1931) as well as *C. cineraria* L.


50


51


52


53 a


53 c


54


53 b


55


56


57

Fig. 50—57. Root-tip metaphases (except 53c): *50 — Carlina onopordifolia* (2n = 20). *51 — Silybum Marianum* (2n = 34). *52 — Centaurea alpestris* (2n = 20). *53 — Centaurea rhenana* (a — 2n = = 18, b — 2n = 18 + 2B, c — I Metaphase in a P.M.C., 9 bivalents). *54 — Cirsium acaule* (2n = = 34). *55 — Taraxacum laevigatum* (2n = 26). *56 — Taraxacum palustre* (2n = 40). *57 — Hieracium alpinum* (2n = 27). (× 3000)

from Italy (Larsen 1956) have likewise the number 2n = 18. According to Moore and Frankton (1954, cit. from Darlington and Wylie 1955) *C. maculosa* has the same basic number x = 9, these authors however reported the tetraploid chromosome number 2n = 36. The results obtained in the course of the present work and those of Moore and Frankton are interesting in view of the fact that some taxonomists regard *C. rhenana* as a subspecies of *C. maculosa*. This suggests the occurrence of types with a different degree of ploidy within such a collective species.

Accessory chromosomes were found only in plants from three habitats: Krzemionki Podgórskie, Tyniec and Mstów. They could be detected in all investigated seedlings, however not all metaphase plates within a root had the accessory chromosomes. They were most frequent in plants from Mstów (in 11 young seedlings 27 plates without accessory chromosomes, 15 plates with one and 17 with two accessories were visible). Possibly the accessory chromosomes are being eliminated during mitosis. In longitudinal sections of one root tip in some anaphase and telophase plates a single lagging chromosome could be discerned between the two groups of separating chromosomes.

Leontodon L. Studied by M. Skalińska.

Leontodon pseudotaraxaci Schur *(L. tatricus* (Kot.) Woł.) (2n = 12).

This mountain species occurring endemically in the Carpathians has in the Tatra Mts a vertical area of distribution extending from the layer of subalpine forests to the alpine layer. Plants for the present study have been collected on the slopes of Ciemniak, in the massif of Czerwone Wierchy (Western Tatra) at the altitude of c. 2000 m o.s.l. The chromosome number found by us in this species (2n = 12) has not been reported previously. The occurrence of various basic numbers within the genus *Leontodon* (x = 4, 5, 6, 7) is interesting. The somatic number 12 known previously only in *L. autumnalis*, has been found recently by Favarger (1953) in two oreophytic species: *L. helveticus* and *L. montanus*. The present result adds to this list a further oreophytic species — *Leontodon pseudotaraxaci*.

Taraxacum L. (x = 8). Studied by J. Małecka.

Taraxacum laevigatum (Willd.) DC. (2n = 26).

Taraxacum palustre (Lyons) Lam. et DC. (2n = 40).

Taraxacum laevigatum, a representative of the Section *Erythrocarpa*, is well distributed in Poland in lowland habitats. The plants have been collected in Jastrzębia Góra (Baltic coast, N. Lat. 54° 42′, E. Long. 18° 20′). The specimens studied had 2n = 26, an aneuploid chromosome number (Fig. 55). The same number has been found previously by Sears (cited from Gustafsson, 1932). On the other hand Gustafsson (l.c.) reported the exactly triploid number (2n = 24) for Scandinavian representatives of this species. It should be added that various spontaneous chromosome aberrants have been described already in apomictic *Taraxaca* by Sörensen and Gudjónsson (1946) and by Sörensen (1958).

These aberrants however represent hypotriploids (2n = 23), whereas the biotype of *T. laevigatum,* studied in the course of this work, is a hypertriploid.

Taraxacum palustre (section *Borealia*) is rather rare in Poland. It occurs in moist meadows, marshes, as well as in peat-bogs in the plain and at lower elevations in the Carpathians. The plants for the present study originated from a marsh in Zabierzów, near Krakow. They were pentaploid, their chromosome number being 2n = 40 (Fig. 56). This number differs from that previously established by Gustafsson (1935) who found the triploid number (2n = 24) in this species. It should be emphasized that in central Europe pentaploid types of *Taraxacum* are rather rare; most species with a higher degree of ploidy have been reported from the north. It is worth while mentioning however that another pentaploid type has been detected recently among the biotypes of *T. alpinum* from the High Tatra (Małecka 1958).

Crepis L. Studied by M. Skalińska

Crepis Jacquinii Tausch. (2n = 12).

This mountain species occurs in Poland only in the Tatra Mts on calcareous rocks. Its vertical distribution extends from the higher mountain layer to the alpine layer. The plants studied originated from three habitats in the Western Tatra: Slope of Mt Nosal, below the peak (c. 1200 m o.s.l.); slopes over the path from valley Jaworzynka to the pass Między Kopami, in calcareous scree (c. 1300 m o.s.l.); higher parts of Gorge Kraków, on steep cliffs (c. 1400 m o.s.l.). All plants had 2n = 12, in accordance with the results of Babcock (1947), summarized in his monograph on the genus *Crepis.*

Hieracium L. (x = 9). Studied by M. Skalińska.

Hieracium alpinum L. (2n = 27).

Hieracium villosum L. (2n = 36).

Hieracium alpinum is a mountain species occurring in Poland in the Western Carpathians (Babia Góra) and in the Tatra Mts, only on higher altitudes up to the alpine layer. The plants for the present study originated exclusively from the High Tatra. They were collected in the following habitats: Layer of *Pinus montana,* a grassy slope over the border of lake Czarny Staw Gąsienicowy, (c. 1600 m o.s.l.), path from the valley of Stawy Gąsienicowe to pass Świnicka (c. 1750 m o.s.l.); alpine layer, near the peak of Mt Beskid (c. 1900 m o.s.l.); all plants were triploid (2n = 27) (Fig. 57) in accordance with the number first established by Rosenberg (1927) on meioses in P.M.C's, and later on confirmed by Böcher and Larsen (1950) on root-tip mitoses of plants from West and East Greenland.

Hieracium villosum is likewise a mountain species, it occurs however only in the limestone part of the Tatra Mts where it grows at lower altitudes. The plants of this species were collected on calcareous rocks on a slope over the valley Jaworzynka and somewhat higher in low grass among stones (c. 1200 m o.s.l.). The chromosome number 2n = 36 is the same as that first established by Christoff and Popoff (1933), and recently found also by Larsen (1954) in specimens from Switzerland.

SUMMARY

The present paper gives the results of our further studies in chromosome numbers of Polish Angiosperms. In the course of this work dealing exclusively with Dicotyledons, 96 species belonging to 25 families have been investigated on plants collected in their native habitats. The following species have not been studied previously:

Betula oycoviensis (2n = 28)
Betula carpatica (2n = 56)
Delphinium elatum, ssp. *intermedium* (2n = 32)
Arabis pieninica (2n = 16)
Viola alpina (2n = 22)
Polygala amara ssp. *brachyptera* (2n = 28)
Campanula alpina (2n = 34)
Inula salicina (2n = 16)
Achillea nobilis (2n = 18)
Artemisia austriaca (2n = 16)
Artemisia absinthium, var. *calcigena* (2n = 18)
Artemisia abrotanum (2n = 18)
Artemisia petrosa (2n = 18, 36?)
Carlina onopordifolia (2n = 20)
Centaurea rhenana (2n = 18 + 0-2B)
Leontodon pseudotaraxaci (2n = 12).

In addition, chromosome numbers which are different from those previously known, have been found in the following species:

Asarum europaeum (2n = 26)
Trapa natans (2n = c. 48)
Galium boreale (2n = 66)
Galium aparine (2n = 42)
Chrysanthemum Zawadzkii (2n = 54)
Centaurea alpestris (2n = 20)
Taraxacum laevigatum (2n = 26)
Taraxacum palustre (2n = 40)
Impatiens nolitangere (2n = 40, in addition to 2n = 20).

The remaining numbers corroborate the results of previous investigations done on plants from other geographic areas.

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