TAXONOMIC AND CYTOLOGICAL NOTES ON TURKISH ORNITHOGALUM

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INTRODUCTION

The work reported in this paper was originally undertaken to provide determinations for the large collections of living *Ornithogalum* plants (largely from Turkey) grown at the Royal Botanic Garden; and to take the opportunity for cytological investigation which this collection afforded. From a very early stage it was clear that, even to achieve the simple aims mentioned above, it would be necessary to make a fairly considerable revision of the classification of the genus in Turkey; this paper represents the outcome.

We have largely restricted ourselves to the Turkish representatives of the genus because material available to us from other areas was fragmentary. Such politically based restriction is unfortunate but unavoidable. However, Turkey obviously represents an important area in the taxonomy and evolution of the genus, as is shown by the frequency with which species, apparently distinct in other areas, intergrade there. This has led us to use a somewhat broader specific concept than most other workers on the genus, which has resulted in the reduction to synonymy of many well-established names. Some of these previously recognised taxa could be used as the basis for subspecies or varieties, but most of them have the nature of 1-character variants, which, in our opinion, do not warrant formal classification.

The cytological work has been done by J. A. Ratter and the taxonomic revision by J. Cullen: the present paper is the result of discussion between both authors.

Voucher specimens of all cultivated material have been placed in the Edinburgh herbarium. They have all been given numbers in the C. series used for that purpose and such material has been listed at the end of the cited specimens under each species. In the cytological discussion plants from wild sources are nevertheless referred to by their collectors numbers in order to maintain continuity between taxonomic and cytological parts. It needs to be clearly understood, however, that any question about the material on which the chromosome numbers are based *must* quote the C. number: reference to the collectors number will lead to the specimen dried in the field.

We should like to thank Dr. P. H. Davis for accumulating the living material and for pointing out how much it was in need of study. We are particularly indebted to Miss H. T. Prentice for assistance with the cytology. Miss R. M. Smith drew the idiograms and the Directors of the Rijksherbarium, Leiden, the Geneva herbarium, and Dr. H. Demiriz (Istanbul) kindly lent herbarium material.

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TAXONOMY

The following revision is in no way complete—the taxonomy of the whole genus is as yet in too fluid a state for this to be possible. In particular, we have avoided (whenever feasible) problems of typification and nomenclature, preferring to use well-known names, rather than spend what might well be a great deal of wasted time in searching out the puritanically correct names. To repeat: the taxonomy of the genus is not yet in a sufficiently settled state for this to be accomplished.

The revision has been based on the following materials:

- (i) Specimens in the Post Herbarium, Geneva, currently on loan to Edinburgh (specimens collected by Post and Aznavour).
- (ii) Specimens from the herbarium of the Pharmacy Faculty, Istanbul University, kindly made available by Dr. H. Demiriz (specimens collected by Demiriz, Heilbronn, Başarman and Mete).
- (iii) Specimens lent from the Rijksherbarium, Leiden, collected on 'Iter Leydenense 1959'.
- (iv) Specimens in the Edinburgh Herbarium (collectors other than those cited above).
- (v) Plants cultivated in the Royal Botanic Garden, Edinburgh, from bulbs collected by various collectors. Herbarium specimens have been made from all plants which have flowered over the last three years.

All specimens cited have been examined.

Only one revision of the genus as a whole has been published—by Baker (1873). This is now very out of date, though the supraspecific classification adopted by Baker has, with minor modifications, remained acceptable. No comprehensive treatment of the species of the eastern Mediterranean region has been published since Boissier revised the genus for volume 5 of the, Flora Orientalis (1882). Feinbrun's revision (1940) of the species of Palestine, Iraq and neighbouring regions and Markgraf's treatment in Hayek's Prodromus Florae Balcanicae (1932) complete the list of useful treatments.*

CYTOLOGY

Ornithogalum is in some respects ideal material for cytological study and hence a considerable amount of literature has already accumulated on this subject. Early studies were carried out by such workers as Delaunay (1925), Heitz (1926) and Sprumont (1928). Among later contributors Neves (1952, 1956a, 1956b) gives a most detailed account of many species chiefly from the Mediterranean region, whilst de Wet (1957) and Pienaar (1963) deal with South African species. These workers have demonstrated the occurrence of a complex and interesting cytological situation involving a range of basic numbers, polyploidy and the occurrence of B chromosomes. The following account attempts wherever possible to correlate the results obtained in this investigation with those of other workers; it needs to be clearly stated, however, that the identification of their material has not been checked.

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*But see the addendum (p. 296).

The plants used in the cytological investigation were all cultivated in pots kept in cold frames at the Royal Botanic Garden, Edinburgh. In many cases there were a number of bulbs per pot and therefore it was often impossible to ensure that all root-tips collected came from the same plant.

Root-tips were collected in March and early April when growth was very active. They were pretreated for four to five hours in a saturated aqueous solution of paradichlorobenzene and then fixed in 3:1 ethanol: acetic acid. Squash preparations were made in iron acetocarmine. No special hydrolysis was necessary; the root-tips were merely tapped out under the coverslip prior to squashing and this gave a good spread of material.

Wherever possible the idiograms have been made from measurements taken from a number of photographs, but in a few cases it has been necessary to use camera lucida drawings which are generally rather less accurate (where this is the case it is stated in the caption of the figure).

Chromosome counts obtained in this investigation are summarised in Table I, p. 337 as are those made on the same species by other workers.

SUPRASPECIFIC CLASSIFICATION

Baker divided the genus into 7 subgenera; one of these, *Ledebouriopsis* (species all African) is not now considered to form part of the genus *Ornithogalum*. The other 6 form easily recognisable, apparently natural units, distributed as follows:

Subgen. *Caruelia:* Africa, Mediterranean area.
Subgen. *Beryllis:* Africa, Mediterranean area, S. Europe.
Subgen. *Ornithogalum* (Subgen. *Myogalum* (Link) Baker): Mediterranean area.
Subgen. *Cathissa:* Africa, W. Mediterranean area (Spain, Portugal & Morocco).
Subgen. *Heliocharmos:* Mediterranean area, S. Europe.
Subgen. *Osmyne:* Africa.

A small number of species also occurs in S. America, but the literature is very reticent as to their subgeneric positions.

Four of these subgenera are represented in the Turkish flora, viz.: *Caruelia*, *Beryllis*, *Ornithogalum* & *Heliocharmos;* Subgen. *Ornithogalum* is represented by one species; *Beryllis* by 6 taxa of somewhat doubtful rank (see below); *Caruelia* by 2 species; and *Heliocharmos* by 15 species, arranged here in 3 informal groups. They may be recognised as follows:

1 Raceme ± cylindrical, the lower pedicels not or scarcely exceeding the upper in length · · · 2
\+ Raceme ± triangular, the lower pedicels clearly longer than the upper 3
2 Filaments of the inner stamens bearing 2 teeth at the sides of the anther; flowers nodding · · · · · · · Subgen. *Ornithogalum*
\+ Filaments without such teeth; flowers horizontal or ascending Subgen. *Beryllis*
3 Perianth segments with a conspicuous green fascia on the back; ovary green or yellowish · · · Subgen. *Heliocharmos*
\+ Perianth segments without a green fascia; ovary dark brown, purplish or almost black · · · · · · · Subgen. *Caruelia*

ADDENDUM

Since the taxonomic part of this paper was written, Zahariadi (1965) has published an important paper on the taxonomy of the Mediterranean species of the genus. This paper is concerned with supraspecific classification; only species which are types of sections or subgenera are referred to, which makes it difficult to give a full comparison between Zahariadi's treatment and the present account.

Using characters of the seed-coat, epidermis, type of germination and bulb structure (which we have not studied), as well as the "normal" characters of external morphology, Zahariadi proposes the following classification (species mentioned in the present paper are marked with an asterisk):

- Subgen. *Beryllis*
  - sect. *Involuta* (type: *O. flavescens**)
  - sect. *Galactea* (type: *O. ponticum*)
  - sect. *Albedo* (type: *O. fischerianum**)
- Subgen. *Eustachys* (type: *O. arcuatum**)
- Subgen. *Ophiogalum*
  - sect. *Oligophylla* (type: *O. oligophyllum**)
  - sect. *Lambda* (type: *O. sigmoideum**)
- Subgen. *Hypogaeum*
  - sect. *Fimbriata* (type: *O. fimbriatum**)
  - sect. *Aptera* (type: *O. amblycarpum*)
- Subgen. *Oreogalum*
  - sect. *Platyphyllum* (type: *O. montanum**)
  - sect. *Lanceolata* (type: *O. lanceolatum**)
- Subgen. *Amphibolum* (type: *O. amphibolum*)
- Subgen. *Anosmium*
  - sect. *Oroidea* (type: *O. oreioides*)
  - sect. *Nana* (type: *O. nanum**)
  - sect. *Pterogalum* (type: *O. wiedemanni**)
- Subgen. *Heliocharmos*
  - sect. *Obtusangula* (type: *O. comosum**)
  - sect. *Umbellatum* (type: *O. refractum**)
- Subgen. *Myogalum* (type: *O. boucheanum*—mentioned here under *O. nutans*).

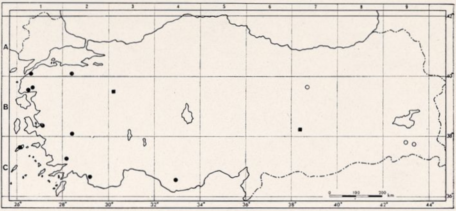
Obviously, this classification, using new information, requires careful consideration and re-examination of material. We have not had the opportunity to do this, but offer the following preliminary comments:

(a) On grounds of general morphology, the splitting of subgen. *Heliocharmos* (sensu orig.) into 6 subgenera seems unjustified.

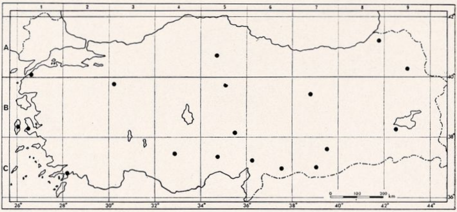
(b) The separation of *O. montanum* and *O. lanceolatum* into different sections seems totally unnecessary in view of the very close morphological and cytological similarity between them, and the occurrence of intermediates (cf. p. 317).

(c) The wide separation (into different subgenera) of *O. nanum* and *O. sigmoideum* (which we have treated as synonymous) is surprising, as also is the separation of *O. nanum* and *O. refractum*.

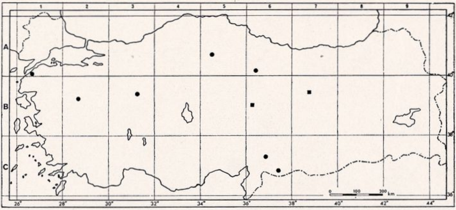
We look forward to seeing an extension of Zahariadi's paper, in which the positions of all the species are given; with this, a full evaluation of the new classification will be possible.



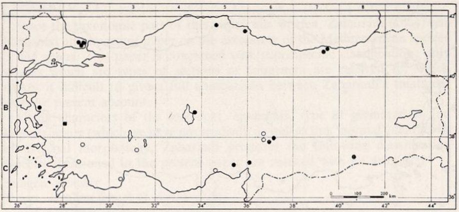
Map 1. ● *O. nutans;* ○ *O. arcuatum;* ■ *O. brachystachys.*



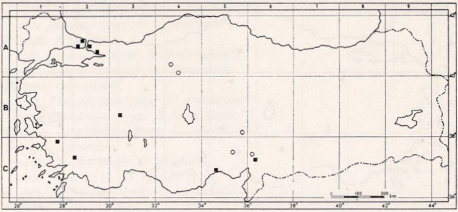
Map 2. ● *O. pyramidale.*



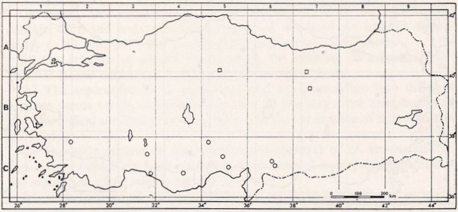
Map 3. ● *O. sphaerocarpum;* ■ *O. flavescens.*



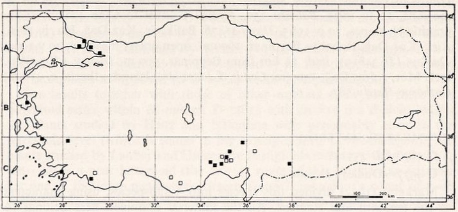
Map 4. ● *O. tenuifolium;* ○ *O. alpigenum;* ■ *O. nivale.*



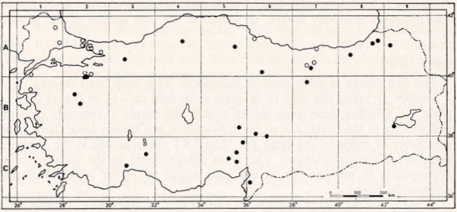
Map 5. ■ *O. umbellatum;* ○ *O. armeniacum.*



Map 6. ○ *O. ulophyllum;* □ *O. tempskyanum.*



Map 7. ■ *O. montanum*; ☐ *O. lanceolatum*.



Map 8. ○ *O. nanum*; ☐ *O. refractum*; ● *O. oligophyllum*.

Subgen. Ornithogalum

(Syn.: Subgen. *Myogalum* (Link) Baker)

O. nutans L., Sp. Pl. 308 (1753).

TURKEY. Çanakkale: Renkoei (Erenköy), in dumetis, 24 iv 1883, *Sintenis* 58. Muğla: Muğla to Ula road, in cemetery, fls. silvery-white, semipendulous, 650 m, 17 iv 1962, *Guichard* TUR/59/62. Bursa: road from Uludağ to Soğukpinar, 30 km from Soğukpinar, 500–1000 m, dry clay outcrops, 16 v 1962, *Dudley* (*D* 34734.) Muğla: distr. Fethiye, Kalkan, 30 m, cornfields, leaves deep green, deeply channelled but not white-lined, tepals green, outside except for a whitish margin, 30 iii 1966, *Davis & Polunin* (*D* 25524).

Izmir: in collibus saxosis Smyrnae, iv 1827, *Fleischer;* Smyrne, dans le moisons, 10 iv 1854, *Balansa* 150. Aydin: Gökbel to Cine 400 m, rocky granitic N. slopes, 20 iv 1965, *Davis* 41476. Balikesir: Kaz Dağ, Ida, iv 1856, *Kirk*. Kaz Dağ, Rabat to Beypinar, 1600 m, open grassy meadow, 20 v 1962, *Dudley*, (*D* 34819); *ibid.* 15 km from Beypinar, 500 m, *Dudley*, (*D* 34863). Içel: Mut, Adras Dağ, 1300 m, *Coode & Jones* 960. Islands: Ikaria, c. 410 m, *Gathorne-Hardy* 587.

CULTIVATED MATERIAL:

C 4976=*D* 25524*

C 4977=Dudley, *D* 34819

Markgraf (1932) divided this species into 3 subspecies, using characters of the perianth and stamens. All the material examined here belongs to subsp. *nutans;* records for *O. boucheanum* and *O. prasandrum* from Turkey should be referred to this species. Subgen. *Ornithogalum* contains one other species, *O. libanoticum* Boiss. & Bl. from the Lebanon, which differs from *O. nutans* in having broader leaves, perianth segments without a green fascia and filaments relatively longer. *O. nutans* is the type species of the genus.

CYTOLOGY

The two stocks in cultivation at Edinburgh have both been studied.

Dudley *D* 34819 has 2n=14 in some roots and 2n=15 in others (fig. 2, plate 12). Whether these roots belong to different plants or merelyre present polysomaty in the roots of a single individual is not known since there were a number of bulbs in the same pot. The SAT chromosome is the shortest member of the complement. The extra chromosome in the 2n=15 roots corresponds in morphology to the metacentric no. 4 for which they are apparently trisomic.

D 25524 has 2n=40 in some roots and 2n=41 in others (fig. 1, plate 12). For the same reason as in the previous stock it is not known whether roots differing in chromosome number belong to different plants. There is only a single pair of SAT chromosomes and as in *D* 34819 this is one of the shortest pairs. Also as in *D* 34819 the extra chromosome, which occurs in the 2n=41 roots, is a large metacentric. The chromosome number suggests that this is a near hexaploid derived from the n=7 type and the karyotype accords quite well with this idea, each chromosome of the haploid genome being represented three times, apart from one of the short subtelocentrics which is represented only twice. Examination of the idiogram shows that the correspondence in threes is not exact but nevertheless it seems to be approximately correct, allowing for inevitable errors in such analyses. Presumably the occurrence of only one pair of SAT chromosomes indicates that the presence of one pair of nucleolar organisers suppresses the development of others.

There are a number of previous chromosome observations in *O. nutans*. Heitz (1926) reported n=14(-16), Sprumont (1928) n=8 and Nakajima (1936) 2n=30. Lauber (1947), however, observed 2n=42 in this species

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*Details of origin of the cultivated material are not given in those cases where the locality has been cited with the collector's number in the specimen citations.

from material growing at the Vienna Botanic Garden; she also observed 2n=28 in the closely related *O. boucheanum* (=*O. nutans* ssp. *boucheanum* (Kunth) Markgraf) and 2n=35 in the hybrid between the species. These results were later confirmed by Holzer (1952). Lauber's drawings show a SAT chromosome identical to that observed by us. Her plants were obviously full hexaploids as opposed to *D* 25524 which is hypohexaploid.

Our results together with those of other workers show that there is a polyploid series within *O. nutans*. *D* 34819 with 2n=14 is a diploid, whilst the plants studied by Heitz and Nakajima were presumably close to the tetraploid level (which is found in the closely related *O. boucheanum*). The plants studied by Lauber and Holzer are hexaploids (2n=42) whilst *D* 25524 (2n=40) is a near hexaploid (the 2n=41 roots of this stock being trisomic for one of the large metacentric chromosomes). Sprumont's count of n=8 indicates the further possibility that more than one basic number may exist in this species.

Subgen. Beryllis (Salisb.) Baker

A very difficult group taxonomically. Two reasons may be advanced for this: (i) taxa which appear to be distinct and easily recognisable in one area intergrade in others; (ii) taxa have been distinguished using characters which are not easy to judge with herbarium material. Thus, a large number of herbarium specimens cannot be satisfactorily identified. In Turkey 5 taxa may be recognised, 4 of which (*pyramidale*, *brachystachys*, *arcuatum* and *sphaerocarpum*) intergrade among themselves. Of the other two, *flavescens* is said to be distinguishable by its perianth segments being pale yellow on the inner surface. This character is easily observed in living material, but cannot be judged on herbarium specimens. Our experience has been that plants yellow-flowered when living *may* retain this coloration when pressed, or may dry whitish. Plants white-flowered when living usually dry whitish, but sometimes develop a yellowish colour. Collectors, therefore, should make adequate field notes, stating the perianth colour, when collecting members of this group. A further taxon, *magnum* (which does not occur in Turkey, being restricted to the Caucasus), is distinct on account of its large size and robust habit, but, in technical characters it resembles *arcuatum* very closely; it has been included in this account because good material was available.

One of the characters used in dividing up this group depends on the position of the perianth segments after flowering. These may just wither and remain loosely surrounding the developing fruit, or may become twisted together and connivent above it. This character is, like flower colour, difficult to judge in herbarium material (a suitable stage is often not represented) as the old perianth segments are fairly brittle, and are easily broken or displaced by pressing. This is another point collectors should mention in field notes. The difficulties in assessing this character probably account for discrepancies in its usage in the literature. Thus Markgraf (1932, 81) divides *O. pyramidale* into 2 subspecies, *eu-pyramidale* and *narbonense*; in the description of the species we find: "*Perigonii phylla . . . post florendum complicata et conniventia.*" There is no mention of this character in the descriptions of the subspecies, so it is justifiable to assume that the description quoted above refers to both.

Meanwhile Feinbrun (1940, p. 137), keying out the same taxa (this time as species), writes as follows:

1 All leaves of the perigonium twisted together after flowering; *O. pyramidale*

1 Leaves of the perigonium not twisted as above, sometimes each twisted separately; 2
(leading ultimately to) . . . . . . *O. narbonense*

Markgraf's account follows a treatment of the group by Kerner (1878), which separates these two taxa on bract and style length and the persistence or absence of the leaves at anthesis. On this basis, *narbonense* does not occur in Turkey, at all, though the name frequently occurs in lists of Turkish records. We have followed Kerner's and Markgraf's interpretation, and have excluded *narbonense* from this account.

The difficulties just mentioned are reflected in the problem of how this variation is to be formally presented. The 6 taxa listed above could be recognised as separate species; they could be recognised as varieties of one species; the four which intergrade could be treated as subspecies (admittedly not very distinct geographically) of one polymorphic species, leaving the other two as oligotypic species. Only on the basis of a great deal more work over the whole range of the group (including other taxa, e.g. '*narbonense*'—see above, *O. bungei* Boiss., from Iran, *O. visianicum* Tomm. from Jugoslavia, *O. sessiliflorum* Desf. from N. Africa, etc.) could a reasoned decision be made as to the most suitable treatment. Indeed, it is doubtful if a treatment agreeable to all taxonomists (and to the facts) could be produced even after all this work. In this preliminary study we do not feel able to offer any settled disposition for these taxa; they are treated as species below purely for the sake of nomenclatural convenience.

The taxa may be distinguished (insofar as our observations show they can be) as follows:

1 Perianth segments yellowish on the inner surface, apparently not connivent and twisted together after flowering . . . 6. *flavescens*

+ Perianth segments white on the inner surface, apparently usually connivent and twisted together after flowering 2

2 Fruiting pedicels arcuate-erect; perianth segments usually without a green fascia 3

+ Fruiting pedicels straight, usually strictly erect; perianth segments usually with a fascia 4

3 Leaves 10 mm or more broad; scapes c. 1 cm in diameter at the base 3. *magnum*

+ Leaves narrower; scapes thinner . . . . . . 2. *arcuatum*

4 Scapes up to 70 cm; racemes 10–20 cm . . . 1. *pyramidale*

+ Scapes up to 35 cm; racemes 4–10 cm 5

5 Leaf margin somewhat denticulate; capsule ± ovoid or cylindrical 4. *brachystachys*

+ Leaf margins smooth; capsules ± globose . . . 5. *sphaerocarpum*

1. O. pyramidale L., Sp. Pl. 307 (1753).

Syn.: *O. narbonense* L. var. *pyramidale* (L.) Boiss., Fl. Or. 5: 214 (1882).
O. pyramidale var. *eu-pyramidale* Markgraf in Hayek, Prodr. Fl. Balc. 3: 81 (1932).
O. narbonense subsp. *typicum* Feinbr. in Pal. J. Bot., Jer. ser. 2: 135 (1940).

TURKEY. Çanakkale: Renkioi (Erenköy), Dardanelles, vi 1856, *Kirk;* Dardanelli, in montosis, 28 v 1883, *Sintenis* 929. Eskişehir: 20 km from Eskişehir towards Çiftiler, 800 m, steppe fields, *Davis & Coode* (*D* 37232). Çorum: between Amasya and Çorum, 1000 m, ploughed land in cornfield, full sun, flower white . . . , 11 v 1960, *Furse & Synge* 111. Samsun: burial mound 2 miles E. of Samsun, 30 m, open field, racemes of white flowers, striped green, 10 vi 1963, *Tobey* 367. Çoruh: Artvin, 850 m, fallow fields, 25 vi 1957, *Davis & Hedge* (*D* 30018). Kars: Yağmurlu Dağ between Sarikamiş and Karaurgan, 2200 m, igneous slopes, 7 vii 1957, *Davis & Hedge* (*D* 30699). Izmir: Çeşme, 10–50 m, rocky limestone slope facing south, fls. white with green fascia, 26 iv 1965, *Davis* 41810. C2 Muğla: d. Marmaris, Soğut to Bozburun, s.l.—50 m, rocky limestone slope, 15 iv 1965, *Davis* 41210. Konya: Konya to Çumra, Küçük Köy, cultivated land, 980 m, flower white, *Helbaek* 2525. Yozgat: Sorgun to Çekerek, 1000 m, *Coode & Jones* 1645. Kayseri: Bakir Dağ above Kisge, 1400 m, fallow field, tepals white with green fascia, leaves green without white line, 28 iv 1952, *Davis* 19297 *Dodds & Çetik*. Seyhan: Bozanti (Pozanti), 1896, *Siehe* 363. Tunceli: above Pertek, 1600 m, rocky igneous slopes, flowers whitish, 14 vii 1957, *Davis & Hedge* (*D* 31056). Gaziantep: Kizilhissardere, 25 km S. of Gaziantep on road to Kilis, fallow fields, 750 m, 13 v 1957, *Davis & Hedge* (*D* 28017). Maraş: near Eloğlu, 400 m, marshy fields, leaves erect, without a white line, 30 iv 1957, *Davis & Hedge* (*D* 27313); montagnes du Kurd Dagh, 1300–1600 m, v 1907, *Haradjian* 1091. Urfa: 5 km W. of Urfa, 800 m, stony limestone ground, flower white, 17 v 1957, *Davis & Hedge* (*D* 28185). Diyarbakir: N. slope of Karacadağ between Siverek & Diyarbakir, 1100 m, moist pasture, 19 v 1957, *Davis & Hedge* (*D* 28299). Bitlis: Pelli Dağ above Pelli, 2500 m, damp slope, *Davis & Polunin* (*D* 22620). Islands: Khios, Ins. Chio, prope Mezaria, iv–v 1856, *Orphanides* 831.

CULTIVATED MATERIAL:

C 3408 = *D* 33294 (Crimea, Nikita)
C 3459 = LE 59. 4230 (Leningrad Botanic Garden)
C 4978 = *D* 28017

The perianth segments in this species vary from 10–20 mm long.

CYTOLOGY

Observations have been made for three stocks of this species: *D* 28017 has $2n=14$, *D* 33294 $2n=16$, and *C* 3459 $2n=18$ (figs. 3–5, plate 13).

The idiograms of *D* 33294 ($2n=16$) and *C* 3459 ($2n=18$) show that the karyotypes are almost identical apart from the absence of one of the short chromosome pairs in the former. The karyotype of *D* 28017 ($2n=14$) is clearly related to these forms, the SAT chromosome with the characteristic long satellite is identical, but the second chromosome has a less median centromere and there are four instead of three pairs longer than the SAT chromosome. Presumably some structural alterations are involved in these dissimilarities, possibly associated with the difference in chromosome number.

The existence of a dysploid series with x=7, 8 and 9 in this species is interesting as in the relationship of the karyotypes of all three numbers. Meiotic studies in hybrids between these dysploid *pyramidale* stocks would no doubt give rewarding results.

A number of other workers have reported cytological observations for this species. Neves (1952) recorded 2n=24 in two stocks from garden sources and his chromosome analyses show that they are diploid. There are, however, in these 2n=24 plants four pairs of very short and one pair of fairly short chromosomes and it seems that the numerical differences between Neves' plants and ours involve these pairs. The tendency in *Ornithogalum* for such short pairs to be supernumerary or semi-supernumerary is discussed later. The longer chromosomes of Neves' plants correspond fairly well to those of ours, although in general their short arms appear to be shorter. Nakajima (1936) also recorded 2n=24 for *pyramidale*. Heitz (1926) reported n=c. 16 and his figure shows a mitotic plate with 2n=33, of which 17 chromosomes are very short. This type of complement occurs in other members of the subgenus *Beryllis* and is dealt with later (p. 308).

As discussed above the two taxa *O. pyramidale* and *O. narbonense* are exceptionally close and almost indistinguishable. It is therefore interesting that some observations for *narbonense* correspond well with ours for *pyramidale*. Heitz (1926) and Sprumont (1928) recorded and figured 2n=14 for *narbonense*. Analysis of Heitz's figure shows a karyotype very similar to *D* 28017 of our investigation (fig. 6) and Sprumont's figures also seem to be fairly similar. Delaunay (1926) recorded 2n=16 for *narbonense*, the number which occurs in *D* 33294. The observations of Neves (1952) for *narbonense*, however, differ from any recorded for *pyramidale*. He found hexaploid (2n=54) and near hexaploid numbers in many collections of *narbonense* from Portugal and the Western Mediterranean region (hexaploidy being conclusively demonstrated by karyotype analysis and the occurrence of hexavalents at meiosis). Up to 11 B chromosomes were also often present in these hexaploid *narbonense* plants. Chiarugi (1950) and Martinoli (1950) have also reported 2n=54 from Italian and Sardinian *narbonense*.

2. O. arcuatum Stev. in Mém. Soc. Nat. Mosc. 7: 271 (1829).

TURKEY. Tunceli: Munzur Dağ above Ovacik, 2400 m, rocky limestone slopes, 18 vii 1957, *Davis & Hedge* (*D* 31377). Hakkari: Cilo Dağ above Sua, 2650 m, flushes, petals white with green vein on the reverse, 10 viii 1954, *Davis & Polunin* (*D* 24299); Cilo Tepe, 3200 m, moist pasture, 8 viii 1954, *Davis & Polunin* (*D* 24093).

CULTIVATED MATERIAL:

C 4979=*Furse & Synge* 103 (Iran)

This taxon has flowers about the same size as those of *O. pyramidale*. *O. schelkovnikovii* Grossh. is the name applied by Russian authors to specimens which deviate from typical *arcuatum* only in the possession of petals with fascias (e.g. *D* 24299, cited above). The following cultivated specimen is somewhat intermediate between *pyramidale* and *arcuatum* (pedicels less arcuate than is usual in *arcuatum*):

Seyhan: Bozoğlan Dağ above Saimbeyli, 1300 m, flower white, fascia obsolescent, *Davis* 26692 (=*C* 3407).

CYTOLOGY

Two stocks of this taxon have been studied, F. & S. 103, a typical *arcuatum*, and *D* 26692 which is more or less intermediate in morphology between *arcuatum* and *pyramidale*.

In F. & S. 103 some roots have 2n=26 and others 2n=28 (fig. 7, plate 14). There are six pairs of longer chromosomes (including a metacentric pair), one intermediate pair and either six or seven very short pairs. Since a number of bulbs were growing in the same pot it is not known whether the two chromosome numbers characterise different plants or represent polysomaty in a single individual (although the former possibility seems the more likely).

D 26692 also shows a clear differentiation of the karyotype into long and short chromosomes (fig. 8, plate 14). The chromosome number is 2n=32, consisting of six long pairs, one (or two) somewhat intermediate and nine (or eight if two are considered intermediate) very short pairs.

A considerable number of chromocenters is visible in the resting nuclei of both stocks.

Most of the differences in the longer chromosomes between the two stocks seem to be due to those of F. & S. 103 showing greater contraction as a result of pretreatment than those of *D* 26692, and this appears to have a disproportionate effect on the short arms. When allowance is made for this it can be seen that the karyotypes are similar. The numerical difference between the stocks involves the short chromosomes and this, plus the fact that they vary in number in F. & S. 103, indicates that they are probably dispensable, or partially dispensable, supernumeraries. Also supporting this view is the occurrence of chromocenters in the resting nucleus which Neves (1952) found associated with the presence of heterochromatic B chromosomes in various *Ornithogalum* species.

The only previous chromosome count for this species is by Delaunay (1926) who reported 2n=34 but gave no illustration. One suspects that the plant he studied might have had one more pair of supernumeraries than *D* 26692. Karyotypes similar to those found by us in this species have been reported in the *Beryllis* complex by other workers. We have already mentioned the *pyramidale* figure of 2n=33 given by Heitz (1926) showing 16 long and intermediate chromosomes and 17 short chromosomes; this karyotype is obviously similar to those found in *arcuatum* in this investigation. A similar karyotype with 2n=32 (14 long and intermediate and 18 short) is described and figured by Sprumont (1928) for *O. pyrenaicum* L. (a synonym of *O. flavescens* Lam.). These reports might indicate that Heitz's *pyramidale* and Sprumont's *pyrenaicum* were actually misidentified *arcuatum* type plants or, on the other hand, that this type of complement with many short supernumeraries also occurs in these two species. Further discussion of this point is made on p. 308.

3. O. magnum Krassch. & Schischk. in Fl. U.R.S.S. 4: 743 (1935).

CULTIVATED MATERIAL:

C 3409=LE 59 4229 (Caucasus, Krasnodar area)

As mentioned above, this taxon is distinct on account of its large size, but it is very close to *arcuatum* in its arcuate-ascending fruiting pedicels, and almost fascia-less perianth segments.

CYTOLOGY

Examination of the only stock of this species in cultivation at Edinburgh, *C* 3409, showed 2n=32 with a karyotype extremely similar to *arcuatum* *D* 26692 (fig. 9, plate 14). As in *arcuatum* there are many chromocenters in the resting nucleus.

As mentioned previously *magnum* and *arcuatum* are very similar species distinguished mainly by the much larger size of the former. This similarity extends also to the chromosomes which do not afford any explanation, such as polyploidy, for the size difference between the two species.

As far as we know this species has not been previously examined cytologically.

4. O. brachystachys C. Koch in Linnaea 22: 248 (1849).

TURKEY. Eskişehir: Eskişehir to Kütahya, 50 km from Kütahya, 800 m, steppe by roadside, common in one spot only, 22 vi 1962, *Dudley* (*D* 36065). Malatya: Malatya, 1170 m, flowers white with light green midrib veins . . . limestone scree, 14 v 1935, *Balls* 2275.

O. brachystachys has somewhat smaller flowers than the preceding taxa, the perianth segments rarely exceeding 15 mm. In the above specimens the denticulation of the leaf margin is well developed. In other cases this character may be only slightly produced, and the capsules often tend to be somewhat globose. These specimens are therefore intermediate between *brachystachys* and *sphaerocarpum:*

Erzurum: Horasan, 1600 m, soft loamy hills, 13 vi 1957, *Davis & Hedge* (*D* 29381). Islands: Khalki, near Anagyris, fort on the side of path to Chorio, 2 v 1964, *Gathorne-Hardy* 717; Nisyros, 25 vi 1963, *Gathorne-Hardy* 392.

O. fischerianum Krassch. (judging from descriptions and photographs) appears to share the small size and pedicel characters of *brachystachys* and the fascia-less perianth segments of *arcuatum:* to this extent it is intermediate between the two.

5. O. sphaerocarpum Kerner in Oest. Bot. Zeitschr. 28: 15 (1878).

Syn.: *O. pyrenaicum* L., p.p. (fide Markgraf).

TURKEY. Çanakkale: Cemetery, British hospital, Renkioi (Erenköy), Dardanelles, v 1856, *Kirk*. Çorum: 2 miles S. of Iskilip, 800 m, *Coode & Jones* 1717. Kütahya: Gediz to Çavdarhisar, 1100 m, chalky cornfield, flowers white, small with green fascia, 7 vii 1962, *Davis & Coode* (*D* 36988).

Eskişehir: 2 miles E. of Sivrihisar, c. 100 m, *Coode & Jones* 2245. Sivas: Suşehri, 1300 m, edge of field, petals white with green line on back, 19 v 1960, *Stainton* 8445. Maraş: Akher Dagh (Ahir Dağ), 800 m, a slender spike of small white and green flowers . . ., 2 v 1934, *Balls* 959. Gaziantep: Gaziantep, flowers greenish white, small . . . , 26 v 1934, *Balls* 1173.

This taxon usually has the smallest flowers in the group (perianth segments 5–8 mm), but occasionally larger flowers occur with globose capsules, i.e. the characters are not very strongly correlated. Cf. observations under *O. flavescens*.

6. O. flavescens Lam., Fl. Fr. 3: 277 (1778).

Syn.: *O. pyrenaicum* L., p.p. (fide Markgraf).

TURKEY. Nevşehir: Ürgüp, 1300 m, rocky slopes, petals pale yellow backed with green, 24 v 1960, *Stainton* 8468. Tunceli: Pertek to Tunceli, 25 miles from Elaziğ, 1400 m, igneous gulley, flowers green outside, greenish-white within (see under cultivated specimen) 6 vi 1957, *Davis & Hedge* (*D* 29106). Cappadocia, Acker Triften, Juni, *Siehe* 77 (det. as "*O. sulphureum* m.").

CULTIVATED MATERIAL:

C 3424=*D* 29106; the flowers are pale yellow.

CYTOLOGY

D 29106 has $2n=18$ and the karyotype includes two pairs of short, nearly metacentric chromosomes (fig. 10, plate 13).

Neves (1952) has examined many stocks of this species (under the synonym *O. pyrenaicum* L.) from spontaneous collections in Portugal and material from various botanic gardens. In the Portuguese material he found a uniform $2n=16$ with only one pair of short chromosomes, as opposed to the two pairs in *D* 29106. In some garden material, however, he found plants with $2n=17$, 18 and 19, with short supernumeraries as the extra chromosomes. The $2n=18$ figure (Neves 1952, p. 70, fig. 42B) from a plant originating from Besançon Botanic Garden comes quite close to our figures, although there seem to be some karyotypic differences between *D* 29106 and the complement Neves found in this species. Neves also discovered a triploid individual ($2n=24$) belonging to this species.

We have already mentioned Sprumont's record of $2n=32$ for *pyrenaicum*, he also found tetraploid cells and roots in his material (ploysomaty). The only other record is the unpublished count by Greeves (1930) of $n=$about 8 which is quoted by Tischler (1931).

As mentioned above, the distinction between *flavescens* and *sphaerocarpum* is slight, and difficult to observe in herbarium specimens. The following cannot be identified with certainty:

TURKEY. Çanakkale: Dardanelli, in montosis, 28 v 1883, *Sintenis* 928. Kastamonu: Tossia (Tosya), Karvak-Tschesme, 7 vi 1892, *Sintenis* 4246. Izmir: in umbrosis collinis Smyrnae, iv & v 1827, *Fleischer*. Antalya: Elmalu, in arvis incultis, 28 vi 1860, *Bourgeau;* Korkuteli to Kizilcadağ, 1350 m, limestone ledges and scree, 31 v 1962, *Dudley* (*D* 35271). Seyhan: distr. Saimbeyli, Bozoğlan Dağ above Obruk Yayla, 2300 m, bulb in crevices, 7 vii 1952, *Davis* 19759 *Dodds & Çetik*. Malatya: Malatya to the Euphrates, wheat fields, 21 vi 1954, *Davis* 22025. Islands: Agathonisi (Gaidaros), tepals with broad pale green stripe inside as well as outside perhaps owing to the flower being on the point of fading, 5 v 1962, *Gathorne-Hardy* 201.

These specimens resemble *flavescens*, *sphaerocarpum* & *brachystachys* in the small size of their flowers (up to 11 mm). None of them has a well developed denticulate leaf margin, and the flower colours are unknown.

CYTOLOGICAL DISCUSSION OF SUBGENUS BERYLLIS

Our observations of the species of this subgenus have shown a range of numbers: 2n=14, 16, 18 in *pyramidale*, 2n=26, 28 and 32 in *arcuatum*, 2n=32 in *magnum* and 2n=18 in *flavescens*. Other workers* record 2n=24 and c. 32 for *pyramidale*, 2n=14, 16 and 54 (+sometimes a varying number of B chromosomes) for *narbonense*, 2n=34 for *arcuatum*, and 2n=16 (+sometimes 1–3 B), 24 and 32 for *flavescens* (usually under the synonym *O. pyrenaicum* L.).

This range of numbers at first seems very complex but karyotype analysis has revealed an underlying pattern. Apart from the 2n=24 *flavescens* which is clearly triploid (Neves, 1952) and 2n=54 *narbonense* which is hexaploid, all the other numbers from 2n=14–32 appear to be diploid.‡ The complements contain more or less seven pairs of longer chromosomes and up to nine pairs of short ones. The variation in basic number at the diploid level seems to be due to alterations in the number of short pairs which are, at least to some extent, supernumerary. Examples of this variation are clearly seen between some stocks of the same species, e.g. *pyramidale D* 33294 and *C* 3459 and our two stocks of *arcuatum* (in the latter case the short chromosomes are evidently heterochromatic, judging from the occurrence of chromocenters at interphase). It would be necessary to have more information regarding numerical variability of these short chromosomes within species and their behaviour at meiosis etc. to fully understand their status. The fact that 2n=32 has been observed by us in *arcuatum* and *magnum* and by Sprumont (1928) in *flavescens* (as *pyrenaicum*) and Heitz (1926) in *pyramidale* (c. 32) possibly indicates a fairly widespread tendency for the short chromosomes to be fixed at about nine pairs. On the other hand it is of course possible that Sprumont and Heitz misidentified their plants so that all 2n=32 records belong to the *arcuatum—magnum* group.

A glance at the idiograms in the subgenus *Beryllis* shows that there are often differences between species and amongst stocks in chromosome morphology. Some of these differences might be caused by accidental factors such as differential contraction on pretreatment, unequal stretching on squashing etc., but clearly most of them are too great for this explanation and must represent chromosome repatterning.

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*The authorities for these counts are given in Table 1 and in the discussion for the individual species.

‡There are no relevant karyotypic data for Delaunay's 2n—34 count for *arcuatum*, but it seems possible that this is also a diploid with two more supernumeraries than our *D* 26692.

Subgen. Caruelia Parl.

This subgenus, which is mainly distributed in Africa, has two species in our area. They may be distinguished as follows:

1 Leaves glabrous; perianth segments 22–26 mm · 1. *O. arabicum*
+ Leaves ciliate; perianth segments 8–11 mm · · 2. *O. melanogynum*

1. O. arabicum L., Sp. Pl. 441 (1753). Ic: Bot. Mag. 19: t. 728 (1804).

TURKEY. Istanbul: Hadimköy, 1945, *Mete*. Islands: Khios, in insula Chio prope Mezaria (rare), 28 iv & 10 v 1856, *Orphanides* 830.

This species was once very popular as a garden plant, but its popularity appears to have declined, perhaps due to the ease with which it spreads. There is some doubt as to whether the species is native in the Mediterranean area; more observations on this point are needed.

2. O. melanogynum Cullen, **sp. nov.** ab *O. arabico* foliis ad margines longe ciliatis, segmentis perigonii 8–11 mm longis, differt.

Bulbus ovatus vel ovato-globosus, circa 25 x 30 mm. Scapi erecti, circa 40 cm alti, glabri. *Folia* late lanceolata, vaginantia, plana, ad margines longe ciliata. *Inflorescentia* anguste deltoidea, densa, 7–12 cm longa. *Bracteae* lanceolate, uninerviae, quam pedicelli breviores. *Pedicelli* erecto-patentes, infimi circa 40 mm longi, superiores breviores. *Segmenta perigonii* alba, concoloria, anguste elliptica, acuta, 8–11 mm longa. *Stamina* circa 6 mm longa, filamentis ad basin dilatatis. *Ovarium* globosum, purpureo-nigrum. *Capsula* ellipsoidea, circa 6–7 mm longa. *Semina* nigra, rugosa, depresse tetrahedra.

Type: Turkey, prov. Tunceli, Pertek to Tunceli, 1350 m, fallow clay field, flowers white, ovary purplish black, 6 vi 1957, *Davis & Hedge* (*D* 29156—E).

This species clearly belongs to Subgen. *Caruelia*, but is very different from the other Turkish species, *O. arabicum*. It is perhaps closest to *O. persicum* Hausskn. & Bornm., which has narrower leaves without ciliate margins. According to Dr. P. Wendelbo of Göteborg (who has seen the specimen cited above) the plant is sometimes called *O. leichtlinii* Stapf, which is a *nomen nudum* based on a plant collected by Sintenis at Suverek in province Urfa. We have not seen this Sintenis specimen, so, as *leichtlinii* is undescribed, we have given our specimen a new name.

Subgen. Heliocharmos Baker

Fifteen species of this subgenus occur in Turkey. We have arranged them in three informal groups (named after the most widespread species in each) on the basis of their overall resemblances. These three groups are not clearly distinguished from one another, and one or two species are of rather doubtful position with respect to them.

One of the characters used by taxonomists in the major division of this subgenus is whether the angles of the capsule are winged or not. This character appears to have caused a great deal of confusion. From our study of cultivated plants we have come to the conclusion that it is not very constant, and that though the situations "no wings" and "wings very prominent" are easy to assess, every transition occurs between them. We have tried to avoid the use of this character, but its use has proved unavoidable with reference to some species of which we have not yet seen good cultivated material. The character is frequently impossible to use with herbarium material; collectors should note the presence or absence of wings.

The species may be identified as follows:

1 Leaves pilose, setose or ciliate, at least on the margins · · 2
+ Leaves completely glabrous · · · · · · 5
2 Leaves and scapes pilose · · · · · 14. *O. fimbriatum*
+ Leaves setose or ciliate; scapes glabrous · · · · 3
3 Leaves 4–10 mm wide; capsule 10–15 mm · · 7. *O. ulophyllum*
+ Leaves less than 4 mm wide; capsule 7–8 mm · · · 4
4 Leaves with a white line on the upper surface; perianth segments 15–17 mm · · · · · · · 5. *O. armeniacum*
+ Leaves without a white line; perianth segments 10–15 mm 6. *O. comosum*
5 Fruiting pedicels refracted vertically downwards, thickened in the axils · · · · · · · · · · · 6
+ Fruiting pedicels erect, spreading or rarely curved downwards, not thickened in the axils · · · · · · · 7
6 Bulb proliferous; perianth segments 17–20 mm 13. *O. refractum*
+ Bulb not proliferous; perianth segments usually less than 16 mm 12. *O. nanum*
7 Leaves linear-lanceolate, tapering ± evenly from the base, ± flat, usually more than 5 mm wide · · · · · · · 8
+ Leaves linear, parallel-sided for some distance from the base, or spathulate, channelled, rarely more than 5 mm wide · · · 10
8 Leaves 5–10 (–12) mm broad; racemes lax, 6–20-flowered 8. *O. montanum*
+ Leaves 10–25 mm broad; racemes usually dense, more than 20-flowered 9
9 Scape almost absent, the raceme ± capitate between the leaves 9. *O. lanceolatum*
+ Scape elongate, the raceme extended · · 10. *O. tempskyanum*
10 Leaves spathulate; pedicels shorter than or equalling the flowers 15. *O. oligophyllum*
+ Leaves usually linear; pedicels (at least the lower) longer than the flowers · · · · · · · · · · 11
11 Capsule winged · · · · · 11. *O. wiedemannii*
+ Capsule ± wingless · · · · · · · · · 12
12 Perianth segments less than 10 (–12) mm · · · · 13
+ Perianth segments 13–20 mm · · · · · · 14
13 Scape 2–10 cm; leaves green, concolorous · · 2. *O. alpigenum*
+ Scape almost 0; leaves white-lined · · · 4. *O. nivale*
14 Capsule ribs approximating in pairs; bulb not proliferous; pedicels arcuate-erect in fruit · · · · · · 1. *O. tenuifolium*
+ Capsule ribs equidistant; bulb proliferous; pedicels ± horizontal in fruit · · · · · · · 3. *O. umbellatum*

TENUIFOLIUM GROUP

Leaves linear, usually less than 5 mm broad. Pedicels horizontal to erect. Capsules apparently usually wingless.

1. **O. tenuifolium** Güss., Fl. Sic. Prodr. 1: 43 (1827).

Syn.: *O. gussonei* Ten., Fl. Neap. 3: 337, t. 226 f. 1 (1824–9).
O. byzantinum Azn. in Bull. Soc. Bot. Fr. 46: 149 (1899).

TURKEY. Istanbul: lieux humides, prairie de Kiathane (Kağithane), 1 vi 1895, *Aznavour;* Menechke, 18 v 1902, *Aznavour;* Tour d'Ovid a Scoumroukeuy, 19 v 1901, *Aznavour;* prairie vallée entre Ali Bey Keuy et l'Aquedec de Justinien, 23 v 1895, *Aznavour* (all the preceding determined as *O byzantinum* Azn.—syntypes and authentic specimens); Sariyer, between Circir, Suyu & Hunkiar Suyu, 50 m, 30 iii 1952, *Demiriz* 865. Sinop: Çangal, viii 1956, *Atay*. Samsun: Çetirli Pinar Köy (Bafra) along banks of river and on open slopes, 60 m, 20 iv 1963, *Tobey* 118. Trabzon: feuchte Stellen in einer Weide 3–4 km westlich Trabzon, 6 iv 1957, *Sauer* 187/57; Trabzon, 50 m, grass banks, no white line on leaf, petals white striped green on back, 30 iii 1960, *Stainton* 8124. Izmir: Aşaği Bey to Bergama, 24 iv 1950, *Heilbronn*. Ankara: Tuz Gölü, 10 km S. of Şereflikoçhisar, 950 m, *Coode & Jones* 160. Seyhan: Adana, 150 m, stony open slopes and among coarse grass, clay and lime, flowers white . . . , *Balls* 2101; Toprakkale, in slightly moist grassland . . . , 11 vi 1934, *Balls* 733. Maraş: distr. Çardak, Berit Dağ, 2800 m, rocky slopes, 26 vii 1952, *Davis* 20336 *Dodds & Çetik*; Maraş to Göksun, nr. Yemiş Dağ, 600 m, shaley slopes in Pinus brutia forest, 3 v 1957, *Davis & Hedge* (*D* 27414). Mardin: 5 km E. of Mardin, 1200 m, shady rock ledges, leaves many narrow, 25 v 1957, *Davis & Hedge* (*D* 28595).

CULTIVATED MATERIAL:

C 4980=*D* 28595.
C 4981=*D* 27414.

O. tenuifolium is a widespread species which has been much divided. Aznavour's *O. byzantinum* represents a robust, many-leaved variant, which crops up in various parts of the range of *tenuifolium* (e.g. near Istanbul, Alpes Maritimes). It might be possible to recognise it as a variety.

CYTOLOGY

Both stocks of this species in cultivation at Edinburgh have 2n=16. The complement of *D* 27414 (fig. 11, plate 15) includes one very short metacentric pair and there is a characteristic small satellite on one of the longer subtelocentric pairs. No figures observed in *D* 28595 have been good enough for detailed analysis.

Delaunay (1926) also recorded 2n=16 for this species but gave no illustration. The recent work of Czapik (1965) reports 2n=18, 19, 20, 20+f, 27, 28 and 29 for Polish and Czechoslovak plants (under the synonym *O. gussonei* Ten.). She examined seven populations of which five were entirely diploid with 2n=18, one was entirely triploid (2n=27) apart from one plant triploid+1 (2n=28). The remaining population contained plants with 2n=18 and 20 (twelve of each number), two with 2n=19 and single plants with 2n=20+f and 29. The karyotype which she observed in this species is rather different from that of our Turkish *D* 27414 but comes close to those observed by us in the *montanum* group. The variation in number between the 2n=18, 19 and 20 plants involves short metacentric chromosomes and therefore follows the pattern already discussed for subgenus *Beryllis* and which also occurs in some other members of subgenus *Heliocharmos* (see p, 332).

2. O. alpigenum Stapf in Denk. Akad. Wiss. Wien, Math.-Nat. Kl. 50: 79 (1885).

TURKEY. Muğla: Sandras Dağ, 2200 m, *Davis* 13535A. Denizli: Tavas ovasi, 23 iii 1957, *Heilbronn*. Antalya: distr. Kemer, Tahtali Dağ, 2000–2300 m, 10 vii 1949, *Davis* 15042; Bozburun Dağ, N. side by snow, 2200–2300 m *Davis* 15647; 15 km along Korkuteli road from junction with Burdur road, *Jackson* 5031. Içel: Mersin, mergeliger Boden, 1896, *Siehe* 61; between Tarsus and Ulaş, 200 m, limestone hills at edge of field, 5 iv 1957, *Davis & Hedge* (*D* 26413). Seyhan: distr. Saimbeyli, Bozoğlan Dağ above Obruk Yayla, 2300 m, under Juniperus excelsa, *Davis* 19670 *Dodds & Çetik*. Maraş: Göksun to Kaleköy, 1300 m, eroded shaley hills, 4 v 1957, *Davis & Hedge* (*D* 27567).

CULTIVATED MATERIAL:

C 4982=*D* 26413.

Although we have not seen the type specimen (collected in Lycia by Luschan) of this species, Stapf's description and diagnosis fit the specimens very well. It seems likely that *O. iraqense* Feinbr. (1940, p. 146) and *O. trichophyllum* Boiss. & Heldr. (a later homonym of a S. African species) will prove to be conspecific.

CYTOLOGY

The chromosome number of the only stock in cultivation at Edinburgh (*D* 26413) is 2n=18 (fig. 12, plate 15). Comparison of the idiogram with that of *tenuifolium D* 27414 shows great similarity particularly in the SAT chromosomes which have an almost terminal nucleolar organiser in both species. *O. tenuifolium*, however, has one pair of very short chromosomes less than *alpigenum* whilst the seventh chromosome is considerably longer, perhaps to compensate for this (see idiograms). *O. alpigenum* and *tenuifolium* are very similar in external morphology and it is interesting to observe that there is also obvious karyotypic relationship.

There are no previous cytological records for this species.

3. O. umbellatum L., Sp. Pl. 307 (1753).

Syn.: *O. divergens* Bor., Fl. Centr. Fr. 507 (1849).

TURKEY. Istanbul: bords d'une fosse humide inter Alemdağ et Tchataldağ près de Manal Tschiftlik, 5 vi 1892, *Aznavour;* Mezarbournou, *Post;* San

Stefano to Florya, 27 iv 1899, *Aznavour;* Scoumroukeuy to Domousdere, 18 iv 1897, *Aznavour;* Soğuksu, W. of the station, 9 v 1953, *Demiriz* 1494; Yeşilköy, 22 iv 1953, *Demiriz* 1391. Kocaeli: lieux humides près Pendik, 21 v 1893, *Aznavour.* Aydin: Sultanhissar between Aydin and Nazilli, 30 m, fig orchards on light soil, bulbs with stalked bulbils at base, leaves with white line, 3 iv 1956, *Davis & Polunin* (*D* 25590); below Karacasu, 400–500 m, sandy river flats, leaves green with whitish line, 23 iv 1965, *Davis* 41645. Muğla: Sandras Dağ at Gökçe Ova, leaves with no white line, 23 vii 1947, *Davis* 13528. Afyon: Afyon, 1938, *Heilbronn & Başarman.* Içel: Mersin, cornfields just above the sea shore, flowers white with green reverse, 9 iv 1934, *Balls* 701. Seyhan: Haruniye ENE of Kurtlar, 1250 m, 2 v 1952, *Demiriz* 931. Islands: Samos, nr. Tigani, s.l., 19 iv 1964, *Gathorne-Hardy* 653.

CULTIVATED MATERIAL:

C 4983=*D* 26001b.
C 4984 coll. *Levrentiades* (Greece, nr. Thessaloniki).
C 4985=*Cook* 8 (Sicily, Piana delle Albanese).
C 4986=*Furse & Synge* 746 (Iran, W. of Meshed).
C 4987=*D* 25590.

CYTOLOGY

Cytological observations are available for three of the five stocks in cultivation at Edinburgh.

C 4984, from Greece, has 2n=36 in some roots and 35 in others (fig. 13). It is not known whether these two numbers characterise different plants, or represent polysomaty in a single plant. The difference involves one of the very short chromosomes, of which there are ten in 2n=36 and nine in 2n=35 roots. 2n=36 is also found in F. & S. 746 from Iran, and although figures here are inadequate for detailed analysis they appear to show a fair resemblance to C 4984.

The Turkish *D* 25590 has 2n=44 (fig. 14, plate 15) with seven conspicuously short pairs of chromosomes. A small satellite similar to that of *tenuifolium* occurs on one of the subtelocentric pairs.

Neves (1952) has carried out a most thorough study of this species using material both of spontaneous Portuguese origin and from botanic gardens. He discovered a complex polyploid series based on x=9 with diploid, triploid, tetraploid, pentaploid, hexaploid and octoploid levels all represented. The situation is further complicated by B chromosomes and the occurrcnce of hypoploid plants at the pentaploid and hexaploid levels. Czapik (1965) has studied many wild Polish populations of *umbellatum* and discovered diploids, triploids and tetraploids of the x=9 series. The basikaryotype in these populations is almost identical to that which she found in Polish and Czechoslovak *tenuifolium* populations. Various other workers have made counts in this species and have encountered triploids, pentaploids and hexaploids of the x=9 series (see Neves, 1952, & Czapik, 1965, for details).

Our 2n=36 stocks no doubt belong to the x=9 series, although their chromosome pairs show some deviation from the straightforward correspondence in twos which might be expected in an autotetraploid. This could, of course, be due to allopolyploid origin or chromosome repatterning after chromosome doubling. The 2n=44 stock could possibly be a near pentaploid of this x=9 series, in which case our matching up of pairs for producing the idiogram would be erroneous.

The cytological complexity of *umbellatum* is obviously correlated with its capacity for vegetative propagation which allows triploids, pentaploids etc. to be maintained.

4. O. nivale Boiss., Diagn. ser. 1 (5): 65 (1844).

TURKEY. Izmir: Boz Dağ, vi 1946, *Heilbronn & Başarman.*

The above specimen (from the *locus classicus*) is the only one we have seen referable to this species. Bulbs from Boz Dağ would be very welcome.

5. O. armeniacum Baker in Gard. Chron. 11: 748 (1879).

TURKEY. Ankara: Hacikadin valley, c. 950 m, 10 iv 1951, *Kasapligil* 350; Kizilcahamam, Çamkoru, c. 1400 m, 20 v 1951, *Kasapligil* 367. Kayseri: Bakir Dağ nr. Akoluk Yayla, 2400 m, leaves hairy, fl. white with green fascia, 29 vi. 1952, *Davis* 19656 *Dodds & Çetik*. Niğde: Kizil Depe, 2800 m, Kalkboden, viii 1895, *Siehe* 256; Bulghar Maaden, alpin region der Kyzil Tepe an den Silbergruben, 2500 m, viii 1912, *Siehe* 237. Seyhan: Gökçayir to Haruniye, 19 v 1951, Haruniye Enstitüsü.

This species is very similar to *O. comosum*, and would, perhaps, be better treated as a subspecies of it. However, we have not seen living material of either taxon, and so have retained them as separate species for the time being.

6. O. comosum L., Cent. Pl. 2: 15 (1755).

Syn.: *O. garganicum* Ten., Ind. Sem. Hort. Neap. 3 (1827).

TURKEY. Istanbul: Prinkipo (Büyükada), Lada to Bellevue, collines, 23 v 1909, *Aznavour;* sommet du Göztepe, Bosphore, 14 vi 1917, *Post;* Tchatal Dagh, prés du sommet, 5 vi 1892, *Aznavour;* prés Riva, collines, 12 vi 1893, *Aznavour*. Çanakkale: Renkoi (Erenköy) in valle Dumbrek, 8 v 1883, *Sintenis* 394. Islands: Keos, between Chora and the lion, 2 iv 1963, *Gathorne-Hardy* 307.

Cf. observations under *O. armeniacum*. Two specimens (Çankiri: Çankiri to Ilgaz, on pass in Pinus nigra forest, 5000′, 5 vi 1954, *Davis* 21487 and Kastamonu: Kastamonu, 900 m, on stiff marl hills facing N, leaves glaucous, without a white line, 8 vi 1954, *Davis* 21682) are more or less intermediate between the two.

MONTANUM GROUP

Leaves lanceolate to linear-lanceolate, ± flat, usually broader than 5 mm. Fruiting pedicels horizontal to ascending. Capsule (apparently) usually not winged.

7. **O. ulophyllum** Hand.-Mazz. in Ann. Nat. Hofmus. Wien 28: 19 (1924).

TURKEY. Aydin: below Karacasu, 400–500 m, chalky hills, leaves glaucous, undulate, margins ciliate and often reddish, 23 iv 1965, *Davis* 41651. Antalya: Korkuteli to Kizilçadağ, 4 miles from Korkuteli, 1100 m, neglected cult. fields, 31 v 1962, *Dudley* (*D* 35252). Konya: Beyşehir (± 33 km S. of Beyşehir along the road from Akseki), stony S. slope, dry grey clayish soil, sunny place, flowers white, 1250 m, 6 v 1959, *Hennipman et al.* (Iter Leydenense 1959: 992). Içel: Mut, Magras Dağ, 1300 m, *Coode & Jones* 749; distr. Tarsus, between Ulaş and Şamlar, 350 m, open maquis on terra-rossa, 5 iv 1957, *Davis & Hedge* (*D* 26430); Cilicia Trachea bei Olba Mara, 1400 m, *Siehe* 75; Pozanti (± 10 km S. of Pozanti), limy E. slope, springy forest with Hedera, Clematis & Carpinus, rather dry place, flowers white, 1400 m, 8 v 1959, *Hennipman et al.* (Iter Leydenense 1959: 992); N. side of Cilician Gates, mountain slope W. of the road Ankara-Adana, sunny S. slope, reddish loamy soil, flowers white, 1800 m, 19 v 1959, *Hennipman et al.* (Iter Leydenense 1959: 1275). Niğde: Hassan Dağ above Taşpinar, 1700 m, 15 vi 1952, *Davis* 18913 *Dodds & Çetik*. Gaziantep: Gaziantep, Murgana, open limestone hillsides, 800 m, flowers dense white with faint green veins on reverse . . . , 25 iv 1934, *Balls* 842; SW. slope of Dülük Baba, 900 m, rocky limestone slopes, leaves glaucous, 11 v 1957, *Davis & Hedge* (*D* 27831).

CULTIVATED MATERIAL:

C 5018=*D* 26430.
C 5019=*D* 27831.
C 5020=*D* 35252.
C 5021=*Polunin* 13 (Lebanon).

Many herbarium specimens of this species show a strange undulation of the leaves (well displayed in the photograph accompanying the original description) e.g. *D* 26430 & *D* 27831. Specimens grown in a cold frame from bulbs from the same populations do not show this character, and, in default of further information, we assume it to be a habitat modification.

O. eigii, described from Palestine by Feinbrun (1940, p. 139) is very similar to *O. ulophyllum* but differs mainly in its narrower leaves (we acknowledge here Dr. Feinbrun's kindness in lending us authentic material). Feinbrun relates *O. eigii* to *O. comosum*, but does not compare it with *O. ulophyllum*, which is, however, mentioned in another section of her paper.

CYTOLOGY

Chromosome studies have been made for three of the four stocks of this species in cultivation at Edinburgh. 2n=14 occurs in *D* 26430 and *D* 35252 (fig. 15, plate 15), the idiograms of the two stocks show such close correspondence that only *D* 35252 is figured.

2n=18 occurs in *D* 27831 (fig. 16, plate 00). There are two small metacentric pairs and the karyotype is very similar to that found in other members of the *Montanum* group.

There are no previous records for *ulophyllum* but Neves (1956b) has reported 2n=36 in the closely related *O. eigii* Feinbr. Chromosome morphology and meiotic behaviour showed that this species was tetraploid.

The idiogram given by Neves corresponds quite well with a straightforward doubling of *D* 27831. He points out that the basic x=9 karyotype of *O. eigii* is remarkably similar to that of *O. umbellatum* and considers that this indicates very close relationship.

8. O. montanum Cyr. in Tenore, Fl. Neap. 1: 176 (1811–15).

TURKEY. Istanbul: near roadside, Yakacik to Kartal, 30 iv 1938, *Post;* Makrikeuy to San Stefano, 18 iv 1923, *Post;* Rumeli Hissar, hills, 18 iv 1919, *Post;* Yakacik, Azayma, 23 iv 1953, *Demiriz* 1406, 1412. Kocaeli: Pendik, 29 iv 1892, *Aznavour.* Izmir: Kuşadasi, 20 m, Poterietum spinosi, leaves green and unlined, 22 iii 1956, *Davis & Polunin* (*D* 25186 & 25193). Aydin: distr. Karacasu, Aphrodisias (Geyrc), 600–700 m, leaves glaucous ± twisted, 22 iv 1965, *Davis* 41614. Muğla: distr. Fethiye, Kalkan, 10 m, rocky limestone slopes, leaves green, not lined, 29 iii 1956, *Davis & Polunin* (*D* 25449); Marmaris to Emecik, 10 m, bank of stream on serpentine, leaves green, not striped, 25 iii 1956, *Davis & Polunin* (*D* 25345). Içel: Findikpinari above Mersin, 1200 m, igneous slope, leaves green, 7 iv 1957, *Davis & Hedge* (*D* 26495); Giosna (Gözne), 1000 m, Kalkberge, v 1895, *Siehe* 26; between Tarsus and Namrun, nr. Ortaköy, 1000 m, rocky slopes among corn plots, 4 iv 1957, *Davis & Hedge* (*D* 26393); below Pozanti towards Tarsus, open rocky meadow, 16 iii 1965, *Lamond* 12. Seyhan: Pozanti, 800 m, dry shady slopes, leaves green, 2 iv 1957, *Davis & Hedge* (*D* 26315); Kozan to Feke, 550 m, banks of fields on igneous slopes, leaves green, 12 iv 1957, *Davis & Hedge* (*D* 26588). Urfa: Biredjik (Birecik), in collibus prope Tschiftlik, 5 iv 1888, *Sintenis* 414. Islands: Lesvos (Mytilene), rocky pine wood near Sanatorium above Agrassa, 600 m, 20 v 1963, *Gathorne-Hardy* 466.

CULTIVATED MATERIAL:

C 4988=*D* 26495.
C 4989=*D* 26588.
C 4990=*D* 25345.
C 4991=*D* 26315.
C 4992=*Cook* 3 (Sicily, Madonie Mts.).
C 4993=*D* 26691 (Turkey, Bozoğlan Dağ).
C 4994=*Dudley D* 34583 (Turkey, Kaz Dağ).
C 4995=*Dudley D* 34900 (Turkey, Yamanlar Dağ).
C 4996=*D* 39388 (Greece, Mt. Parnassus).
C 4997=*Polunin* 36 (Lebanon).

See observations under *O. lanceolatum.*

CYTOLOGY

Ten stocks of this species have been examined; of these one from Sicily, one from Greece, one from the Lebanon and six from Turkey have 2n=18 (*Cook* 3, *D* 26315, *D* 26495, *D* 26588, *D* 26691, *Dudley* 34583, *Dudley* 34900, *D* 39388, *Polunin* 36) (figs. 17–20, plate 16), whilst *D* 25345 from Turkey has 2n=14 (fig. 21). The karyotypes of the 2n=18 plants are all obviously related (see idiograms which are given for four representative stocks) but there are significant differences between some of them, e.g. in the length of the shorter arm of the second chromosome in *Polunin* 36 as compared to the other stocks. The 2n=14 karyotype is also close to the others and seems to differ mainly in the absence of two of the shortest pairs whilst, possibly in compensation for this, the shorter arm of the second chromosome is longer. The occurrence of dysploid changes in chromosome number in Heliocharmos is discussed on page 332. In all stocks the satellite is on the fifth chromosome and is very similar in morphology.

The only previous count for this species is by Heitz (1926) who recorded n=8(-9) but does not provide any illustration or further details. There is some doubt over the identification of the material he studied since he regarded *O. montanum* as a probable synonym of *O. byzantinum* (=*O. tenuifolium* Guss.).

9. O. lanceolatum Lab., Ic. Pl. Syr., Dec. v: 11 (1812).

TURKEY. Muğla: distr. Fethiye, Elbis Dağ, 1600 m, in turf, leaves flat, dark green, 1 iv 1956, *Davis & Polunin* (*D* 25583). Içel: distr. Anamur, Kaldokan Dağ above Anamur, 1500 m, turfy hollows, 13 iv 1956, *Davis & Polunin* (*D* 25895); distr. Gülnar, Gülnar to Gökbelen, 1000 m, shady banks, 14 iv 1956, *Davis & Polunin* (*D* 26063); Gülek Boğaz, 1150 m, fls. white with green veins . . . , 7 iv 1934, *Balls* 679; Gülek Gusguta, 1300 m, 1896, *Siehe* 165; SW. of Pozanti, Elmali Dağ, SE slope with forest . . . , 20 v 1959, *Hennipman et al.* (Iter Leydenense 1959: 1921). Seyhan: Bürücek, 1300 m, rocky slopes, leaves all green, adpressed to ground, 3 iv 1957, *Davis & Hedge* (*D* 26341). Maraş: Akifiye, Findik Dere, 1500 m, *Coode & Jones* 1185.

CULTIVATED MATERIAL:

C 4998=*D* 25583.
C 4999=*D* 25895.
C 5000=*D* 26341.
C 5001=*Polunin* 13 (Lebanon).

In its typical form, *O. lanceolatum* is a very striking species with broad, tapering leaves lying more or less flat on the ground, and the inflorescence almost sessile between them. It appears to flower 2–4 weeks earlier than its closest ally, *O. montanum*, both in Turkey and in the cold frames in Edinburgh (where it is the earliest flowering species). In Lycia the two species grow in the same general areas, and one or two specimens are intermediate between them, having narrower leaves and longer scapes than is typical in *lanceolatum:* Antalya: S. side of Avlan Gölü (±80 km SW. of Antalya), E. slope and valley . . . , 1050 m, 28 iv 1959, *Hennipman et al.* (Iter Leydenense 1959: 696 & 768). An opportunity to study such material in cultivation would be welcome. Until such a study can be made it seems best to maintain the two as separate species.

CYTOLOGY

All four stocks of this species in cultivation at Edinburgh have been examined. The Lebanese (*Polunin* 13) has 2n=16 (fig. 23, plate 16), one of the Turkish stocks (*D* 25583) has 2n=22, another (*D* 25895) has 2n=20 whilst the third (*D* 26431) contains plants with both 2n=20 and 22 (fig. 24–26, plate 16). The Lebanese stock and *D* 25583 contain a number of plants of uniform chromosome number, *D* 25895 consists of only a single plant, whilst *D* 26341 contains several plants of each number.

The idiograms show that a high degree of similarity exists between the karyotypes of all stocks, particularly between *D* 25583, *D* 25895 and *D* 26431. The Lebanese plants have a subtelocentric eighth chromosome, as opposed to a metacentric in the others, but apart from this their idiogram matches well with the 1–8 chromosomes of the others, allowing for some difference in absolute size. The numerical differences involve the three shortest pairs of chromosomes, all of which are metacentric. In the plants with 2n=22 all of these pairs are represented whereas in the Lebanese plants (2n=16) they are completely absent. The fact that these chromosomes vary in number even in a single stock indicates that at least to some extent they are dispensable supernumeraries. As in *arcuatum*, *magnum* and various species studied by Neves (1952) these supernumeraries are associated with the occurrence of chromocenters. In the interphase nuclei of 2n=20 and 22 plants the chromocenters (plate 16) sometimes equal the number of supernumeraries present but often are less (probably due to fusion).

Comparison of idiograms shows that in karyotype as in external morphology, *O. lanceolatum* and *O. montanum* are extremely similar.

There are no previous cytological records for *O. lanceolatum*.

10. O. tempskyanum Freyn & Sint. in Bull. Herb. Boiss. 4: 189 (1896).

TURKEY. Çorum: 12 miles from Alaca to Sungurlu, 1200 m, marshy ground, *Coode & Jones* 1674. Gümüşane: Armenia Turcica in prat. humidis subalpinas ad Stadodopi, 10 vii 1894, *Sintenis* 6262 (isotype). Erzincan: Tercan, 1450 m, moist pasture, leaves 2–4, green, *Davis & Hedge* (*D* 29331).

CULTIVATED MATERIAL:

C 5002=*D* 31428 (Turkey, Munzur Dağ).

This is a rather obscure species, of which more material is necessary. Russian authors (e.g. Grossheim, Fl. Kavk. 2: 164, 1940) recognise a related species, *O. gracilliflorum* Koch (described from the Turkish province of Rize), distinguishing it from *tempskyanum* by its leaves not or scarcely exceeding the inflorescences. In our experience this character is not very constant within any other species, and it seems likely that the two should be combined. However, as we have seen no authentic material of *gracilliflorum*, we have retained the name *tempskyanum* for the present.

CYTOLOGY

D 31428 with 2n=54 is the only stock of this species which we have examined cytologically. Five similar satellited chromosomes were observed in one of the few figures seen (plate 17).

Delaunay (1926) and Randolph & Mitra (1957) recorded 2n=18 for this species. Fig. 22 is an idiogram made from the excellent photograph of mitotic metaphase in Randolph & Mitra's paper. Since these workers have shown the occurrence of n=9 in this species it seems reasonable to suppose that our plant is a hexaploid of this series.

The karyotype of Randolph & Mitra's diploid *O. tempskyanum* is very similar to those of the related species, *O. montanum* and *O. lanceolatum*.

11. O. wiedemannii Boiss., Fl. Or. 5: 221 (1882).

TURKEY. Istanbul: Sariyer to Zekeriekeuy, 22 v 1898, *Aznavour;* Bahçekoy (19 km N. of Istanbul), Belgrad Ormani, 150 m, along rivulet in deciduous forest, flowers white, 8 iv 1959, *Hennipman et al.* (Iter Leydenense 1959: 472). Amasya: Mersifon, Tarschan Dağ, 15 v 1908, *Manissadjian.* Kars: Yalnizçam, 1900 m, marshy meadow, leaves green, 16 v 1957, *Davis & Hedge* (*D* 29656). Malatya: Kangal to Hekimhan, 1300 m, in damp meadow, no white line on leaf, 7 vi 1960, *Stainton & Henderson* 5393. Van: distr. Gevaş, Artos Dağ, 3000 m, largest specimens near sheep pens, 15 vi 1954, *Davis & Polunin* (*D* 22862).

The name *wiedemannii* is applied to the above specimens with some doubt. Boissier grouped the species with those with winged capsules, and certainly the specimens cited above all seem to have prominent wings (but cf. p 309). Apart from this character, we are not clear how *wiedemannii* (in our sense) can be separated from *tempskyanum.* This is a problem which living material might help to solve.

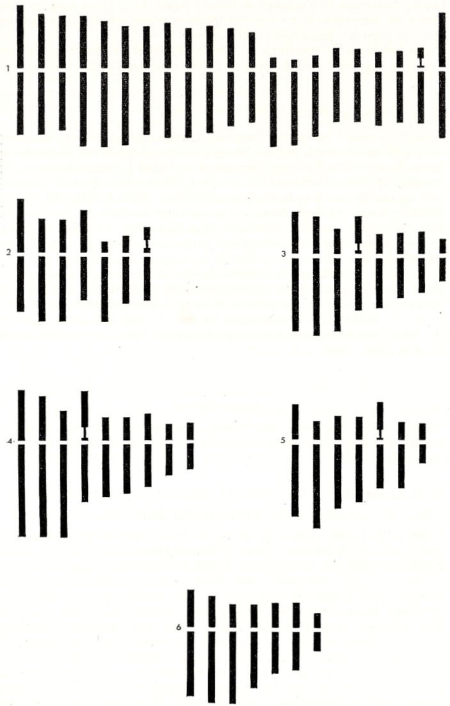
NANUM GROUP

Leaves linear, less than 5 mm broad, or spathulate, usually channelled. Pedicels frequently reflexed or refracted. Capsules (apparently) usually conspicuously winged.

12. O. nanum Sibth. & Sm., Prodr. Fl. Graec. 1: 230 (1809).

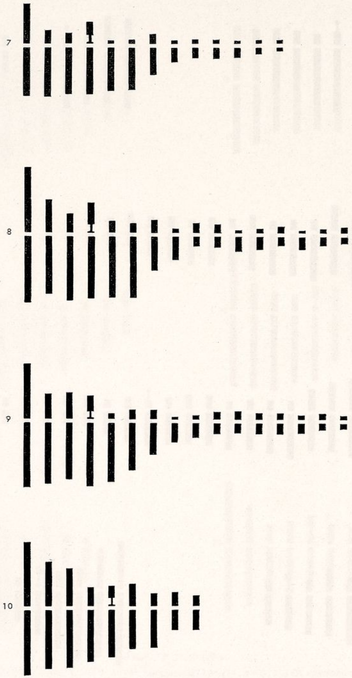
Syn.: *O. sigmoideum* Freyn & Sint. in Bull. Herb. Boiss. 4: 189 (1896).

TURKEY. Kirklareli: Vize, 200 m, 27 iv 1962, *Demiriz* 4736. Tekirdağ: Çorlu, 20 iv 1958, *Demiriz.* Istanbul: Rumeli Hissar, hills, 7 iv 1919, *Post;* Baltaliman valley, 10 iii 1905, *Post;* Istanbul Golf Course, open turf slopes, 100 m, 11 v 1935, *Balls* 2059; *ibid., Demiriz* 1259; Başibüyük, 27 iii 1953, *Demiriz* 1276; Kağithane, 4 iv 1953, *Demiriz* 1322. Çanakkale: Thymbra, ad pagum Kassan Oglu Cham, 26 iii 1883, *Sintenis* 96; Erenköy, iii 1856, *Kirk.* Balikesir: summit of Kaz Dağ, iv 1856, *Kirk.* Balikesir: Kaz Dağ, Çeyis Dere, 1000–1500 m, in damp Pinus nigra woods, 19 v 1962, *Dudley* (*D* 34809). Bursa: Bursa, iv 1893, *Robert College Herbarium;* Gemlik to Bursa, 100 m, in turf, leaves green with obscure white line, 20 iii 1956, *Davis & Polunin* (*D* 25132); on road from Bursa to Uludağ, about 1000 m, by running water, mostly on scree slopes, 16 v 1962, *Dudley* (*D* 34729). Samsun: Ravine NW. of Samsun on coast, 60 m, open slopes in grass . . . , 19 iv 1963, *Tobey* 117. Gümüşane: Gumuschkhane (Gümüşane) in pascuis alpinis, v 1894, *Sintenis* 5463 (isotype of *O. sigmoideum*); Kaldirimdagh, in graminosis



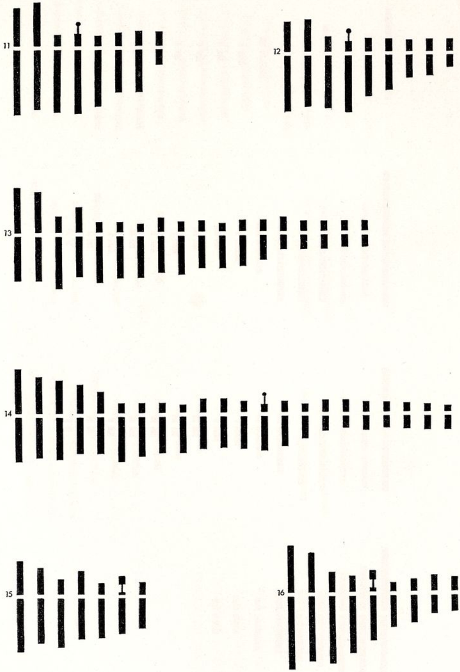
FIGS. 1–6; mag. 1–5 x 2,000; 6 x 3,000.

1) *O. nutans* D 25524, n=20 (+1 unpaired). The large metacentric chromosome on the furthest right is unpaired; 2) *O. nutans* Dudley 34819, n=7; 3) *O. pyramidale* D 33294, n=8; 4) *O. pyramidale* C 3459, n=9; 5) *O. pyramidale* D 28017, n=7; 6) *O. narbonense* n=7, constructed from figure in Heitz (1926) Abb. 13.



FIGS. 7–10, x 2,000.

7) *O. arcuatum* F. & S. 103, n=13; 8) *O. arcuatum* D 26692, n=16; 9) *O. magnum* C 3409, n=16; 10) *O. flavescens* D 29106, n=9.



FIGS. 11–16, x 2,000.

11) *O. tenuifolium* D 27414, n=8; 12) *O. alpigenum* D 26413, n=9; 13) *O. umbellatum* C 4084, n=18, idiogram constructed from camera lucida drawings; 14) *O. umbellatum* D 25590, n=22; 15) *O. ulophyllum* D 35252, n=7; 16) *O. ulophyllum* D 27831, n=9.

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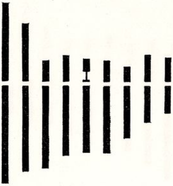

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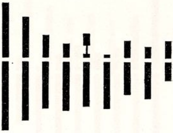

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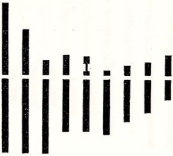

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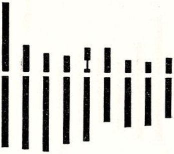

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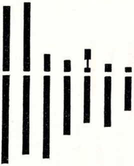

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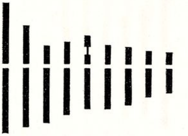

FIGS. 17–22, x 2,000.

17) *O. montanum* Cook 3, n=9; 18) *O. montanum* D 26315, n=9; 19) *O. montanum* D 26691, n=9; 20) *O. montanum* Polunin 36, n=9; 21) *O. montanum* D 25345, n=7; 22) *O. tempskyanum*, n=9, constructed from a photograph from Randolph & Mitra, 1957.

23


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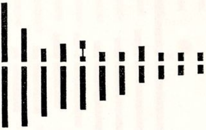

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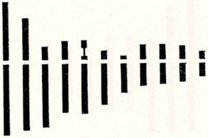

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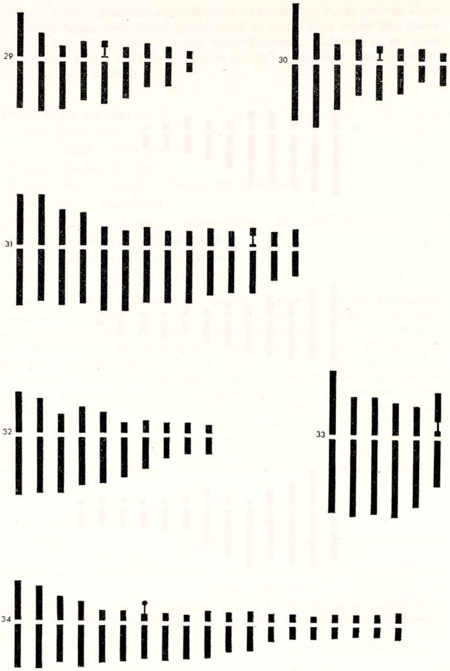
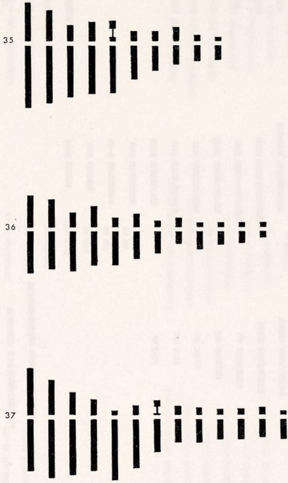
FIGS. 23–28, x 2,000.

23) *O. lanceolatum* Polunin 13, n=8; 24) *O. lanceolatum* D 25895, n=10; 25) *O. lanceolatum* D 25583, n=11; 26) *O. lanceolatum* D 26431, n=11; 27) *O. nanum* C 5009, n=6; 28) *O. nanum* Tobey 117, n=6.



FIGS. 29–34, X 2,000.

29) *O. nanum* D 34809, n=8 (+1 unpaired), the small metacentric chromosome on the furthest right is an unpaired B; 30) *O. nanum* C 5008, n=8; 31) *O. nanum* F. & S. 5, n=14; 32) *O. nanum* Dudley 34729, n=10; 33) *O. fimbriatum* D 26208, n=6; 34) *O. fimbriatum* D 25783, n=18 (+1 unpaired), one of the small metacentric chromosomes is unpaired.



FIGS. 35–37, x 2,000.

35) *O. oligophyllum* Moore 7256, n=10; 36) *O. oligophyllum* S. & H. 5319, n=12, idiogram constructed from camera lucida drawings; 37) *O. oligophyllum* F. & S. 745, n=13.

subalp., 5 v 1894, *Sintenis* 5463b; Bayburt to Gümüşane road, 2000 m, short turf, petals white with broad green band at back, faint white line down centre of leaf, 20 iv 1960, *Stainton* 8216. Trabzon: Trabzon, 50 m, grass banks, petals white, marked with green on back, white line down centre of leaf, 31 iii 1960, *Stainton* 8126.

CULTIVATED MATERIAL:

C 5003=*Tobey* 117.
C 5004=*Dudley, D* 34809.
C 5005=*Dudley, D* 34729.
C 5006=*Furse & Synge* 5 (Trieste, Mt. Spaccato).
C 5007=*Furse* 2682 (Iran).
C 5008=*LE* 59 4231 (as *O. woronowii* from Leningrad Bot. Gard.).
C 5009=*LE* 60 2946 (as *O. sintenisii* ,, ,, ,, ,,).
C 5010=*LE* 60 2947 (as *O. hyrcanum* ,, ,, ,, ,,),
C 5011=*LE* 60 2948 (as *O. woronowii* ,, ,, ,, ,,).

There is no clear distinction between the western *nanum* and the eastern *sigmoideum;* both have the fruiting pedicels sharply refracted and thickened (to varying extents) in the axils. What is noticeable, however, is a cline in size and robustness, the smallest plants occurring in the west, the largest in the east. This cline also involves a number of Caucasian "species", e.g. *O. sintenisii* Freyn & *O. schmalhauseni* Miscz. (possibly also *O. schischkinii* Krassch.), which, on the whole, are more robust than the specimens from eastern Turkey.* The species is also variable in the shape of its leaves, varying from almost flat to deeply channelled in section, and in degree of development of the white line, which is sometimes very obscure. None of these varying characters are strongly correlated, however, and their use as a basis for recognising other taxa leads to the pulverisation of the species into numerous 1-character variants.

CYTOLOGY

A number of cytological types have been observed amongst *O. nanum* in cultivation in Edinburgh.

2n=12 occurs in *Furse* 2682, *Tobey* 117 and three of the stocks sent from Leningrad, C 5009, C 5010, C 5011 (figs. 27 & 28, plate 17). The Leningrad stocks come from the Caucasus and belong to the variant which is sometimes known as *O. sintenisii* Freyn. The karyotypes of *Furse* 2682, C 5009, C 5010 and C 5011 are virtually identical, whilst that of *Tobey* 117 is similar but differs in the length of the two longest pairs of chromosomes relative to the rest of the complement.

In *Dudley* 34809 some roots have 2n=16, whilst others have the same complement plus a small extra nearly metacentric chromosome which is not equivalent to any other member of the set, and is presumably a supernumerary B (fig. 29, plate 17). There are a number of bulbs in the same pot

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*Agapova (Bot. Zhurn. 51: 210–220, 1966) treats *O. schmalhausenii* as a synonym of *O. balansae*, and *O. schischkinii* as a synonym of *O. sintenisii.*

so that one cannot be certain that the 2n=16 and 17 roots belong to different plants although this is probably the case. One or two chromocenters have been observed in interphase nuclei of this stock. In C 5008 there is also 2n=16 and a very similar karyotype to *D* 34809 (fig. 30); this stock like the others from Leningrad is of the *sintenisii* type.

In *Dudley* 34729 (fig. 32), both 2n=19 and 20 occur in different roots (again it is not known whether these two numbers characterise different plants). The numerical variation involves one of the shortest chromosomes. The karyotype seems to be rather close to the 2n=16 type of *Dudley* 34809 but with two extra short pairs (probably supernumeraries).

2n=28 is found in *F. & S.* 5 (fig. 31, plate 17). The idiogram shows that the chromosome pairs match reasonably well in twos and therefore it seems reasonable to suppose that it is a tetraploid. A satellite is present on the twelfth chromosome pair. The eleventh pair corresponds well in size with the twelfth and is presumably its homoeologue but shows no secondary constriction. Chromocenters are not present in the nucleus of this polyploid which probably indicates that none of the chromosomes are heterochromatic supernumeraries.

The relationship of the 2n=12 karyotype of this species with the 2n=16, 17, 19 and 20 karyotypes is interesting. The karyotypes of the latter group correspond closely to the *montanum* type and differ from each other principally in number of short (supernumerary?) chromosomes. The karyotypes with 2n=12 are obviously less like *montanum* although they bear a resemblance to the 1–6 chromosome pairs of this type with the other pairs eliminated. The tetraploid *F. & S.* 5 with 2n=28 has presumably been derived from a 2n=14 type intermediate between the 2n=12 and 16. Evidently karyotype evolution has been active in *O. nanum* and a detailed study of this subject would no doubt be rewarding.

There are three previous records for this species. Delaunay (1926) reported 2n=12 and gave dimensions for the chromosomes which correspond reasonably well with our 2n=12 stocks. The same number is recorded for *O. sintenisii* Freyn. in the recent work of Agapova (1966) and again, apart from a somewhat longer SAT chromosome, the karyotype corresponds well with ours. Kožuharov & Zuzmanov (1964) record 2n=24 for a West Bulgarian collection of this species but their figure shows 2n=25. Analysis of their figure shows that this plant is not a tetraploid produced by a straightforward doubling of the 2n=12 form. It may, however, represent a continuation of the 2n=16, 17, 19, 20 series.

13. O. refractum Willd., Enum. Hort. Berol. Suppl. 18 (1814).

TURKEY. Istanbul: Koustoundjuk et Beylerbey, 20 iii 1917, *Aznavour;* Kartal to Yakacik, 22 iv 1894, *Aznavour*. Kocaeli: Pendik, champs cultivés, argileux, 7 iii 1897, *Aznavour*.

A specimen from Izmir, Kuşadasi, 30 m, weedy banks, many small bulbils, *Davis* 40700, which is in early flower, and lacks leaves, should probably be referred to this species.

O. refractum is very similar to the small (western) variants of *O. nanum*, the only clear distinction being the proliferous bulb of *refractum*. The two should probably be treated as subspecies.

14. O. fimbriatum Willd. in Ges. Naturf. Fr. Neue Schr. 3: 420 (1801).

TURKEY. Istanbul: Rumeli Hisar hills, 7 vi 1919, *Post;* Burgaz Ada (Antigoni), 5 m, near Hondulu Café on slopes near the sea, leaves greyish-green without a white line, *Davis & Hedge* (*D* 26208); Kinali Ada, summit, 4 iv 1953, *Demiriz* 1320. Çanakkale: Thymbra, in valle Scamandri, 4 v 1883, *Sintenis* 392; Dardanelli, in montosis, 10 iii 1883, *Sintenis* 238. Balikesir: Kaz Dağ, iv 1856, *Kirk*. Kütahya: Murat Dağ above Banaz, 1800 m, *Coode & Jones* 2470. Bursa: Olympus (Uludağ) vi 1893, *Post*. Çorum: 3 miles from Çorum to Merzifon, 800 m, *Coode & Jones* 1845. Izmir: Samsun Dağ above Güzelçamli, 800 m, summit ridge in sward, 24 iv 1965, *Davis* 41730. Aydin: Aydin, 1936, *Başarman*. Mugla: d. Marmaris, Yarimadasi, 300 m, rocky serpentine N. slopes and in open places, 18 iv 1965, *Davis* 41268. Antalya: distr. Akseki, Yarpuz Dağ, 1200 m, eroded turf, leaves long ciliate, 9 iv 1956, *Davis & Polunin* (*D* 25783). Içel: distr. Mut, Adras Dağ, 1300 m, *Coode & Jones* 972. Cilicischer Taurus, mittlere Waldregion, auch subalpin, 1000–1800 m, *Siehe* 76.

CULTIVATED MATERIAL:

C 5012=*D* 25783.
C 5013=*D* 26208.

This is perhaps the most handsome and easily recognised of the Turkish species. Apart from its indumentum, however, it is very similar to *O. nanum*. The var. *ciliatum* recognised by Boissier and most later authors does not seem worth maintaining, as the density of the indumentum and the lengths of the hairs vary considerably from specimen to specimen in any one gathering; these characters certainly vary from year to year in shoots produced from the same bulb.

CYTOLOGY

The two stocks of this species in cultivation at Edinburgh have both been examined.

The number $2n=12$ occurs in *D* 26208 (fig. 33, plate 18). The SAT chromosome is the shortest of the set but the satellite itself is rather long. The karyotype morphology is very similar to that described for a stock of this species by Neves (1956b). $2n=12$ was also reported for *fimbriatum* by Delaunay (1926) but there is no illustration. The karyotype of *D* 26208 is rather similar to the $2n=12$ forms of the related *O. nanum*, but there is a considerable difference in the SAT chromosomes.

Roots with $2n=35$, 36 and 37 occur in *D* 25783 (fig. 34, plate 18); these probably belong to different plants but this is not definitely known. There are 11–13 chromosomes of the short supernumerary type and correlated with this many chromocenters are present in the interphase nuclei. The rest of the complement, consisting of 24 longer chromosomes, falls into fours reasonably well so that it seems likely that it represents tetraploidy of an $x=6$ basic number. There is normally only one pair of SAT chromosomes but one figure was observed with three such chromosomes, so that suppression of the nucleolus organisers of the second pair is presumably sometimes incomplete. The karyotype of the twelve longer chromosomes is somewhat different from that which would be produced by doubling those of *D* 26208, so probably some chromosome repatterning has occurred within the species.

15. O. oligophyllum Clarke, Travels 4: 555 (1813–23).

Syn.: *O. ruthenicum* Gris., Spic. 2: 393 (1843).
O. aucheri Boiss., Diagn. ser. 1 (5): 65 (1844).
O. bifolium C. Koch in Linnaea 19: 10 (1849).
O. aemulum Schott & Kotschy in Oest. Bot. Wochenbl. 4: 162 (1854).
O. brevipedicellatum Boiss. ex Baker in J. Linn. Soc. Bot. 13: 263 (1873).
O. balansae Boiss., Fl. Or. 5: 222 (1882).

TURKEY. Bursa: Olympus (Uludağ), vi 1855, *Kirk; ibid.*, 2000–2180 m, 18 vi 1956, *Moore* 7256; *ibid.*, Kirazli, 23 v 1954, *Heilbronn;* above Tahtakopru (Tavşanli to Inegöl road), 1300 m, Beech forest, 25 iv 1962, *Guichard* TUR/74/62. Kastamonu: Ilgaz Dağ, 2200 m, earthy limestone scree . . . , 6 vi 1954, *Davis* 21552. Amasya: Amassia (Amasya), 1 v 1896, *Foerster*. Bolu: Abandgölü, 1947, *Heilbronn & Başarman*. Sivas: Bey Dağ S. of Zara, 2000 m, on dry N. slopes, sandstone, 1 vi 1960, *Stainton & Henderson* 5319. Samsun: Ladik, 1200 m, in grass, clay soil . . . , 19 v 1964, *Tobey* 573. Gümüşane: Kaldirimdagh, in pascuis subalpinis, 7 v 1894, *Sintenis* 5464. Rize: Ikizdere to Ispir, top of pass, 3000 m, on grassy ledges on granite, leaves lack white line, 15 vii 1960, *Stainton & Henderson* 6239. Çoruh: Borçka, 700 m, amongst shrubs . . . , leaves glossy with no white line, 18 iv 1960, *Stainton* 8209; distr. Ardanuç, Kordevan Dağ (Yalnizçam Dağlari), 2700 m, rocky igneous slopes, leaves green, 28 vi 1957, *Davis & Hedge* (*D* 30387); Artvin, 2000 m, Picea forest, no white line on leaf, 27 iv 1960, *Stainton* 8268. Kars: Ziyaret Dağ (Yalnizçam Dağlari) between Ardahan & Artvin, by snow patch, 1500 m, leaves green, 28 vi 1957, *Davis & Hedge* (*D* 30268). Kütahya: Murat Dağ above Kesik Söğüt, 1900 m, moist igneous slopes, 5 vii 1962, *Davis & Coode* (*D* 36773 & 36797); Murat Dağ above Banaz, summit ridge, 2150 m, *Coode & Jones* 2513. Kayseri: Bakir Dağ at Akoluk Yayla above Kisge, 2000 m, by snow, leaves 2, green with no white line, 29 vi 1952, *Davis* 1940 *Dodds & Çetik*. Tunceli: Munzur Dağ above Ovacik, turf near melting snow, leaves green, *Davis & Hedge* (*D* 31145 & 31271). Bitlis: Karz Dağ above Kotum 2100 m, damp ground round snow melt, no line on leaf . . . , 28 vi 1954, *Davis & Polunin* (*D* 22290). Antalya: in petrosis montis Tscharyklar prope Adalya (Antalya), 20 iv 1860, *Bourgeau;* Lycia, in regione alpina, *Bourgeau* (isotype of *O. brevipedicellatum*). Konya: Beyşehir to Akseki, 1500 m, 29 v 1961, *Demiriz* 4508. Içel: Gülek Boğaz, 1100 m, Abhang, iv 1896, *Siehe* 209; 15 km SW. of Pozanti, Elmali Dağ, SW slope with forest on open place, 1600 m, 20 v 1959, *Hennipman et al.* (Iter Leydenense 1959: 1290). Niğde: Antitaurus über Bereketli Maden, 2000 m, *Siehe* 74. Maraş: distr. Göksun, Binboğa Dağ on Işik Dağ above Karli Yayla, 2700 m, E. side of summit ridge, 15 vii 1952, *Davis* 20023 *Dodds & Çetik;* distr. Cardak, Berit Dag above Arpa Cukuru Yayla, 2800 m, edge of snow, 26 vii 1952, *Davis* 20302 *Dodds & Çetik*. Hatay: distr. Belen, Karlik Tepe above Soğuk Oluk, 1200 m, humus under Abies, leaves 2, glaucous, without a white line, 4 iv 1957, *Davis & Hedge* (*D* 27061A).

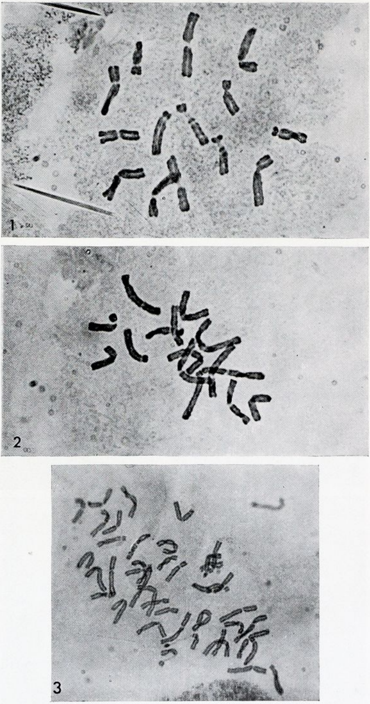

PLATE 12. 1) *O. nutans* Dudley 34819, $2n = 14$; 2) Dudley 34819, $2n = 15$; 3) D 25524, $2n = 41$. 1 and 2 x 1,000, 3 x 600; all plates in this paper are of root tip mitosis.

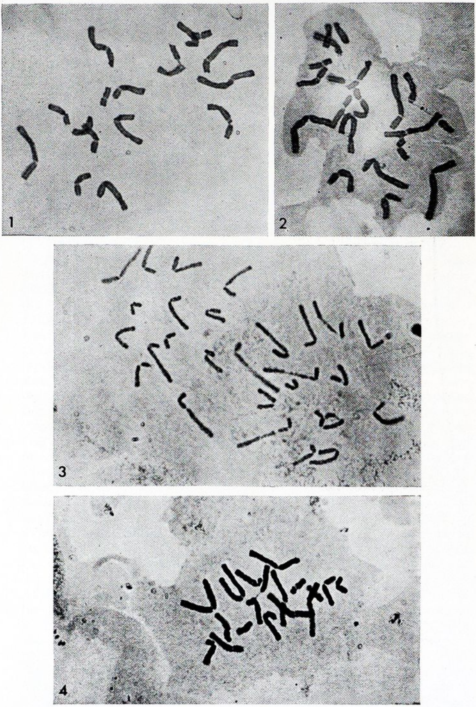

PLATE 13. 1) *O. pyramidale* D 33294, $2n = 16$; 2) *O. pyramidale* C 3459, $2n = 18$; 3) *O. pyramidale* D 28017, $2n = 14$, anaphase; 4) *O. flavescens* D 29106, $2n = 18$. All x 1,000.

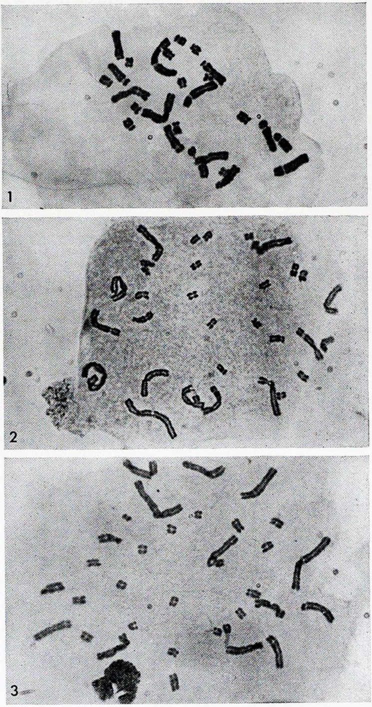

PLATE 14. 1) *O. arcuatum* F. & S. 103, 2n = 26; 2) *O. arcuatum* D 26692, 2n = 32; 3) *O. magnum* C 3409, 2n = 32. All x 1,000.

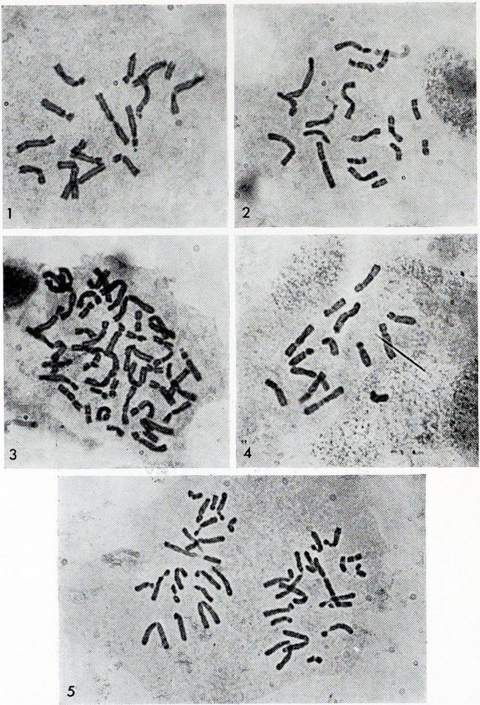

PLATE 15. 1) *O. tenuifolium* D 27414, 2n = 16; 2) *O. alpigenum* D 26413, 2n = 18 (the faint body at the top right of the figure is a dust particle not an out-of-focus chromosome); 3) *O. umbellatum* D 25590, 2n = 44; 4) *O. ulophyllum* D 35252, 2n = 14; 5) *O. ulophyllum* D 27831, 2n = 18, late anaphase. All x 1,000.

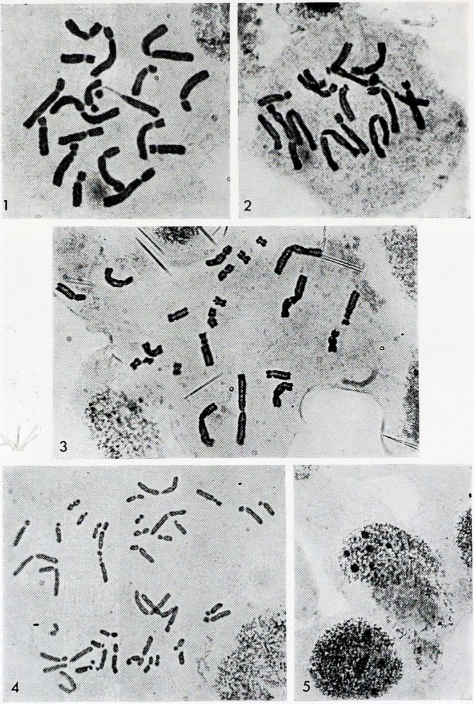

PLATE 16. 1) *O. montanum* Polunin 36, $2n = 18$; 2) *O. lanceolatum* Polunin 13, $2n = 16$; 3) *O. lanceolatum* D 25583, $2n = 22$; 4) *O. lanceolatum* D 26431, $2n = 20$; 5) *O. lanceolatum* D 25583, chromocenters in interphase nuclei of root with $2n = 22$. All x 1,000.

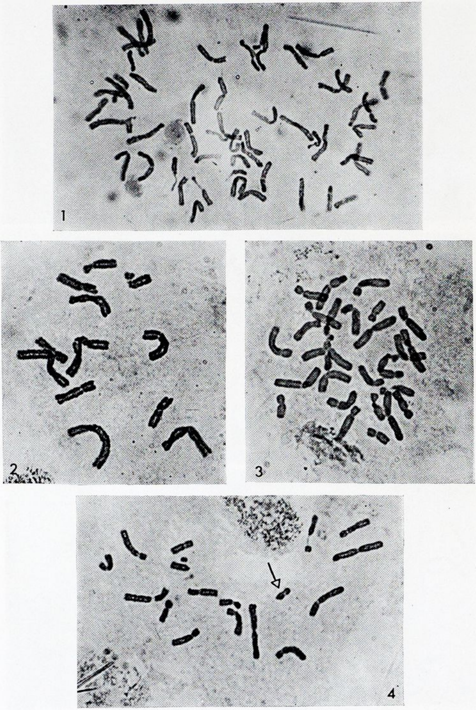

PLATE 17. 1) *O. tempskyanum* D 31428, 2n = 54; 2) *O. nanum* Tobey 117, 2n = 12; 3) *O. nanum* F. & S. 5, 2n = 28; 4) *O. nanum* D 34809, 2n = 16+1B, the B is marked with the arrow. All x 1,000.

PLATE 18. 1) *O. fimbriatum* D 26208, 2n = 12; 2) *O. fimbriatum* D 25783, 2n = 37; 3) *O. oligophyllum* Moore 7256, 2n = 20; 4) *O. oligophyllum* F. & S. 745, 2n = 25. All x 1,000.

CULTIVATED MATERIAL:

C 5014=*D* 30387.

C 5015=*Stainton & Henderson* 5319.

C 5016=*Moore* 7256.

C 5017=*Furse & Synge* 745 (Iran).

O. oligophyllum is the most widespread species of Subgen. *Heliocharmos* in Turkey and also the most polymorphic, as the list of synonyms shows. Most of these names were treated as synonyms of *oligophyllum* by Boissier, and require no further discussion, but two of them, *O. balansae* and *O. brevipedicellatum* were maintained as separate species by him. Our reasons for treating them as synonyms are given below:

O. balansae. Plants corresponding to Boissier's description, with very broad leaves, broad, blunt perianth segments, larger flowers and shorter pedicels (than 'typical' *oligophyllum*) occur only in the north of Turkey. Extreme specimens (e.g. *Sintenis* 5464, *Tobey* 573) look very different from 'typical' *oligophyllum* (sensu Boissier), but every transition occurs between the two types, and *oligophyllum* occurs in the same general area as the *balansae* types. With these facts in mind it seems impossible to recognise *balansae* as a species or subspecies; it might, however, qualify as a variety.

O. brevipedicillatum. We have seen an isotype of this species, which Boissier separated widely from *O. oligophyllum* because of its lack of capsule wings. We have discussed this character earlier (see above); in the specimen in question it is not possible to say whether a wing is present or not. However, in all other characters the plant is typical of *O. oligophyllum*, so, in view of the doubt we have already expressed about the capsule wing character, we feel that it must be sunk in *oligophyllum*.

CYTOLOGY

Several chromosome numbers have been observed in the stocks of this species in cultivation at Edinburgh.

2n=20 occurs in *Moore* 7256, 2n=24 in *S. & H.* 5319 and roots with 2n=25 and 26 in *F. & S.* 745 (fig. 35–37, plate 18). The numerical differences are probably mainly due to variation in the number of short supernumerary or semi-supernumerary chromosomes. The karyotype of *Moore* 7256 is close to those of *O. nanum D* 34809 (2n=16 and 17) and *D* 34729 (2n=20) and also to those of the *montanum* group. The smallest pairs of chromosomes look rather like supernumeraries but chromocenters have not been observed in interphase nuclei. The idiogram of *S. & H.* 5319 has been constructed from measurements from only two camera lucida drawings and therefore is probably far from accurate; nevertheless it appears to correspond reasonably well with that of *Moore* 7256 except that there are two additional very short pairs. The karyotype of *F. & S.* 745 is somewhat different: the SAT chromosome is the seventh as opposed to the fifth in *Moore* 7256 (the SAT chromosome was not determined in *S. & H.* 5319). The presence of many short supernumerary type chromosomes in *S. & H.* 5319 and *F. & S.* 745 is surprisingly unaccompanied by occurrence of chromocenters in the resting nuclei.

Delaunay (1926) reported 2n=24 for this species but his only illustration is of the SAT chromosome which corresponds exactly with that observed by us in *F. & S.* 745. Agapova (1966) has found 2n=24, 25 and 26 in *O. oligophyllum*, (under the synonym *O. balansae* Boiss.): as in our plants the numerical differences involve the very short chromosomes.

CYTOLOGICAL DISCUSSION OF SUBGENUS HELIOCHARMOS

The investigation has revealed a basic diploid karyotype showing dysploid variation which is widespread amongst those members of the subgenus *Heliocharmos* which were studied. As shown by the idiograms there is considerable variation in this basic karyotype but nevertheless the relationship of its various forms seems fairly obvious. The chromosome number of plants with this typical karyotype, which will be called the '*montanum*' type in this discussion, ranges from 2n=14 in *montanum D* 25345 to 2n=24 in *oligophyllum S. & H.* 5319. The cause of differences in basic number is exactly similar to that discussed in the subgenus *Beryllis* (p. 308), i.e. variation in the number of shorter chromosomes. In some cases such as the *lanceolatum* stocks with 2n=22 some of these short chromosomes are obviously dispensable heterochromatic supernumeraries. In other cases such as 2n=18 stock of *montanum* the supernumerary nature of the smaller chromosomes is less obvious, and the difference between the 2n=18 and 14 stocks of this species possibly involves rearrangement of genetic material rather than a mere gain or loss of supernumeraries. The typical karyotype is found in all the *montanum* stocks studied (2n=14 and 18), all *lanceolatum* stocks (2n=16, 20 and 22), Randolph & Mitra's diploid *tempskyanum* (2n=18), *ulophyllum D* 27831 (2n=18), *nanum Dudley* 34809 (2n=16, 17), C 5008 (2n=16) and *Dudley* 34729 (2n=19, 20) and *oligophyllum Moore* 7256 (2n=20) and *S. & H.* 5319 (2n=24).

The 2n=12 karyotype which is found in four stocks of *nanum* may represent a reduction from the typical '*montanum*' type (or less likely it could be the precursor of the higher numbers), and it seems possible that the *fimbriatum* 2n=12 type is derived from it. *O. ulophyllum D* 26430 and *Dudley* 35252 (2n=14) probably represent a variation of the typical '*montanum*' type, although the first and second chromosomes tend to be shorter relative to the other members of the complement than is usual. In *alpigenum D* 26413 (2n=18) and *tenuifolium D* 27414 (2n=16) the karyotypes, which are very similar, differ from the '*montanum*' type in their very small satellites but are otherwise fairly similar. The karyotype observed by Czapik in Polish and Czechoslovak material of *tenuifolium* comes closer to the '*montanum*' type than does that of *D* 27414. *O. oligophyllum F. & S.* 745 (2n=25, 26) has its satellite on the seventh chromosome, which is unusual for this group. Some chromosome repatterning must have been involved in the origin of its karyotype which bears a strong superficial resemblance to those of the very dissimilar species *arcuatum* and *magnum* belonging to the subgenus *Beryllis*. This raises the point that the typical '*montanum*' karyotype of *Heliocharmos* is rather similar to some found in the subgenus *Beryllis* (e.g. see idiogram of *O. flavescens*) and it would probably be impossible to separate the two subgenera on karyotypic characters.

Polyploidy is of common occurrence in *Heliocharmos*. As already mentioned many levels of ploidy are known for *umbellatum* and the work of Czapik has revealed the occurrence of triploids in *tenuifolium*. In *ulophyllum* we have found 2n=14 and 18 whilst the stock of the very closely related *O. eigii* Feinbr. from Israel studied by Neves (1956b) was tetraploid with 2n=36. Our stock of *tempskyanum* was hexaploid (2n=54) whilst that studied by Randolph and Mitra (1957) was diploid with 2n=18. *O. nanum F. & S.* 5 is a tetraploid with 2n=28, whilst the other stocks studied are diploids with 2n=12, 16, 17, 19 and 20. In *fimbriatum* we have found, in addition to the 2n=12 diploid, a tetraploid with twelve pairs of large chromosomes and six pairs of small apparent supernumeraries.

GENERAL DISCUSSION OF CYTOLOGICAL RESULTS

The results of this investigation together with those from other cytological studies reveal a rather complex picture involving intraspecific polyploidy, dysploid series at both intra- and inter-specific levels and the occurrence of supernumerary chromosomes (Table I and the accounts for the species and subgenera show the extent of this). This complexity indicates that many of the species are in an active state of evolution and explains many of the difficulties experienced by the taxonomist in dealing with the group.

Chromosome repatterning has obviously been active to some extent in karyotype evolution amongst the species studied, but usually it seems to have brought about relatively minor alterations rather than the spectacular V replacing two rods (or vice versa) type of change. It is difficult from the information available to detect any obvious trends in karyotype evolution, although it seems possible that there might be one towards reduction in chromosome number in several independent lines. For instance stocks occur with 2n=18 in *ulophyllum* and *montanum* and 16, 17, 19 and 20 in *nanum* but there are also stocks with 2n=14 in the two former species and 2n=12 in the latter. It is difficult, of course, to say which number is original and which derived but since the higher numbers (2n=16, 18 etc.) occur in the majority of species of *Heliocharmos* it seems more likely that it is the lower numbers (2n=12, 14) which have been derived.

Meiotic studies in hybrids both between species and between dysploid stocks of the same species would undoubtedly be a fruitful subject for further research in the subgenera *Heliocharmos* and *Beryllis*.

EXTRA-TURKISH TAXA OF WHICH MATERIAL HAS BEEN AVAILABLE:

O. fischerianum Krassch. *Cf.* under *O. brachystachys*.

O. schelkovnikovii Grossh. *Cf.* under *O. arcuatum*.

O. sintenisii Freyn, **O. schmalhauseni** Miscz. & **O. schischkinii** Krassch. *Cf.* under *O. nanum*.

O. woronowii Krassch. This appears (from descriptions and photographs) to be a robust variant or ally of *O. tenuifolium*. Bulbs sent under this name from Leningrad, cultivated in Edinburgh, do not match the descriptions, and agree best with large variants of *O. nanum* (i.e. *O. sintenisii*).

O. hyrcanum Grossh. An apparently distinct species of the *montanum* group.

O. transcaucasicum Miscz. A specimen from Turkey, Prov. Hakkari, Kara Dağ, 3600 m, near snow, leaves green, no white line, 16 viii 1954, *Davis* 24414 & *O. Polunin*, has been doubtfully determined as this Caucasian species by N. D. Agapova of Leningrad. The specimen is unfortunately in early flower, and is too young for accurate determination. Judging from published descriptions, *O. transcaucasicum* belongs to the *nanum* group; Agapova (1966) has recorded a chromosome number of 2n=30 for it. Our specimen shows a very conferted raceme, and its leaves appear to have been very glaucous—two unusual characters for the *nanum* group.

Names of uncertain application abound in the literature. They are too numerous to list here. Any attempt at laying them to rest would involve an intensive search of the literature, and the borrowing of numerous specimens from herbaria all over Europe. It is doubtful whether such a process would be worth the expense (both of time and money) involved. It is hoped, as information about them comes to light during the normal processes of taxonomic study, to extend the nomenclature and synonymy given in this paper.

CONCLUSIONS

Both the taxonomic and cytological results show that *Ornithogalum* is in an actively evolving state in the East Mediterranean region. This is reflected in the somewhat amorphous mass of variation within subgenera which is difficult to divide into species and species groups. At the cytological level the active evolutionary processes can be seen in the frequent occurrence of intraspecific polyploidy and dysploid series.

The group would provide excellent material for a thorough cytological study involving karyotypic investigations of populations, meiotic analyses of synthetic hybrids etc. Such a study would undoubtedly give useful information as to the importance of chromosome repatterning in speciation and the status of the short supernumerary type of chromosomes. The main difficulties in such a research project might be the necessity for the destruction of bulbs to obtain flower buds at meiosis, and the time taken for synthetic hybrid seed to flower.

Herbarium material is inadequate for the classification of *Ornithogalum;* living material is absolutely essential. Much of the existing herbarium material is of little value, due to the absence of notes about such important characters as capsule wings and tepal colour. Collectors should note such features, in order to increase the value of their specimens (and the chance of having them accurately named).

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SUMMARY

Twenty-four species of *Ornithogalum* are recognised from Turkey including one new species, *O. melanogynum* Cullen, of subgenus *Caruelia.* Keys are provided for each subgenus and the distribution of the more important species is mapped. Fifteen species have been studied cytologically and chromosome numbers are listed in Table I whilst the idiograms (figs. 1–37) give details of karyotype.

The cytological results show intraspecific polyploidy and dysploid series within and between species. Such a background suggests active evolution and explains the taxolomic difficulties in recognizing clear-cut species.

Note: This work was done while J.C. was S.R.C. Research Assistant on the *Flora of Turkey*.

TABLE I

Species and Stock	Present Investigation 2n	Previous Records 2n	Reference
O. nutans L.			
Dudley 34819	14, 15		
D 25524	40, 41		
		28(−32)	Heitz, 1926.
		16	Sprumont, 1928.
		30	Nakajima, 1936.
		42	Lauber, 1947.
		42	Holzer, 1952.
O. pyramidale L.			
D 28017	14		
D 33294	16		
C 3459	18		
		C.32	Heitz, 1926.
		24	Nakajima, 1936.
		24	Neves, 1952.
O. narbonense L. (see p. 00 for reasons for including this species here).		14	Heitz, 1926.
		16	Delaunay, 1926.
		14	Sprumont, 1928.
		54	Chiarugi, 1950.
		54	Martinoli, 1950.
		54(52–65) — variation in no. mainly due to the presence of B chromosomes.	Neves, 1952.
O. arcuatum Stev.			
F. & S. 103	26, 28		
D 26692	32		
		34	Delaunay, 1926.
O. magnum Krassch. & Schischk.			
C 3409	32		
O. flavescens Lam. (O. pyrenaicum L. p.p.)			
D 29106	18		
		32	Sprumont, 1928 } *O. pyrenaicum* L.
		C.16	Greeves, 1930 }
		16 (+sometimes 1–3B)	Neves, 1952, *O. pyrenaicum* L.
		16 (+sometimes 1B)	Neves, 1952, *O. flavescens*. Lam.
		24	Neves, 1952, *O. flavescens*, Lam.

TABLE I (*continued*)

Species and Stock	Present Investigation 2n	Previous Records 2n	Reference
O. tenuifolium Guss.			
(*O. gussonei* Ten.)			
D 27414	16		
D 28595	16		
		16	Delaunay, 1926.
		18, 19, 20, 20+F, 27, 28, 29.	Czapik, 1965.
O. alpigenum Stapf			
D 26413	18		
O. umbellatum L.			
C 4984	35, 36		
F. & S. 746	36		
D 25590	44		
		18, 27, 36, 45, 54, 72+various complications due to B chromosomes and the occurrence of hypoploidy at higher ploidy levels.	Neves, 1952. See this reference and also Czapik (1965) for records by other workers.
O. ulophyllum Hand.-Mazz.			
D 26430	14		
D 35252	14		
D 27831	18		
		36	Neves, 1952, as *O. eigii.* Feinbr. (cf. p. 000).
O. montanum Cyr.			
Cook 3	18		
D 26315	18		
D 26495	18		
D 26588	18		
D 26691	18		
Dudley 34583	18		
Dudley 34900	18		
Dudley 39388	18		
Polunin 36	18		
D 25345	14		
		16(–18)	Heitz, 1926.

TABLE I (*continued*)

Species and Stock	Present Investigation 2n	Previous Records 2n	Reference
O. lanceolatum Lab.			
Polunin 13	16		
D 25583	22(?16+6B)		
D 25895	20(?16+4B)		
D 26341	20, 22(?16+4 or 6B)		
O. tempskyanum Freyn. & Sint.			
D 31428	54		
		18	Delaunay, 1926.
		18	Randolph & Mitra, 1957.
O. nanum Sibth. & Sm.			
Furse 2682	12		
Tobey 117	12		
C 5009	12		
C 5010	12		
C 5011	12		
C 5008	16		
Dudley 34809	16, 16+1B		
Dudley 34729	19, 20(?16+3 or 4B)		
F. & S. 5	28		
		12	Delaunay, 1926.
		24	Kožuharov and Kuzmanov, 1964.
		12	Agapova, 1966, as *O. sintenisii* Freyn.
O. fimbriatum Willd.			
D 26208	12		
D 25783	35, 36, 37		
		12	Delaunay, 1926.
		12	Neves, 1956b.
O. oligophyllum Clarke			
Moore 7256	20		
S. & H. 5319	24		
F. & S. 745	25, 26		
		24	Delaunay, 1926.
		24, 25, 26	Agapova, 1966.