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A Striking Polyploid Complex in the Alpine Flora: Arenaria ciliata L.

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In a previous paper (FAVARGER 1963) the author has demonstrated that the taxon *Arenaria ciliata* L. sensu stricto (viz. after exclusion of *Arenaria moehringioides* Murr which in the opinion of HALLIDAY (1961) and of the author deserves specific recognition)[1] is represented in Central Europe by several "chromosome races" having, respectively, n=20, 40, 60, and ca 120 chromosomes. The diploid (n=20) has hitherto been found only in the Tatra mountains of Poland and Czechoslovakia. The author has proposed (FAVARGER 1963, p. 174) to name this last taxon *A. ciliata* L. ssp. *tatrensis* (Zapal.) Favarger, putting it on the same level as ssp. *pseudofrigida* Ostenf. et Dahl from the arctic region and ssp. *hibernica* Ostenf. et Dahl from Ireland (which are also diploid), in spite of the very slight morphological differences separating these three taxa.

The tetraploid "race" (n=40) extending from the Gran Paradiso mountains to the "Canton des Grisons" in Switzerland, and the hexaploid "race" (n=60) from the Basse Engadine (National Swiss Park) are difficult to distinguish from each other and the author has classified them provisionally in ssp. *ciliata*. As to the dodecaploid "race" (n=ca 120) that was discovered by the author in the "Préalpes bernoises", it represents a very striking plant on account of its size, its loose growth, its very large flowers, and also by its ecology. It has been named ssp. *bernensis* Favarger. However, in 1963, the author had not studied the populations of the Austrian Alps. It was only stated, on account of an approximate count on plants from seeds gathered at the Rax-Schnee-

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[1] The author thinks that it is simply for reason of commodity that CHATER & HALLIDAY have subordinated again *Arenaria moehringioides* to *Arenaria ciliata* in Flora europaea (1964).

berg by the Botanical garden in Vienna, that there should exist a high polyploid taxon in the calcareous North-eastern Alps. On the other hand, one could wonder where the eastern limit of the hexaploid "race" is situated.

In August 1964, during a journey with Mr. A. BAUDIÈRE and Mr. L. ZELTNER, we had an opportunity to gather living material of *Arenaria ciliata* at two places in the Austrian Alps, viz., on the Wiener Schneeberg and on the Hochtor (Gross Glockner). The result of the cytological observations on these collections is presented below.

Material from the Wiener Schneeberg

Not having been able to detect good pictures of meiosis, the author has concentrated his interest on the mitosis of root tips. Twelve metaphase plates have been drawn and carefully analysed. On the best ones, 196 to 205 chromosomes were counted. The average of the 12 plates is 200, the extreme values being 189 and 213. The author feels justified to conclude that the population from the Wiener Schneeberg is decaploid with 2n=200. The variation observed is due either to technical difficulties in the interpretation, or to the fact that in such high polyploids, the chromosome number is not absolutely constant.

Morphologically, the plants from the Wiener Schneeberg are strikingly resembling those of the "Préalpes bernoises" (Gantrisch). They have the same loose and trailing appearance, the very numerous stems and the large flowers. Cultivated as well as dried herbarium specimens are easily recognizable from the other Alpine populations of *Arenaria ciliata*.

As for the ecology, the populations of the Wiener Schneeberg are growing chiefly in the alpine zone, on limestone, in the *Carex firma* association (*Firmetum*) and also at the limit of the subalpine zone, in meadows with scattered individuals of *Pinus mugo*. These habitats are not unlike those where ssp. *bernensis* is growing on the Gantrisch in Switzerland.

On account of the important analogies between the plants of Wiener Schneeberg and those of the Gantrisch, the author has counted again the chromosomes of ssp. *bernensis* to verify whether this taxon (at its 'locus classicus') is really dodecaploid. On the plants 60/779, not studied in 1960, numbers near 2n=240 were counted, e.g., 2n=222, 227 and 231 (once only 207). The author believes that these plants are really dodecaploid, but it is not impossible that their chromosome number showed unimportant variations as in the preceding case.

In spite of the slight difference in the degree of polyploidy, the plants of the Wiener Schneeberg and those of the Gantrisch seem to belong to a single taxon, ssp. *bernensis*. At the most, it was observed that the flowers from the Wiener Schneeberg have often wider petals, with overlapping edges, not unlike those of *Cerastium arvense* ssp. *strictum*.[2]

Material from the Hochtor

The examination of the mitoses of root tips gives $2n = ca\ 160$. On the clearest plates 155 and 158 chromosomes were counted, and on a metaphase of division I of meiosis, one can observe a minimum of 72 bivalents. So, it seems doubtless that this race is octoploid. The variations observed in the number of chromosomes are attributable to reasons stated above.

It should be noted, that in the hexaploid taxon, besides $n = 60$, the author has also counted $n = 62$, whereas the mitosis of root tips sometimes showed 129 chromosomes. Moreover (cf. FAVARGER 1963, p. 163), the same kinds of variation have been observed about the number $2n = 80$ in the tetraploid taxon.

The detection of octoploids on the Gross Glockner has induced the study of a plant found by Mr. VILLARD at Murtèr (National Park in Switzerland), which the author had in culture in Neuchâtel but which was not yet examined. On root tip mitoses, the number $2n = ca\ 160$ was counted.

From the above follows that the octoploid race very likely ranges from the Basse Engadine to Obere Tauern, replacing in the East the western race with $n = 40$. On the other hand, the plants with $n = 60$ have a much narrower area, and, which is very striking, they occur in the frontier zone between the tetraploid race and the octoploid one. It would be unreasonable not to conclude that this race with $n = 60$ is the result of a crossing between the western race and the eastern one: $40 + 80 = 120$.

In conclusion, the different Alpine races of *Arenaria ciliata* have the following chromosome numbers:

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[2] While writing this paper, the author has been able to study also material of *Arenaria ciliata* gathered on the Raxalpe by the Botanical garden in Vienna. On this collection the number $2n = ca\ 200$ was counted.

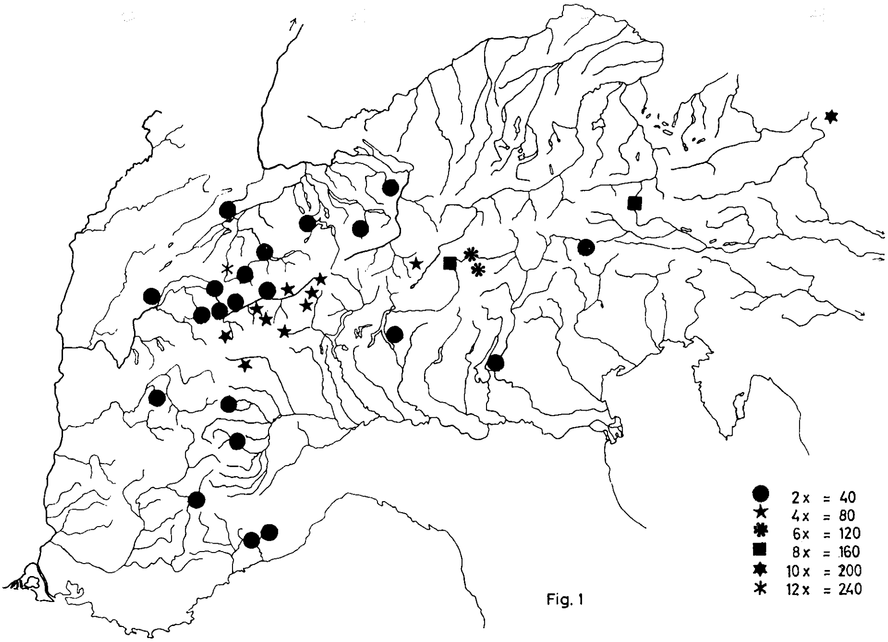

Fig. 1

Fig. 1. Distribution in the Alps of the *Arenaria ciliata* complex. The diploid taxon (2n=40) is *A. moehringioides* Murr. The cytotypes with 2n=80, 120 and 160 are corresponding to *A. ciliata* L. ssp. *ciliata*; the cytotypes with 2n=200, 240 to *A. ciliata* L. ssp. *bernensis* Favarger.

	Race[3]	2n
4x:	Alpes graies, Valais, W. Grisons	80 ± 3
6x:	Basse Engadine (Ofenpass and Val dal Botsch)	120 ± 9
8x:	Gross Glockner and Murtèr Alp	ca 160
10x:	Wiener Schneeberg, Raxalpe	ca 200
12x:	Gantrisch	ca 240

The distribution of these races is shown on the map (Fig. 1), which completes the one published in FAVARGER 1960.

Discussion

The taxonomical problems in the group studied are rather intricate. Contrary to the hypothesis stated earlier (FAVARGER 1963), it has not yet been possible to distinguish, either by morphology or by ecology,

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[3] Following HALLIDAY (1961), the author regards n=20 as the basic number of the group, instead of n=10, which has been observed in *A. serpyllifolia*.

the tetra-, hexa-, and octoploid races. They should be considered as simple cytotypes within ssp. *ciliata.* However, these cytotypes, contrary to those of *Caltha palustris* (REESE 1954) seem to have each a special geographical distribution. At any rate, neither the octoploid has been found westward from long. 10° nor the tetraploid eastward from the designated longitude. On the other hand, there is no important morphological difference between the population of the Wiener Schneeberg (10x) and that of the Gantrisch (12x). From a strictly taxonomical point of view, the cytotypes deserve no special status, since they can not be differentiated either on living plants or in the herbarium. Thus, in the Alps the whole group of *Arenaria ciliata* includes definitely three taxa, differing by their morphology, chromosome number, and distribution:

	n
Arenaria moehringioides Murr	20
Arenaria ciliata L. ssp. *ciliata*	40, 60, 80
Arenaria ciliata L. ssp. *bernensis* Favarger	100, 120

It would be rather convenient to consider these taxa as three distinct species. However, the Alpine problem cannot be dissociated from the northern and Carpathian problems. If the arctic, the Carpathian, and the Irish populations are considered as subspecies of *Arenaria ciliata,* it would not be convenient to give specific recognition to the taxon *bernensis.*

In conclusion, the propositions made in an earlier paper (FAVARGER 1963), which were completing those of HALLIDAY (1961), will be resumed and specified.

Arenaria ciliata L.[4]

	n	
ssp. *pseudofrigida* Ostenf. et Dahl	20	Grönland, Arctic Europe, Novaya-Zemlya
ssp. *hibernica* Ostenf. et Dahl	20	Ireland
ssp. *tatrensis* (Zapal.) Favarger	20	Tatra
ssp. *ciliata*	40, 60, 80	Central and Eastern Alps
ssp. *bernensis* Favarger	100, 120	Prealps of Berne (Switzerland), Calcareous Northeastern Alps (Austria)

The first three taxa are diploid and allopatric. Morphologically, they are not very different from each other, but the geographical isolation together with some morphological differences justify, in the author's

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[4] *A. moehringioides* excluded.

opinion, the subspecific level. One might also treat them as varieties of *A. ciliata,* but this would not take into consideration the differences in chromosome number (diploid and polyploid taxa).

With regard to biosystematics and cytogeography, the group of *Arenaria ciliata* in the Alps presents numerous interesting problems. It is noteworthy, that cytotypes may have special geographical distributions without showing morphological or ecological differences.

HABELER (1963) has recently given a rather similar example in *Cardamine amara.* The tetraploid she has found in the Eastern Alps is not morphologically different from the diploid. However, this cytotype has its own geographical distribution.

It is possible that we are dealing with an incipient state of species formation, but before drawing this conclusion, it would be advisable to investigate whether the cytotypes with $n=40$, 60 and 80 are separated by genetical barriers, which is as yet uncertain. At any rate, these cytotypes represent an intermediate stage between cytotypes without any geographical separation (distribution at random) and true geographical subspecies.

A glance on the map (Fig. 1) shows that the diploid *Arenaria moehringioides* is growing on the western and southern Alpen ranges and in the North on the Prealpine range, which is said to have been ± unglaciated during the Quaternary glaciations.

The polyploid *A. ciliata* ssp. *ciliata,* with its three cytotypes, is growing in the most central ranges of the Alps. As to the two cytotypes of ssp. *bernensis,* they are growing at comparable places, on the northern limit of the Alps. One is led to consider the possibility that such local high polyploids could have originated there by a crossing between a taxon which could have remained on the place during the glaciations and an immigrant taxon which might have come from the arctic region or arisen in the free land between the Alpine and the northern glaciers.

At present any attempt to reconstruct the origin of these different taxa seems premature. The following statements, however, seem justified:

1) The separation of the northern taxa (*A. ciliata* ssp. *pseudofrigida* and *A. humifusa*) from the Alpine-Pyrenean taxon *A. moehringioides* is certainly old and most probably took place during the Tertiary.

2) It seems most likely that the Alpine *Arenaria ciliata* ssp. *ciliata* arose during the ice age by polyploidization from ssp. *pseudofrigida* when the latter immigrated to Central Europa. Moreover, the northern diploid taxon has left a remainder in the Tatra with ssp. *tatrensis.*

3) The fact that ssp. *ciliata* is represented by a higher polyploid in the Eastern Alps is worth noticing. The two cytotypes with n=40 and n=80 behave like pseudovicariads of the western-eastern type (FAVARGER 1962). On the other hand, it is not surprising that in the border-line between the two cytotypes, hybridogenous individuals have arisen.

4) The question arises whether ssp. *bernensis* is polytopic, i.e., the Gantrisch cytotype and that of the Wiener Schneeberg having independents origins. However, the great morphological similarity between the two cytotypes speaks against such an assumption. Another possibility is that ssp. *bernensis* originated in the calcareous northern Austrian Alps,[5] having spread from east to west and in the Bernese Prealps given rise to the cytotype with n=120, through a second crossing with a diploid taxon.

5) Unless intermediate stations should be discovered, *Arenaria ciliata* ssp. *bernensis* shows one of the most important disjunctions known in the Alpine flora. This disjunction resembles the one exhibited by *Heracleum austriacum* L. (MERXMÜLLER 1952) though it is larger. The presence in the Bernese Prealps of species with discontinuous areas (*Cerastium alpinum* L. ssp. *glabrescens*,[6] *Cochlearia officinalis* ssp. *alpina* (Bab.) Hook. f. var. *alpina, Androsace lactea, Arenaria ciliata* ssp. *bernensis*) is very interesting and speaks in favour of the theory that this region would have been a nunatak at least during the last glaciation. Ssp. *bernensis* very likely represents an apoendemic taxon whose origin dates back to the glaciations.

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[5] Perhaps by allopolyploidy between the cytotype with n=80 and ssp. *pseudofrigida* (n=20).

[6] FAVARGER, in *Schedis Herbarii monacensis.*

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Pollen Morphology of Some Families of Monochlamydeae

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Introduction

Considering the various aspects of plant morphology including pollen morphology, the *Monochlamydeae* (BENTHAM & HOOKER 1883, RENDLE 1952), is composed of a heterogeneous group of families. Among these families, the *Aristolochiaceae, Piperaceae* (including *Saururaceae*), *Chloranthaceae* and *Myristicaceae,* are significant by having 1-aperturate (colpate and porate) and sometimes inaperturate (ERDTMAN 1952) pollen grains, which form the subject of the present investigation. Regarding the systematic position of these monochlamydous families, there has been considerable divergence of opinion among systematists (Table 1).

BENTHAM & HOOKER (1883) placed the family *Aristolochiaceae* along with *Nepenthaceae* and *Cytinaceae* (*Rafflesiaceae* and *Hydnoraceae*) in the series *Multiovulatae Terrestris* (corresponding to the *Aristolochiaceae* of HUTCHINSON, 1926), while the families *Piperaceae, Chloranthaceae* and *Myristicaceae* along with *Monimiaceae* and *Lauraceae* have been placed in *Micrembryae* (corresponding to the *Piperales* and *Laurales* together of HUTCHINSON, 1926). Excluding the *Nepenthaceae,* all other families of *Multiovulatae Terrestris* are placed in *Aristolochiaceae* by ENGLER & PRANTL (1889—1911) and HALLIER, and in *Myrtales* by BESSEY, associated with which are other families of *Monochlamydeae,* namely *Lacistemaceae* (ENGLER & PRANTL) or *Balanophoraceae* (HALLIER). All the families of *Micrembryae* are considered in the order *Ranales* by BESSEY. ENGLER & PRANTL include the *Myristicaceae, Monimiaceae* and *Lauraceae* in *Ranales* leaving the *Piperaceae, Saururaceae* and *Chloranthaceae* in the order *Piperales.* HALLIER includes the *Piperaceae* and *Saururaceae* alone under *Piperineae,* and leaves the rest in the *Anonales* (cit. LAWRENCE 1958).

Table 1. **System of classification**
(Based on LAWRENCE 1958)

BENTHAM & HOOKER Families	Series	ENGLER & PRANTL Order	BESSEY Order	HALLIER Order	HUTCHINSON Order
Aristolochiaceae	*Multiovulatae Terrestris*	*Aristolochiales*	*Myrtales*	*Aristolochiales*	*Aristolochiales*
Piperaceae	*Micrembryae*	*Piperales*	*Ranales*	*Piperineae*	*Piperales*
Chloranthaceae				*Anonales*	
Myristicaceae		*Ranales*			*Laurales*

Pollen morphological study of the plants belonging to the families considered here have previously been made mainly by ERDTMAN (1952), and important data on pollen and other aspects of morphology have been given by JOSHI (1946), SWAMY & BAILEY (1949, 1950), SINCLAIR (1958), and MURTY (1959).

Material and Method

Polliniferous material has been procured from the herbarium of the National Botanic Gardens (abbrev. NBG), the Botanical Survey of India, Western circle, Dehra Dun (BSIW) and Southern circle, Coimbatore (BSIS). Pollen preparations have been made by the acetolysis method, and the terminology used in pollen descriptions is after that of NAIR (1961). The plants studied and the details regarding its source (Herbarium; Coll. No.; Locality of collection; Sl.=serial number of the pollen slide deposited in the Palynology Laboratory, National Botanic Gardens, Lucknow) are listed below:

Aristolochia bracheata Retz., NBG 14507; Rajkote, Sl. 3747.
A. elegans Mast., Abu, Sl. 4322.
A. grandiflora Swartz, BSIW; Fresh plants used; Sl. 4294.
A. indica L., Rajasthan, NBG, Acc. No. 37069; Sl. 3748.
A. ridicula N.E. Br., BSIW; Sl. 4293.
Apama siliquosa Lamk. (*Bragantia wallichii*), BSIS 14146; Sl. 4296.
Peperomia pellucida H. B. & K., Lucknow; Fresh coll.; Sl. 3628.
Piper argyrophyllum Miq., BSIS 5547; Sl. 4302.
P. betel L., Institute of science, Bombay; Dist. Nasik; Sl. 4312.
P. hymenophyllum Miq., BSIS 5458; Sl. 4303.
P. methysticum Forst, NBG 56377; Sl. 497.
P. subpeltatum Willd., BSIS 16080; Sl. 4313.
P. sylvestre Lam, BSIW; Sl. 4424.
P. trichostachyon Cas. DC., BSIS 12705; Sl. 4301.

P. wightii Miq., BSIW; Sl. 4299.
Sarcandra irvingbaileyii Swamy (*Chloranthus brachystachys* Bl.), BSIS 15844; Sl. 4307.
**Knema attenuata* (Wall.) Warb., Kerala; Sl. 4247.
**K. sphaerula* HK. f., Burma; Sl. 4248.
**Myristica prainii* (Warb.) King, Malaya; Sl. 4246.

Observations

Considering all the genera and species studied, pollen grains are dimorphic, being 1-colpate - ellipsoidal, or 1-porate - spheroidal. The colpus is variously shaped, being either elliptical, or ovate. Similarly, the pores are either triangulate, or circulate, almost covering one face of the grain. There are a few grains with trichotomocolpate apertures along with the porate and colpate forms.

Aristolochiaceae

Aristolochia bracheata Retz. Figs. 1—3: Pollen grains 1-colpate, ellipsoidal or sphaeroidal (largest diameter 49 μ; range 43—56 μ). Exine 1 μ thick, surface faintly foveolate. — *A. elegans* Mast.: Dimorphic in size (diameter 60 μ, range 57—64 μ; & 49 μ, range 32—50 μ). Ectine dissected, being formed of small, closely placed, irregularly shaped units, giving an areolate appearance (Fig. 4). Aperture forms include the trichotomocolpate, 1-porate (Fig. 5), and colpate ones and their intermediaries. — *A. grandiflora* Swartz.: Largest diameter 60 μ (range 53—68 μ). Exine 5.6 μ thick. Ectine dissected as in *A. elegans,* but the areoles are circular (Fig. 6). — *A. indica* L.: largest diameter 47 μ (range 39—56 μ). Exine surface foveolate. Other characters as in *A. elegans.* — *A. ridicula* N. E. Br.: Grains dimorphic in size (diameter 72 μ, range 68—78 μ; & 55 μ, range 46—60 μ). Exine surface rugulate (Fig. 7). Other characters as in *A. elegans.* — *Apama siliquosa* Lamk. Fig. 8: Largest diameter 34 μ (range 28—36 μ). Ectine dissected being formed in isolated, closely placed, circular or rectangular (seen in surface view) units. Aperture forms as in *Aristolochia elegans.*

Piperaceae

Peperomia pellucida H. B. & K. Fig. 9: Grains dimorphic, being 1-colpate or 1-porate. Largest diameter 14 μ. Exine 1.4 μ thick. Ectine thicker

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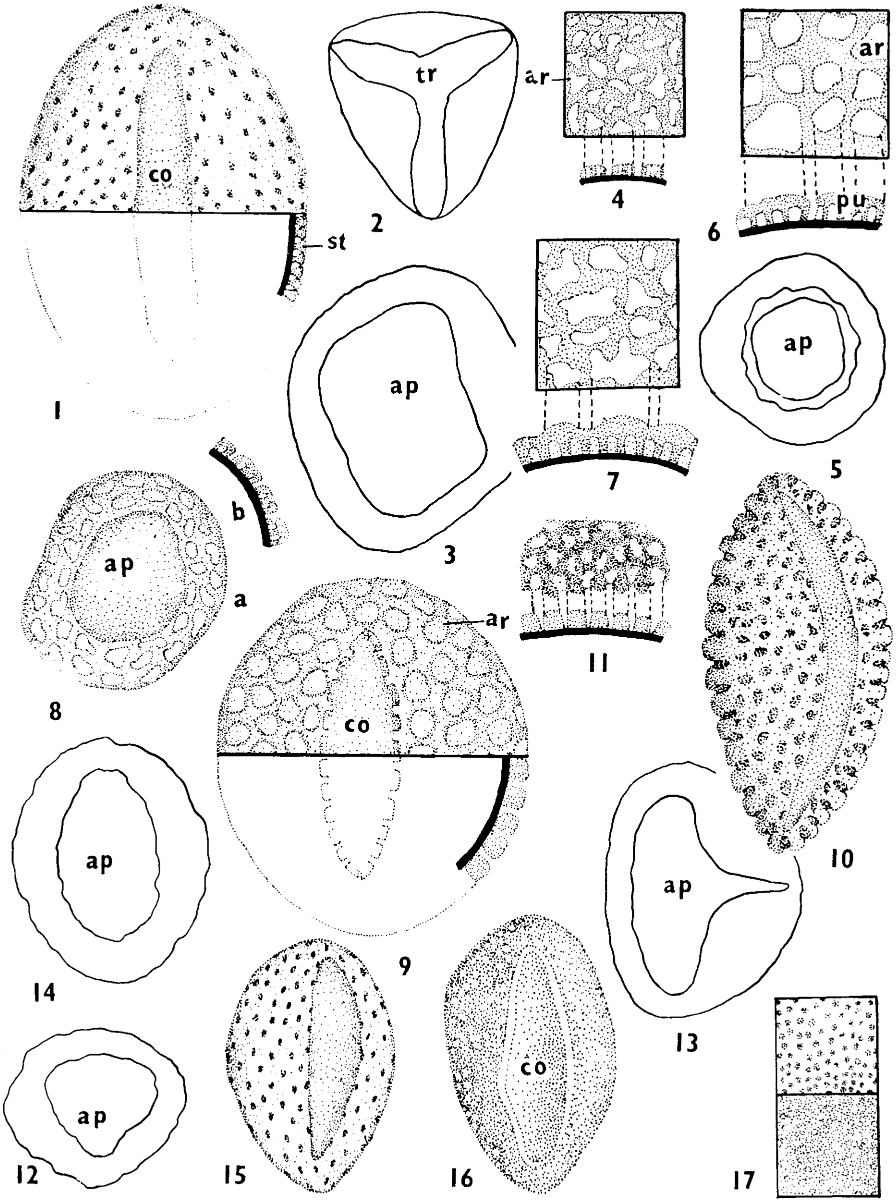
* Material obtained from the personal collection of Dr N. C. Nair, Botanical Survey of India, Northern Circle, Poona.



Figs. 1—17. Pollen morphology of *Aristolochiaceae* (1—8), *Piperaceae* (9—15) and *Chloranthaceae* (16—17). — 1—3. *Aristolochia bracheata* (1. grain showing general exine surface in upper half; 2. trichotomocolpate grain; 3. 1-porate grain). — 4—5. *A. elegans* (4. strata and exine surface showing areoles; 5. operculate grain). — 6. *A. grandiflora*. Strata and exine surface showing areoles. — 7. *A. ridicula*. Exine strata and surface showing areoles. — 8. *Apama siliquosa* (a. grain showing general surface; b. exine strata). — 9. *Peperomia pellucida* (grain showing general surface

than endine, dissected into closely placed units, appearing rectangular or circular in surface view. The aperture types include the colpate and the porate ones (pollen grains few in the slide). — *Piper argyrophyllum* Miq. Figs. 10—14: Largest diameter 14 or 18 μ. Exine surface foveolate; foveoles often deep-seated (punctate). Aperture types include porate, colpate and trichotomocolpate ones (colpus-like on one side of the aperture). — *P. betel* L.:Largest diameter 8 μ (range 7—9.5 μ). Exine very thin; surface psilate. — *P. hymenophyllum* Miq. Fig. 15: Largest diameter 9 μ (range 7—11 μ). — *P. methysticum* Forst: Largest diameter 10.5 μ. — *P. subpeltatum* Willd.: Largest diameter 10 μ. Exine surface foveolate. — *P. sylvestre* Lam.: Grains sphaeroidal (diameter 10.5 μ) or ellipsoidal (14×9 μ). — *P. trichostachyon* Cas. DC.: Largest diameter 14 μ (range 13—16 μ). Exine surface foveolate. — *P. wightii* Miq.: Largest diameter 15 μ. Exine surface foveolate.

Chloranthaceae

Sarcandra irvingbaileyii Swamy. Fig. 16—17: 1-colpate or 1-porate (few only). Largest diameter 14 μ. Exine 1 μ thick, faintly granulose.

Myristicaceae

Knema attenuata (Wall.) Warb. Figs. 18—19: Grains 1-colpate or 1-porate. Longest diameter 57 μ (range 47—57 μ; longest×shortest diameter in another material obtained from BSIW, Poona is 35×33 μ). Ectine reticulate. Aperture types include porate, colpate and their intermediaries. — *K. sphaerula* HK. f.: Grains ellipsoidal (largest size 40 μ; range 32—43 μ). Exine 5 μ thick (Fig. 20). — *Myristica prainii* (Warb.) King. Figs. 21—22: Largest size 27×34 μ (range 14×23—27×34 μ). Smallest size 23 μ (range 23—34 μ).

Discussion

The palynological observations presently made have significance, both taxonomically and pollen morphologically. The 1-colpate type of aperture is not very characteristic of the dicotyledons. Among the families of *Monochlamydeae,* the four families namely *Aristolochiaceae, Piperaceae* (BENTHAM & HOOKER 1883), *Chloranthaceae* and *Myristicaceae,*

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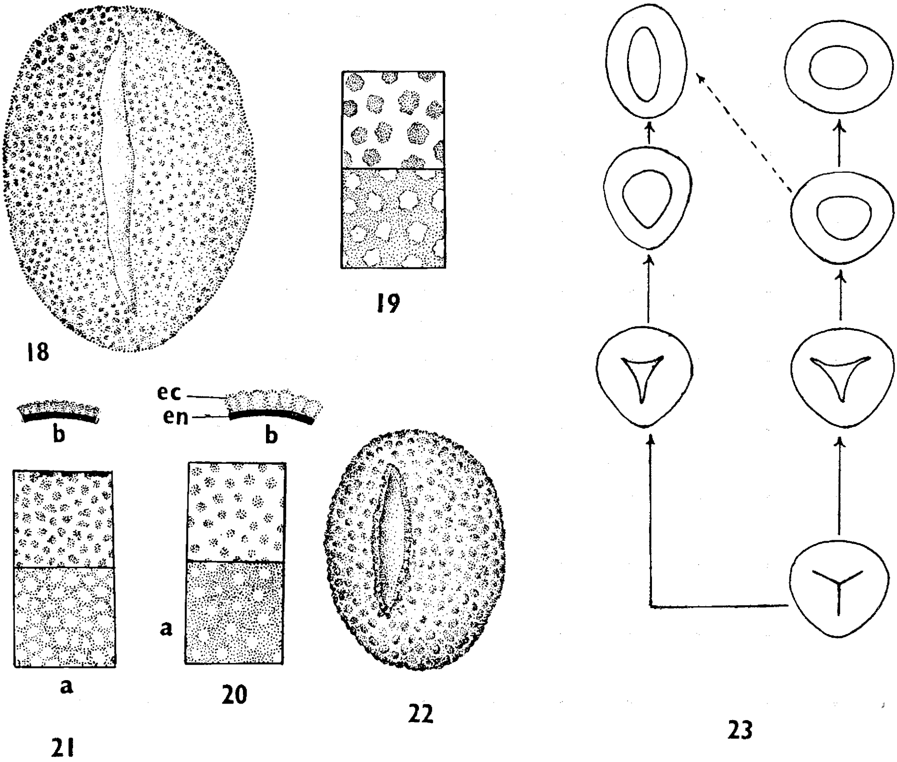
in upper half). — 10—14. *Piper argyrophyllum* (10. general surface; 11. exine strata and surface ornamentation; 12—14. apertural types). — 15. *P. hymenophyllum.* — 16—17. *Sarcandra irvingbaileyii.* (16. general surface; 17. LO-pattern). ap. aperture; ar. areole; co. colpus; pu. puncta; st. strata; tr. trichotomous aperture. — Magnification: ×1000 (Figs. 2, 3, 6, 12—14), ×1500 (1, 8, 10, 15, 16), ×2000 (4, 5, 7, 9, 11, 17).



Figs. 18—22. Pollen morphology of *Myristicaceae*. — 18—19. *Knema attenuata* (18. general surface; 19. LO-pattern). — 20. *K. sphaerula* (a. LO-pattern; b. strata). — 21—22. *Myristica prainii* (21. a. LO-pattern, b. strata; 22. general surface). — Fig. 23. Possible lines of apertural evolution. ec. ectine; en. endine. — Magnification: ×1000 (Figs. 2, 3, 6, 12—14), ×1500 (Figs. 1, 4, 5, 7, 11, 17), ×2000 (Fig. 9).

alone contain 1-colpate sporomorphs, and among other dicots such grains are known in the families *Magnoliaceae, Anonaceae* including *Himantandraceae, Canellaceae, Centrolepidaceae* (colpus-like), and *Cynastraceae*. The 1-furrowed grains are common in the monocotyledons. Apart from the 1-colpate type, inaperturate types are known in *Peperomia* (along with doubtfully 1-colpate types), while in *Chloranthaceae* both inaperturate and stephano-zonocolpate types along with intermediary forms occur (ERDTMAN 1952). The affinities of the *Aristolochiaceae, Chloranthaceae, Piperaceae,* and *Myristicaceae* have been the subject of discussion of taxonomists. HUTCHINSON derived the *Aristolochiaceae* from the ranalian plexus through the *Berberidaceae*. The

Piperaceae is considered by most botanists to be an 'independent and terminal offshot of direct ranalian ancestry' (cit. LAWRENCE 1958, p. 445), contrary to the views of ENGLER & PRANTL. The ranalian affinity of the *Myristicaceae* and *Chloranthaceae* also has been favoured by BESSEY and HALLIER, but HUTCHINSON considered the *Myristicaceae* to be closer to *Lauraceae*.

The 1-aperturate (colpate, porate with large pores or trichotomocolpate) sporomorphs are observed only in the *Magnoliaceae* and *Nymphaeaceae* among the ranalian families. Pollen morphology does not seem to offer evidence to support the affinity of *Aristolochiaceae* with *Berberidaceae* (pollen grains 3-colpate or spiraperturate) as assumed by HUTCHINSON. The occurrence of inaperturate grains (ERDTMAN 1952) in some of *Chloranthaceae* and *Piperaceae* (*Peperomia*; 1-colpate in the Indian species) might be considered to indicate affinities with the *Anonaceae*; similarly, the inaperturate pollen types in the *Lauraceae* (with which the *Myristicaceae* is considered to show affinities) may possibly indicate its affinity to the *Anonaceae*. On embryological evidences CAMPBELL (1900) indicated the affinity of *Piperaceae* with *Gnetum*, but such a view does not find sufficient palynological evidence (although both taxa contain inaperturate sporomorphs). SWAMY & BAILEY (1949, 1950) have indicated the possible affinities of the *Piperales* with "certain categories of the Ranales", from morphological studies including those of pollen grains. The bulk of palynological evidence suggests that the families *Aristolochiaceae, Piperaceae, Chloranthaceae* and *Myristicaceae* have each originated directly from those ranalian families having 1-colpate (or inaperturate) sporomorphs.

In all the families under consideration, there occur both the 1-colpate and 1-porate grains. In these families a few trichotomocolpate grains also have been noticed. The intermediary aperture forms, between the trichotomocolpate (trilete) and 1-porate types, have provided important suggestions regarding the possible lines of evolution of apertures in pollen. It is presumed that the trichotomous form of aperture is the basic type, from which have evolved the 1-colpate form, by the widening and elongation of the trichotomous aperture, corresponding to which is a change from the spheroidal to ellipsoidal shapes. The porate form (pore covering the whole of one face), might have evolved from the trichotomous type by the widening of the triletous aperture. The porate types having smaller pores might have evolved from the colpate or the porate form by the processes of reduction (Fig. 23).

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Meiotic Chromosome Numbers in Some Vascular Plants of Indus Delta I.

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Introduction

An investigation of the chromosome numbers of the vascular plants of Indus delta has been carried out. This region is yet unexplored. Very little information appears to be existing as far as the cyto-morphological and cyto-genetical behaviour of plants of this region is concerned. In this connection a general survey of the plants, with special reference to those of medicinal importance, has been initiated. The present paper is the first in a series designed to establish the basic chromosome pattern with a view to characterize the major phyletic lines in the flora of this area. In this work chromosome numbers of 25 species distributed over 12 families are reported. The important role played by polyploidy during the course of evolution in the indigenous flora is also under investigation, the results of which will be published separately.

Material and Method

Chromosome counts were made from pollen mother cell squashes. Buds were collected in the field from plants growing in their natural habitats. They were fixed in Carnoy fluid (Alcohol-Chloroform-Acetic acid in a ratio of 6 : 3 : 1) and stored in 75 % alcohol. Suitable young anthers were subsequently removed and squashed in aceto-carmine. Camera lucida drawings were made at a magnification of approximately 2000 ×. For nomenclature and identification of plants HOOKER's "Flora of British India" (1887) was used. Type specimens are deposited in the Herbarium of Central Laboratories, Pakistan Council of Scientific and Industrial Research, Karachi.

Fig. 1. a. *Cocculus pendulus* n=13 (Met I), b. *Cadaba farinosa* n=16 (Met I), c. *Cleome brachycarpa* n=30 (Met I), d. *Gossypium stocksii* n=13 (Met II), e. *Fagonia cretica* n=11 (Diakinesis), f. *Peganum harmala* n=12 (Met I), g. *Tribulus terrestris* n=6 (Met II), h. *Zygophyllum simplex* n=8 (Met I), i. *Alhagi camelorum* n=8 (Met I), j. *Crotalaria burhia* n=8 (Met II), k. *Sesbania aegyptiaca* n=6 (Met II), l. *Citrullus colocynthis* n=11 (Met I), m. *Cucumis prophetarum* n=12 (Met I), n. *Mollugo hirta* n=18 (Met I), o. *Oldenlandia aspera* n=9 (Met II), p. *Enicostema littorale* n=ca 38 (Met I), q. *Trichodesma indicum* n=11 (Met II), r. *Convolvulus microphyllus* n=18 (Met II), s. *Convolvulus pluricaulis* n=20 (Diakinesis), t. *Cressa cretica* n=14 (Met II), u. *Solanum nigrum* n=12 (Met I), v. *Solanum xanthocarpum* n=12 (Met II), w. *Physalis minima* n=24 (Met I), x. *Withania somnifera* n=24 (Diakinesis), y. *Lycium barbarum* n=18 (Met II).

Results

Menispermaceae

1. *Cocculus pendulus* Diels (Syn. *C. leaeba* DC.) n=13

This is a rare species in this region and displays great morphological variation in leaf shape, marginal lobes and pubescence. HAGERUP (1932) reported 2n=26 for this species which agrees to our finding of a basic number of 13.

Capparidaceae

2. *Cadaba farinosa* Forsk. n=16

MIEGE (1962) reported 2n=16 for this species. Our investigation of pollen mother cells (Metaphase I) also shows clearly 16 bivalents. This gametic number of 16 is a new record.

3. *Cleome brachycarpa* Vahl ex DC. n=30

This species does not appear to have been studied before. From the counts reported by various workers (cf. DARLINGTON & WYLIE 1955) for other allied species the basic numbers 9, 10 and 11 have been established. This suggests that the population of *Cleome* presently investigated lies at a triploid level.

Malvaceae

4. *Gossypium stocksii* Mast. n=13

This is a rare but wild species of *Gossypium* occurring in arid regions especially on limestone rocks of Sind and Indus delta. The basic number n=13 found by us agrees to the previous report of 2n=26 (SKOVSTED 1935) for this species as well as for other species of *Gossypium*.

Zygophyllaceae

5. *Fagonia cretica* L. n=11

The only count reported for this species is 2n=18 (NEGODI 1939), which suggests a basic number of 9. REESE (1957) recorded a somatic number of ca 24 for *F. glutinosa* Delile and ca 20 for *F. longispina* Batt., which suggests the occurrence of the basic numbers 12 and 10. Our investigation showed clearly 11 bivalents at Metaphase I. From the above information it would appear that aneuploidy is playing a part in this genus having a possible basic set of 9, 10, 11 and 12 chromosomes.

6. *Peganum harmala* L. n=12

A glabrous, dichotomously and corymbosely branched medicinal herb with perennial roots. The number n=12 is a confirmation of the previous reports of WARBURG 1938 (2n=24) and REESE 1957 (n=12).

7. *Tribulus terrestris* L. n=6

Previous counts as reported by various workers show 24 (NEGODI 1937, 1939; SUGIURA 1940 a, b; HEISER & WHITAKER 1948) and 48 (SCHNACK & COVAS 1947) as the somatic numbers. Our investigation shows 6 and not 12 to be the basic number, which is a new record for this species. It shows a great cyto-morphological variation which is under investigation and will be dealt with separately.

8. *Zygophyllum simplex* L. n=8

Z. simplex is a frequently occurring species of this region. The chromosome number n=8 found by us appears to be a new record. MIEGE (1960) reported 2n=20 for this species. Other species of *Zygophyllum,* as *Z. fabago* L. with 2n=22 (WARBURG 1938) and *Z. album* L. with 2n=20 (REESE 1957), show a basic set of 11 and 10 chromosomes, respectively, which is different to our finding. This basic difference suggests the presence of aneuploidy in the genus *Zygophyllum.*

Papilionaceae

9. *Alhagi camelorum* Fisch. n=8

A low shrub armed with numerous pungent spines. Quite common in lower Sind and Indus delta. This species does not appear to have been studied before. The gametic number n=8 is a new record.

10. *Crotalaria burhia* Hamilt. n=8

A tomentose, unarmed deciduous under-shrub, which is frequently occurring in dry sandy plains of W. Pakistan, ascending up to about 4000 ft. The chromosome count for this species is a confirmation of the previous report of n=8 by MALIK (1960).

11. *Sesbania aegyptiaca* Poir. n=6

This is a very common under-tree growing usually near the inhabited areas. It displays a very anomalous meiotic cycle. HAQUE (1946) and RAO (1946) reported a somatic number of 12 for this species. Our investigation confirms 6 to be the basic number for this taxon.

Cucurbitaceae

12. *Citrullus colocynthis* Schrad. n=11

This species has been investigated by various workers, as WHITAKER (1933), KOZHUCHOW (1934), KHOSHOO (1955), FURUSATO & MIYASAWA (1956), REESE (1957), and SHIMOTSUMA (1958), who reported a somatic number of 22. SHIMOTSUMA (1961) also recorded a gametic number of 22. Our study reveals 11 to be the basic number for this species.

13. *Cucumis prophetarum* L. n=12

Out of the four species of *Cucumis* namely: *C. melo, C. sativus, C. trigonus* and *C. prophetarum* only the last two are indigenous to the region while the first two are cultivated. *C. prophetarum* is a very common scabrous herb with a very characteristic ellipsoid fruit, which is usually green with paler vertical stripes. Somatic counts reported by KOZHUCHOW (1930) and MIEGE (1960) shows 2n=24, which falls in line with our record.

Ficoideae

14. *Mollugo hirta* Thunb. n=18

SHARMA & BHATTACHARYYA (1956) reported a gametic number of 18 and somatic number 36 which is also confirmed by our investigation.

Rubiaceae

15. *Oldenlandia aspera* (Heyne) DC. (Syn. *O. retrorsa* Boiss.) n=9

A basic number of 9 for *O. aspera* is a new record although for other allied species as *O. crystallina* and *O. senegalensis* a diploid number of 18 has already been reported by RAGHAVAN & RANGASWAMY (1941) and HAGERUP (1932), respectively. First mentioned authors also recorded 2n=36 for *O. aspera.* Our investigation of this population of *Oldenlandia* confirms the basic number to be 9.

Gentianaceae

16. *Enicostema littorale* Blume n=ca 38

The genus *Enicostema* is represented by a single species, *E. littorale,* which is endemic throughout Sind and Indus delta with a greater frequency near the coastal region. It appears to have been studied only once before, by SRINAVASAN (1941), who reported a somatic number of 38.

Boraginaceae

17. *Trichodesma indicum* R.Br. n=11

This basic number, n=11, is in accordance with the previous finding of MALIK et al. (1959) for this species. REESE (1957) reported n=12 for *T. calcaratum* Coss. which suggests that more than one basic number occurs in the genus *Trichodesma.*

Convolvulaceae

18. *Convolvulus microphyllus* Sieb. ex Spreng. n=18

This is a very common species in Sind and Delta region and at times creates some difficulty in its identification with *C. pluricaulis.* It is distinguished, however, in flower colour, which is rose yellow, and length of the stem being 6—24 inches in contrast to *C. pluricaulis,* which has pale rose coloured corolla and rarely longer stem than 6 inches. Pubescence, leaf texture and bracts are also distinguishable. The meiotic chromosome number of 18 is a new record as this species does not seem to have been studied before.

19. *Convolvulus pluricaulis* Choisy n=20

This species appears to display aneuploidy as more than one basic number (9 & 10) has been reported. SINGH 1951 recorded 2n=20 which falls in line with our finding of n=20. TANDON & MALIK (1959) and MALIK & TANDON (1959) on the other hand reported 9 and 18 as gametic numbers.

20. *Cressa cretica* L. n=14

Cressa is a predominant genus of sandy and saline areas and is represented by a single species, *C. cretica,* in this region. It displays great cyto-morphological aberrations. Although this particular species has not been studied before, the basic number of n=14 is in accordance with the results of HEISER & WHITAKER (1948), who reported 2n=28 for *Cressa truxillensis.*

Solanaceae

21. *Solanum nigrum* L. n=12

This species has been investigated by a large number of workers and many counts are available on record (Table 1). All the numbers 24, 48, 72, 96 and 144 indicate an example of euploidy except n=20 reported by RAI (1959) which is a variation from normal and, according to him, has originated from a poly-haploid (n=36) plant. The material

Table 1. Chromosome counts in Solanum nigrum

n	2n	Author	
—	24, 48, 72	BAHADURI	1933
—	24, 72	STEBBINS & PADDOCK	1949
—	(96, 144)	JORGENSEN	1928
12	—	NANDA	1962
20	—	RAI	1959
36	—	GOTTSCHALK	1954

examined by us shows clearly 12 bivalents at Metaphase I. Whether 12 is the basic number and not 6 is yet to be confirmed.

22. *Solanum xanthocarpum* Schrad. (Syn. *S. surrattense* Burman) n=12

A very common prickly, diffuse herb with typical yellow or whitish and green-blotched berry. The only previous report of a chromosome count for this species is from BAHADURI (1933), who recorded 2n=24.

23. *Physalis minima* L. n=24

A pubescent annual herb which is quite common in this region and is distributed throughout the tropical region. Previous somatic count 48 (BAHADURI 1933) and gametic number 24 (GOTTSCHALK 1954) agree with our present record of n=24.

24. *Withania somnifera* Dun. n=24

One of the most common unarmed shrubs of lower Sind and Indus delta. It is distributed throughout the drier subtropical Indo-Pakistan subcontinent. BAHADURI (1933) and MIEGE (1960) reported 2n=48 and GOTTSCHALK 1954 recorded n=24, which agrees to our finding. This species displays great cyto-morphological anomalies which will be published elsewhere.

25. *Lycium barbarum* L. (Syn. *L. europeum* L.) n=12, 18

This perennial armed shrub is also common throughout the dry sandy expanse of this region. The gametic number 18 is a new record, while 12 was reported before by MALIK (1960). The basic number n=12 reported (DARLINGTON & WYLIE 1955) for this species of *Lycium* apparently holds good until plants having n=6 are found. It is certain, that this species displays polyploidy apart from various cytological aberrations.

Summary

Chromosome counts for 25 indigenous species of Indus delta are presented for the first time. These include new records for 12 species (marked with *), while the chromosome numbers of the remaining 13 are the confirmation of previous counts. Some genera, apart from various meiotic anomalies, display polyploidy of either eu- or aneuploidy type. The polyploidal analysis and the cyto-morphological aberrations will be published separately.

Cocculus pendulus Diels	n=13
*_Cadaba farinosa_ Forsk.	n=16
*_Cleome brachycarpa_ Vahl ex DC.	n=30
Gossypium stocksii Mast.	n=13
*_Fagonia cretica_ L.	n=11
Peganum hermala L.	n=12
*_Tribulus terrestris_ L.	n=6
*_Zygophyllum simplex_ L.	n=8
*_Alhagi camelorum_ Fisch.	n=8
Crotalaria burhia Hamilt.	n=8
Sesbania aegyptiaca Poir.	n=6
Citrullus colocynthis Schrad.	n=11
Cucumis prophetarum L.	n=12
Mollugo hirta Thunb.	n=18
*_Oldenlandia aspera_ (Heyne) DC.	n=9
*_Enicostema littorale_ Blume	n=ca 38
Trichodesma indicum R.Br.	n=11
*_Convolvulus microphyllus_ Sieb. ex Spreng.	n=18
*_Convolvulus pluricaulis_ Choisy	n=20
*_Cressa cretica_ L.	n=14
Solanum nigrum L.	n=12
Solanum xanthocarpum Schrad.	n=12
Physalis minima L.	n=24
Withania somnifera Dun.	n=24
*_Lycium barbarum_ L.	n=12, 18

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Förteckning över den epifytiska diatomefloran vid svenska västkusten

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Diatoméerna utgör enligt GESSNER (1959) den alggrupp, som är ekologiskt och systematiskt bäst känd. Detta påstående kan äga berättigande när det gäller planktoniska diatoméer (huvudsakligen centriska). Den fundamentala betydelse dessa utövar inom havens fria vattenmassor är väl känd genom talrika undersökningar av mycket varierande slag. Utforskningen av litorala diatoméer, sessila och bottenlevande former, har emellertid ännu så länge förbisetts och frågan är om vi i vår kunskap om dessa nått över begynnelsestadiet. Inte desto mindre torde betydelsen av de sessila och bottenlevande diatoméerna (huvudsakligen pennata) vara av grundläggande natur för de biologiska skeendena inom litoralen.

De tidigaste bidragen om diatomefloran vid svenska västkusten lämnades av C. A. AGARDH under förra delen av 1800-talet. Den bristfälliga metodiken och mikroskopens begränsade möjligheter gjorde att blott ett fåtal arter kunde identifieras och beskrivas. Först senare blev det möjligt att noggrannare studera diatomefloran och år 1868 kunde P. T. CLEVE för Sverige angiva 189 olika arter varav 80 som marina. Ytterligare 114 marina arter lämnades 1875 av N. LAGERSTEDT, som under sommaren 1871 vistats i Bohuslän för algologiska studier. P. T. CLEVES pionjärarbeten inom diatoméforskningen fortsattes under 1900-talet av ASTRID CLEVE-EULER. Hennes största arbete, »Die Diatomeen von Schweden und Finnland» publicerades under åren 1951—1955 i Kungliga Svenska Vetenskapsakademiens Handlingar och innehåller beskrivningar av inte mindre än omkring 1600 olika arter. Det bör emellertid framhållas, att av dessa arter finnes flera, vilka inte alls iakttagits inom Sveriges eller Finlands gränser men vilka A. CLEVE på goda grunder anser bör finnas inom undersökningsområdet.

Nedan lämnas en förteckning över de epifytiska diatoméarter som förf. identifierat genom undersökningar av olika substrat, huvudsakligen från området kring Kristinebergs Zoologiska Station vid Fiskebäckskil och från Göteborgs skärgård. Antalet diatoméer (inklusive former och varianter) med sessilt levnadssätt, som iakttagits utgör 95 fördelade på 29 släkten. Av dessa 95 har 51 tidigare inte varit kända från svenska västkusten eller från Sveriges kuster. Anledningen härtill är dels att söka i tidigare bristfälliga undersökningar, dels säkerligen också i förändrade miljöförhållanden under de senaste decennierna, t.ex. i de klimatförändringar som ägt och ännu äger rum. Vad den högre algfloran beträffar vet vi nämligen att nya arter på senare tid tillkommit medan andra avtagit i frekvens.

I hydrografiskt hänseende är svenska västkusten att betrakta som mycket heterogen. Detta avspeglar sig också i diatomélorans sammansättning. I den följande artförteckningen finns således arter, vilka är att karaktärisera som »högmarina» med krav på salthalter över 30 $^{0}/_{00}$, dels också arter som kännetecknar typiska brackvattensområden t.ex. Östersjön. De utpräglade typiska brackvattensarterna påträffas oftast i vikar eller inom andra områden, som påverkas av sötvattenstillförsel från land, de »högmarina» arterna finner man däremot bara på djup under cirka 15 meter.

Som metodik vid undersökningar av epifytiska diatoméer har behandling med svavelsyra visat sig lämplig, då syran bränner bort organiskt material, således inte endast cellinnehållet hos diatoméerna utan också fytosubstratet, vilket diatoméerna är vidhäftade.

Den följande taxonomiska uppställningen följer olika arbeten av F. HUSTEDT (1930, 1930—1962) och A. CLEVE-EULER (1951—1955). För arterna anges dessutom förekomsterna i gradation »vanlig, mindre vanlig och sällsynt». Vidare anges kraven på olika salthalter och om arterna tidigare inte varit kända från Sveriges kuster.

	Tidigare inte känd från		Toleransintervall F sötvattensart B brackvattensart S saltvattensart (> 17—20 ‰ S)	Förekomster +++ vanlig ++ mindre vanlig + sällsynt
	Sveriges kuster	Sveriges västkust		
Centrales				
Melosira Ag.				
nummuloides (Dillw.) Ag.	—	—	B S	+++
moniliformis (Müll.) Ag.	—	×	B S	++
Podosira Ehr.				
stelliger (Bail.) Mann.	—	—	S	++
Hyalodiscus Ehr.				
scoticus (Kutz.) Grun.	—	×	B S	+++
Triceratium Ehr.				
reticulum Ehr.	—	—	S	+
f. *trigona*	—	—	S	+
f. *tetragona*	—	—	S	+
alternans Bail.	—	—	S	+
Biddulphia Gray.				
aurita (Lyng.) Breb. et God.	—	—	S	+++
v. *obtusa* (Kütz.) Hu.	—	—	S	+++
Isthmia Ag.				
enervis Ehr.	—	—	S	++
Pennales				
Rhabdonema Kütz.				
minutum Kütz.	—	—	S	+++
arcuatum (Ag.) Kütz.	—	—	S	+++
f. *constricta* Fricke	—	—	S	++
adriaticum Kütz.	—	—	S	++
Tabellaria Ehr.				
fenestrata (Lyng.) Kütz.	—	×	F B S	+
Striatella Ag.				
delicatula (Kütz.) Grun.	—	×	B S	+
unipunctata (Lyng.) Ag.	—	—	S	+++
Grammatophora Ehr.				
angulosa Ehr.	×	—	S	++
arcuata Ehr.	×	—	S	+
marina (Lyng.) Kütz.	—	×	B S	++
oceanica (Ehr.) Grun.	—	—	B S	++
v. *macilenta* (W. Sm.) Grun.	—	—	B S	+++
serpentina (Ralfs.) Ehr.	—	—	S	+++
longissima (Petit.)	×	—	S	+
Licmophora Ag.				
flabellata (Carm.) Ag.	×	—	S	+
gracilis (Ehr.) Grun.	—	×	S	++
v. *anglica* (Kütz.) Perag.	—	×	S	++
juergensii Ag.	×	—	S	++
abbreviata Ag.	—	—	S	+++
ehrenbergii (Kütz.) Grun.	×	—	S	++
f. *angustata* Grun.	×	—	S	++

	Tidigare inte känd från		Toleransintervall F sötvattensart B brackvattensart S saltvattensart (> 17—20 ‰ S)	Förekomster +++ vanlig ++ mindre vanlig + sällsynt
	Sveriges kuster	Sveriges västkust		
paradoxa (Lyng.) Ag.	—	—	S	+++
v. *tincta* (Ag.) Hu.	×	—	S	++
communis (Heib.) Grun.	—	—	S	+++
hyalina (Kütz.) Grun.	—	—	S	+++
Diatoma DC.				
vulgare Bory.	—	×	F B	+
elongatum (Lyng.) Ag.	—	×	F B	+
Plagiogramma Grev.				
staurophorum (Greg.) Heib.	—	—	S	++
robertsiana Grev.	×	—	S	+
Dimmerogramma Ralfs.				
minor (Greg.) Ralfs.	×	—	B S	++
Opephora Petit				
marina (Greg.) Petit.	—	—	S	+++
Fragilaria Lyng.				
hyalina (Kütz.) Grun.	—	—	S	+++
Rhaphoneis Ehr.				
surirella (Ehr.) Grun.	×	—	B S	++
v. *australis* Petit.	×	—	S	+
amphiceros Ehr.	—	—	S	++
nitida (Greg.) Grun.	×	—	S	+
Synedra (Ralfs.) Kütz.				
pulchella . (Ralfs.) Kütz.	—	×	B S	++
v. *naviculacea* Grun.	—	×	B S	+
gaillonii (Bory) Ehr.	×	—	B S	+++
investiens W. Sm.	—	—	S	+++
tabulata (Ag.) Kütz.	—	—	B S	+++
v. *fasciculata* (Kütz.) Grun.	—	—	B S	+++
hennedyana Greg.	×	—	S	+
undulata Bail.	—	—	S	++
fulgens (Grev.) W. Sm.	—	—	S	+++
crystallina (Ag.) Kütz.	—	—	B S	+++
Campyloneis Grun.				
grevillei (W. Sm.) Grun.	×	—	S	++
Cocconeis Ehr.				
costata Greg.	—	—	S	+++
scutellum Ehr.	—	—	B S	+++
v. *sturoneiformis* W. Sm.	—	×	B S	+++
distans Greg.	×	—	S	+
v. *bahusiensis* (A. Cl.) Edsb.	—	—	S	+++
placentula Ehr.	×	—	F B S	++
v. *euglypta* (Ehr.) Cl.	×	—	F B	++
molesta (Kütz.) Grun.	×	—	S	++
v. *crucifera* Grun.	×	—	S	++
dirupta Greg.	×	—	S	+
pseudomarginata Greg.	—	—	S	+++

	Tidigare inte känd från		Toleransintervall F sötvattensart B brackvattensart S saltvattensart (> 17—20 ‰ S)	Förekomster +++ vanlig ++ mindre vanlig + sällsynt
	Sveriges kuster	Sveriges västkust		
pelta A. Schmidt.	×	—	S	+
peltoides Hu.	×	—	B S	+
Achnanthes Bory.				
hauckiana Grun.	—	×	B S	++
delicatula (Kütz.) Grun.	—	×	B S	++
groenlandica (Cl.) Grun.	×	—	S	+
brevipes Ag.	—	—	B S	+++
v. *intermedia* (Kütz.) Cl.	—	—	B S	++
v. *parvula* (Kütz.) Cl.	×	—	B S	++
v. *elliptica* Cl.	×	—	S	++
longipes Ag.	—	—	S	++
Rhoicosphenia Grun.				
curvata (Kütz.) Grun.	—	×	F B S	+++
marina (W. Sm.) M. Schmidt.	×	—	S	++
pullus (M. Sm.) A. Schmidt.	×	—	S	+
Mastogloia Thwaites.				
elliptica (Ag.) Cl.	—	×	B S	++
apiculata W. Sm.	×	—	S	+
pumila (Grun.) Cl.	—	×	B S	++
Diploneis Ehr.				
smithii (Bréb.) Cl.	—	—	S	++
Amphipleura Kütz.				
rutilans (Trent.) Cl.	—	—	B S	+++
Brebissonia Grun.				
boecki (Ehr.) Grun.	—	×	B	+
Navicula Bory.				
directa W. Sm.	—	—	B S	+++
grevillei Ag.	×	—	S	++
comoides (Ag.?) Perag.	×	—	S	++
crucigera (W. Sm.) Cl.	—	—	S	+++
complanatula Hu.	×	—	S	++
Amphora Ehr.				
exigua Greg.	—	—	B S	+++
Rhopalodia O. Müll.				
gibberula (Ehr. Kütz.) O. Müll.	—	—	B S	+
musculus (Kütz.) O. Müll.	—	—	B S	++

Summary

The article gives a list of epiphytic diatoms on the Swedish westcoast. The water along the coast is to be regarded as very heterogeneous. Genuine marine conditions are to be found only below about 15 meters depth. Brackish water is to be found in places influenced by fresh water from land. These facts can be observed in the composition of the diatom flora. Of the 95 mentioned diatoms 51 have not earlier been recorded from the Swedish westcoast or from Swedish sea waters at all.

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Notes on the Limnology and Post-Glacial Development of Lake Trummen

(Preliminary report)

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Lake Trummen, situated near Växjö, Kronoberg county in central South Sweden, has since long been an attractive object for limnological and paleolimnological investigations. Like the adjacent lakes Växjösjön and Södra Bergundasjön Lake Trummen has been utilized as recipient for sewage. This has resulted in an auxotrophication with striking quantitative and qualitative changes in, for example, the plankton, the macrophyte vegetation and the waterfowl fauna. The pollution effect is in this case accentuated by the fact that the highly productive Växjö Lakes are situated in the fairly uniform oligotrophic region of central South Sweden.

Lake Trummen has an area of 1.2 km^2, a greatest depth of about 2 m and is situated 161 m above sea level. It belongs to the drainage area of the River Mörrumsån.

A general survey of the limnological conditions of Lake Trummen and analyses of its summer net plankton are given by THUNMARK (1945 a, b). BRUNDIN (1947, 1949) has studied the chironomide fauna and has also described environmental conditions. Planktological notes are given by LANG (1928) and the lake is mentioned in the Växjö Lake study by GESSNER (1934). The sediment investigations by LUNDQVIST (1926, 1927) are referred to below.

In 1951 one of the authors (BJÖRK) started investigations on the macrophyte vegetation in Lake Trummen. These also included studies on the bottom substratum and the formation of floating stands of hyperhydates (plaur). Observations made during the sediment studies, among other things the presence of subfossil fruits of *Trapa natans,* inspired DIGERFELDT to carry out investigations on the development of Lake Trummen, including the water level fluctuations, by means of pollen- and macro-fossil analysis.

In this precursory report a general survey of present limnological conditions (notes on water quality, plankton, macrophyte vegetation and plaur formation) is given by BJÖRK and the results from the studies of the history of development (micro- and macro-fossil analysis) are described by DIGERFELDT.

General survey of present limnological conditions

The water. In 1960—1961 a reconnoitring investigation on water quality and plankton in the central part of northern Lake Trummen was made. In 1960 samplings were carried out monthly from the time before the break-up of the ice in the spring until the lake was ice-coated the following winter (i.e. March—December). The samplings in 1961 included the months March—August. Some results concerning the surface water from these preliminary studies are given in Fig. 1 to show characteristic features in the environmental conditions.

The water colour, expressed as mg Pt/l, varied between 25 and 80. In 1960 the colour curve has a fairly regular course. The colour is low in early spring, high in May and June and then successively lower until a minimum is reached in September—October, whereupon the colour again becomes higher.

From June and September 1944 THUNMARK (1945 a, b) gives the values 178 and 197 concerning specific conductivity (here calculated in μS_{20}) of the surface water in Lake Trummen. These values are both higher than those obtained in 1960—1961 which varied between 121 and 149. No doubt the lowering of the specific conductivity is due to the decrease in the sewage discharge to the lake which has taken place since the fourties. Values as great as those given by THUNMARK (opp. cit.) have, however, been obtained in water sampled near the bottom during winter, when, under the ice, there is developed a stratification with respect to different environmental and organism conditions. Under ice-free conditions no more permanent stratification persists in the lake, but there is constantly an exchange of water between the surface and the bottom layers.

The changes during the year in the composition and the quantitative development of the plankton (for plankton bloom during the summer,

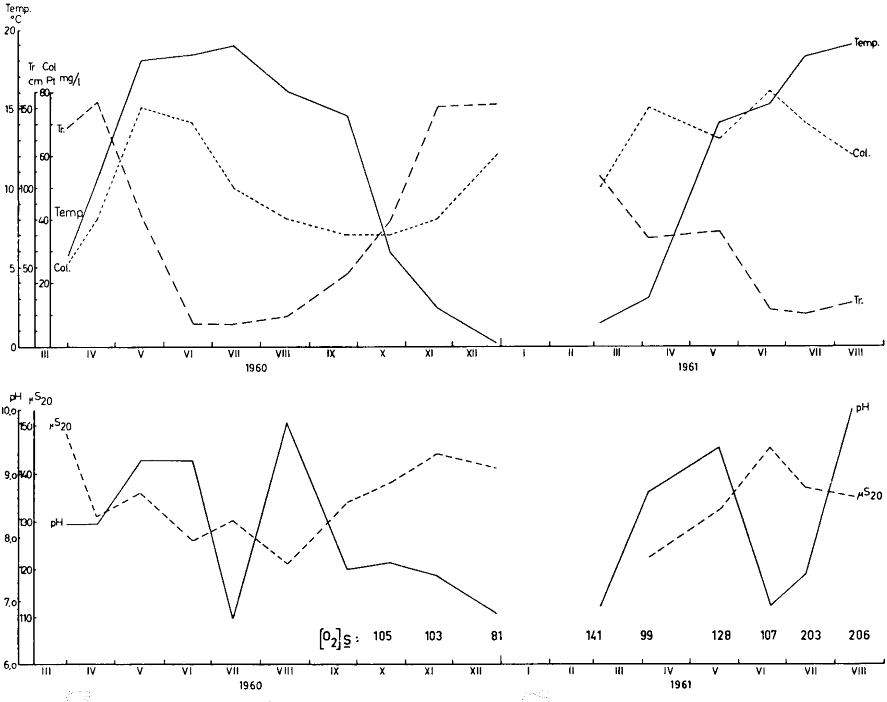

Fig. 1. Temperature, Secchi disk transparency (Tr), colour, specific conductivity, pH, and oxygen saturation of surface water in Lake Trummen. The values of oxygen saturation, $[O_2]_{\underline{S}}$, are corrected with respect to the atmospheric pressure.

see below), changes in weather conditions as well as the physiologic response of the plankton to these, are the main reasons for the variations in Secchi disk transparency, pH, and oxygen content which are illustrated in Fig. 1. When the weather is windy the superficial sediment layer is often whirled up, causing a turbidity of the water, which also contributes to a lowering of the transparency. On such occasions there is also a marked drop in pH (cf., e.g., July 1960 and June 1961).

On the whole the environmental conditions in the central part of northern Lake Trummen in several respects resemble those which are well known from other shallow polluted lakes with plankton blooms, e.g. the Danish lake Lyngby Sø (cf. OLSEN 1955, JOHNSEN et al. 1962).

The plankton. In great tracks the most characteristic features in the plankton development during different seasons in 1960 and 1961 were as follows.

In early spring (March 1960) there was, under the ice, a rich development of nanoplankton, especially small centric diatoms, causing a greenish colour of the water from ice to bottom. After the break-up of the ice (April 1960) the nanoplankton community was succeeded by a mass development of rotifers (above all *Brachionus angularis, B. calciflorus, Keratella quadrata* and *Polyarthra dolichoptera,* cf. Fig. 2). Among the *Microcystis* spp., which often characterize the summer plankton community in Lake Trummen, *Microcystis flos-aquae* was rather frequent already in the middle of April 1960. In May the same year the frequence of rotifers was still high. The volumetrically dominating phytoplankton species in the net plankton was *Micractinium pusillum.* During the summer months there are in Lake Trummen regularly plankton blooms caused by *Microcystis* and *Anabaena* spp., in 1960 by *Microcystis flos-aquae.* In October 1960 the high production of cyanophytes was followed by diatoms (*Asterionella formosa* and *Melosira* spp.) and in November and December the rotifers formed a new maximum and again constituted the totally dominating part of the net plankton. In November *Keratella quadrata* and *Polyarthra dolichoptera* had about the same frequency, but in December the latter was in absolute majority.

The ice conditions during the winter 1960—1961 were fairly irregular and periods with thin ice coating alternated with periods when the ice broke up or ice-holes occurred. Due to this, among other things, the course in the first part of 1961 concerning the changes in the environmental conditions as well as the aspect changes in plankton in some respects considerably differed from those observed during the corresponding time in 1960.

In March 1961 a mass development of *Synura uvella* characterized the plankton. In April there was a *Melosira* maximum and in May a *Micractinium pusillum* maximum. During June and above all in July *Anabaena planctonica* was responsible for a vigorous plankton bloom, which in August was continued by *Microcystis flos-aquae.*

Macrophyte vegetation. The notes on the macrophyte vegetation given here exclusively refer to the conditions in the northern part of the lake. In the bays here luxuriant stands of *Equisetum fluviatile, Phragmites communis, Schoenoplectus lacustris* and *Typha latifolia* are expanding lakewards. The outer front of the hyperhydate belt usually consists of *Equisetum fluviatile,* while the other species form the shoreward part of the belt (cf. Fig. 3). In openings in the hyperhydate stands there is a thick layer of *Riccia fluitans*, and *Lemna*

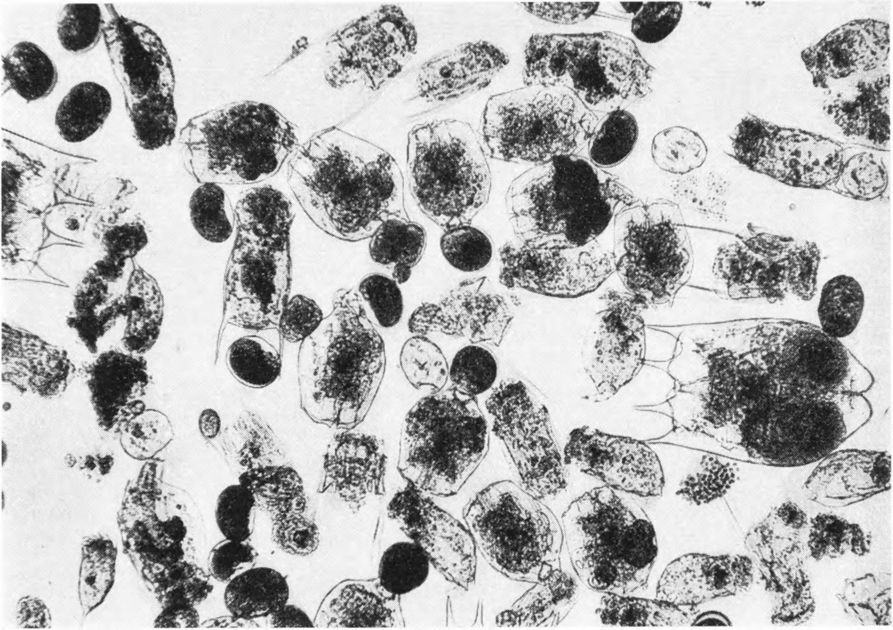

Fig. 2. Detail picture of net plankton with *Brachionus angularis, B. calciflorus, Keratella quadrata,* and *Polyarthra dolichoptera.* Lake Trummen 19/4 1960. — S. Björk photo.

minor is frequent (Fig. 4). Since about 1960 *Ricciocarpus natans* occurs in Lake Trummen and is now common in the north part. This species, new to the flora of central South Sweden (Björk 1955), is nowadays found in several localities within the region, e.g. in the drainage area of the River Emån (in 1961, e.g., common at Markestad, north of Lake Solgen).

The vegetation in the zone of ephydates consists of large-leaved stands of *Nuphar luteum* and *Nymphaea alba.* These species also occur in the hyperhydate zone.

In the highly productive macrophyte communities in the northern part of Lake Trummen the accumulation of organic matter is considerable and a rapid growth of the sediments takes place.

Plaur formation. From the Danube delta Antipa (e.g. 1910) has described the floating hyperhydate stands, which are termed plaur (from popular Roumanian idiom). A description, including instructive figures, of the development of these formations, characteristic for the

Fig. 3. The inner part of the bay at the St. Sigfrid hospital. In the foreground *Equisetum fluviatile* plaur and along the shore reeds of *Phragmites communis* and stands of *Typha latifolia*. — S. Björk photo. 17/8 1954.

Danube delta (cf., e.g., Rodewald-Rudescu 1958, 1961, Bârcă 1962), has been given by Rodewald (1943). From Swedish eutrophic lakes Thunmark (1952) reported the occurrence of plaur and also pointed out that conditions for plaur formation often arise in polluted lakes (Thunmark 1955).

Broadly speaking a plaur is a hyperhydate (in known cases graminide) stand or part of such, which with its rhizome and root system, including the bottom substratum penetrated by this, has been lifted and lost its contact with the bottom and continues to grow floating on the water surface. The cause of the lifting is gas development in the sediment.

A multiplicity of "floating islands" with different appearance and developed under different conditions is reported in the literature. (Cf., e.g., Olsen 1955 and 1964 and the literature referred to there. As to lakes with quagmires, cf. Alm 1943.) With respect to the environmental conditions in which it develops as well as to its physio-

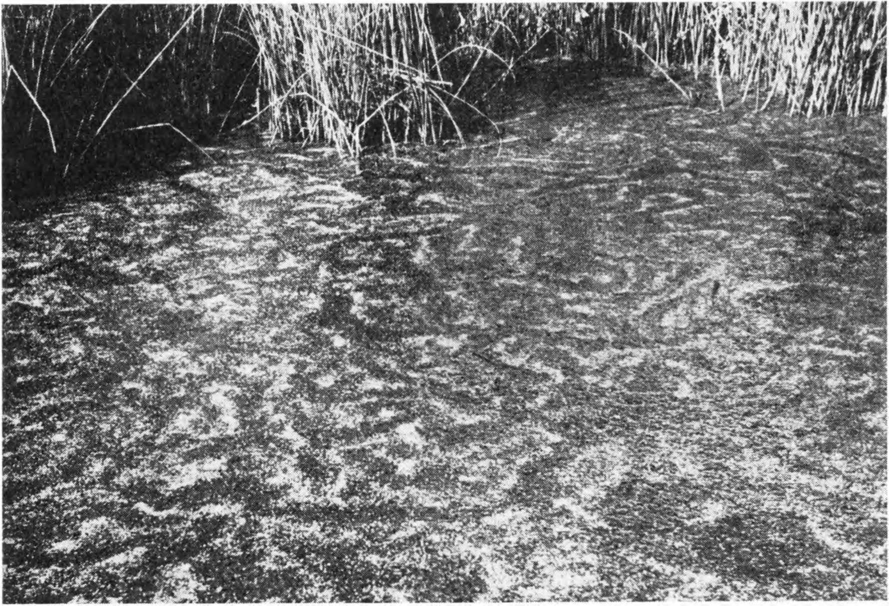

Fig. 4. Opening in the hyperhydate stands shown in Fig. 3. In the surface water layer a c. 3 cm thick felt of *Riccia fluitans*. Swimming tracks of *Fulica atra* are indicated by the arrangement of *Lemna minor*. — S. Björk photo. 17/8 1954.

gnomy the plaur is a uniform and well defined formation which ought to be the subject of more attention. The appearance of plaur is an indication of certain environmental conditions, it has consequences concerning the stratigraphy of the sediments, and it offers possibilities of ecologic studies in unique biotopes.

In Sweden the formation of plaur takes place in fresh as well as in mixohaline waters. Along the coast of Blekinge, in the south-east of Sweden, e.g., plaur often occurs in the inner part of the bays.

Due to the auxotrofication of Lake Trummen there are good conditions for plaur development in the northern bays. Fairly large areas of dense *Equisetum fluviatile* as well as stands of luxuriant *Typha latifolia* and *Schoenoplectus lacustris*, all superficially rooted in the loose upper gyttja layers, are lifted up and developed as characteristic plaur formations (cf. Fig. 3 and 5).

In Fig. 6 a section from 1954 through a plaur area is shown diagramatically. In the shoreward zone the hyperhydate vegetation consists of *Typha latifolia*, floating in its outer margin. The main part of

Fig. 5. Plaur formation in stands of *Typha latifolia,* turning over in their outer margin. — S. Björk photo. 17/8 1954.

the middle zone is developed as *Equisetum* plaur. Different phases in plaur formation are represented here. In one section the rhizome and root layer with the gyttja penetrated by it has not yet lost the contact with the bottom, and fixed as well as unfixed (detached) plaur occurs. It ought to be noted that the whole sediment layer is lifted up from the mineral bottom in the inner part of the plaur area. In the lakeward zone of the section there is *Equisetum* which is rooted in the bottom and intermingled with *Nuphar luteum* and *Nymphaea alba.* The area within which this section was laid out is shown in Fig. 3.

From the Danube delta (e.g. Antipa 1910) as well as from Swedish eutrophic lakes (Thunmark 1952, 1955) the occurrence of a rich flora on the plaur has been described. *Bidens cernua, B. tripartita, Calla palustris, Calystegia sepium, Carex pseudocyperus, Cicuta virosa, Epilobium hirsutum, Galium palustre, Lastrea thelypteris, Mentha aquatica, Myosotis palustris, Naumburgia thyrsiflora, Rumex hydrolapathum, Solanum dulcamara, Scutellaria galericulata, Sparganium erectum* and *Veronica anagallis-aquatica* are examples of species observed

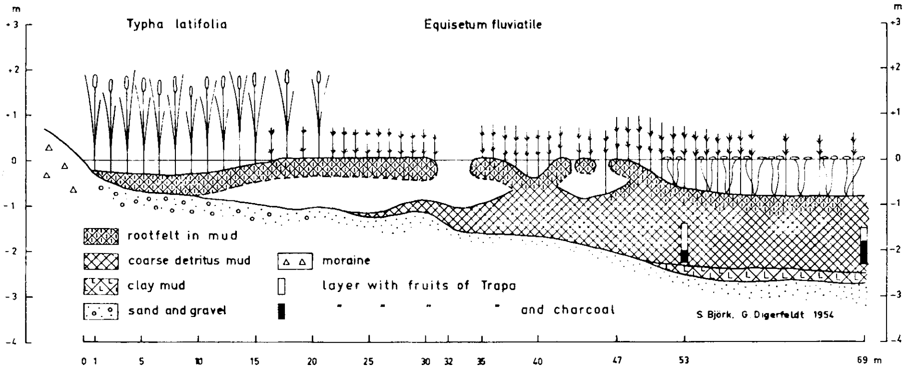

Fig. 6. Section through the *Typha-Equisetum* plaur area shown in the right half of Fig. 3.

on plaur by the author (BJÖRK) in eutrophic lakes in Sweden (Scania and Södermanland). Especially in the margin of the plaur the above-mentioned plant species and even others form a qualitatively as well as quantitatively well developed fringe, the parafyllion according to THUNMARK (opp. cit.).

In Lake Trummen the paraphyllion is, however, weakly developed. Besides the graminides forming the plaur, single specimens of the following plant species were observed on the *Equisetum* plaur shown in Fig. 3: *Bidens cernua, Calla palustris, Dryopteris cristata, Epilobium* sp., and *Lycopus europaeus. Marchantia polymorpha* was, however, frequent.

Equisetum fluviatile is, together with *Phragmites communis,* one of the most common hyperhydates of the lakes in central South Sweden. From a quantitative point of view, and with respect to standing crop as well as to shoot qualities, both species markedly react to different environmental conditions. As to *Equisetum fluviatile* this is here demonstrated in Table 1 by means of some biometric data collected from the lakes Fiolen, Bodasjön, Trummen, and Jägern in order to compare the Trummen plaur biotope with other *Equisetum* biotopes.

Lake Fiolen, situated 30 km NNW of Lake Trummen, is a typical *Lobelia* lake, with oligohumic water and still fairly little affected by human activity. It is recognized internationally as a lake to be preserved for research purposes. For further information concerning this lake, see, e.g., THUNMARK (1931) and MALMER (1960).

The water level of Lake Bodasjön, situated 40 km NNW of Lake Trummen,

Table 1. Biometric data on Equisetum fluviatile from five biotopes

Biotope	Date	Sampling area m²	Water depth cm	Shoots per m²		
				S	F	T
Lake Fiolen, middle reach of east shore. Minerogenous bottom (hard archaean morain)	23/8 1954	16	28—50	9.7	3.9	13.6
Lake Fiolen, south-west shore. Minerogenous bottom (hard archaean morain)	24/8 1954	16	32—51	15.8	6.6	22.4
Lake Bodasjön. Organogenous bottom (coarse — fine detritus gyttja)	19/7 1955	4	19—31	431	44	475
Lake Trummen. Fixed plaur	11/8 1954	4	0	213	329	542
Lake Jägern. Organogenous bottom (coarse — fine detritus gyttja)	12/9 1957	2	42—50	212	267	479

has been lowered several times since the 1870's. The whole lake is now densely overgrown by graminides, in the main by *Equisetum fluviatile*. The character of the lake was originally oligotrophic.

For comparison some data from Lake Jägern are also given. This lake is situated in the county of Södermanland. It has been described by THUNMARK (1952) and given as an example of an eutrophic lake. The *Equisetum* sampling was here carried out relatively later than in the other lakes. For the comparisons made here, this circumstance is, however, of fairly little importance.

In all the four lakes the samples have been collected in pure or practically pure stands. From the data given in Table 1 it is quite clear that *Equisetum fluviatile* grows under favourable conditions in the Trummen plaur area. There it shows the greatest shoot density, highest fertility, dry matter and ash weights per biotope area as well as the highest degree of branchiness.

Results of chemical analyses of the sediments within the plaur area in Lake Trummen will be treated elsewhere. In this connection it will only be mentioned, that the potassium content in the lifted up young layers of gyttja is markedly higher than in the underlying layers.

During the observation period 1951—1964 great changes in the distribution of different macrophyte species have taken place in the northern bays of Lake Trummen. The inner *Equisetum* stands and also part of the plaur area have, for instance, been overgrown by *Phragmites*. In lowered as well as in polluted lakes in south Sweden this type of succession is very common.

in four lakes in South Sweden. S=sterile. F=fertile. T=total

Fertility %	Shoots without branches S+F %	Branches per branched shoot S+F			Dry matter per m^2 S+F g			Ash per m^2 S+F T g
		min.	mean	max.	Stems	Branches	T	
29	78	1	2.3	9	7.4	0.19	7.6	1.1
30	83	1	4.5	17	14.7	0.23	14.9	2.2
9.3	13	1	29	111	668	62	730	79
61	3	1	56	170	760	217	977	137
56	39	1	7.4	42	956	19	975	127

In the last few years the innermost parts of the bays, where the accumulated sediments reach the water surface, have in some reaches been filled up with stones, soil and wastes and the shore line has moved lakewards as much as 70 m. The area within which the section shown in Fig. 6 was situated, is now also covered with a thick layer of stone and soil.

Notes on the History of Development

During the investigation of the plaur ("floating island") described above, several subfossil fruits of *Trapa natans* L. were found in the mud (section Fig. 6 and Fig. 7). Even if a rather large number of finds are already known from adjacent regions (cf. MALMSTRÖM 1920), the find reported here constitutes a new former habitat for the species in question.

For some years the author (DIGERFELDT) has been occupied with a fairly intensive investigation of the Post-glacial development of Lake Trummen, based on pollen- and macro-fossil analyses and certain other micro-fossil analyses. The profile described in this paper originates from a reconnoitring boring made at the very beginning of this investigation.

A paleolimnological investigation of Lake Trummen, as well as of the adjacent Lake Växjösjön and Lake Södra Bergundasjön, was earlier made by G. LUNDQVIST (1926, 1927 pp. 107—108). The principal aim of that investigation was an examination of the composition of the microphyte vegetation and its development during different periods, and the conclusions concerning trophic and similar conditions that could be drawn therefrom. On the basis of both quantitative and qualitative changes in the microphyte vegetation, LUNDQVIST considered it possible to state that all the lakes investigated with regard to trophic conditions diverged from the normal course of development. Around the transition from the Sub-boreal to the Sub-atlantic period, changes in the microphyte vegetation should thus have taken place indicating not, as is normally the case, a continued meiotrophication, but, on the contrary, a noticeable increase in the trophic potential. Furthermore, according to LUNDQVIST, in all the lakes the mud deposited during the following Sub-atlantic period, was dark coloured on account of the presence of FeS. LUNDQVIST considered that the cause of the conditions mentioned was to be found in an auxotrophication by cultural influence in so far as there was already at that time (i.e. around the transition from Bronze Age to Iron Age) unusually dense settlement within the region in question, and this had led to pollution of the water of the lakes. Later, THUNMARK (1945 a, pp. 65—82) thoroughly examined and criticized this investigation by LUNDQVIST, mentioned here only briefly; and in doing so — on good grounds as it seems to the author — came to a different conclusion. The criticism covers not only the interpretation of the micro-fossil diagrams, but also the interpretation of the causes possibly underlying eventual changes in the microphyte vegetation.

The profile described by the present author makes no contribution to this problem, but perhaps this will be possible after finishing the present investigation. So much can already be said, however, that in connection with reconnoitring borings undertaken covering the largest part of Lake Trummen, a FeS colouring of the surface sediments was observed only in the inner part of the north-western bay which has received most of the sewage from the hospital. The FeS colouring includes at most the upper 10—20 cm, certainly only representing the most recent sedimentation.

The boring point is situated 50—60 m south of the section through the investigated plaur at a distance of 40 m from the eastern shore. It lies outside the plaur region in an accidental gap in the ephydate vegetation. The water depth was 42 cm.

1.	42—185 cm	Brown detritus mud, the lower 10—15 cm sligthly sandy.
2.	185—195 cm	Brown detritus mud, very sandy.
3.	195— cm	Grey slightly muddy clay, the upper 3—5 cm rather sandy.

The macro-fossil sampling covered 95—205 cm of the sequence. Only samples for pollen-analysis were taken of the upper very soft mud (not the uppermost, however).

The zoning of the pollen diagram has been carried out according to the Scanian zone system (T. Nilsson 1935, 1961, 1964). As is usual in profiles situated near the shore, more or less extensive gaps in the sequence, due to erosion and/or interrupted deposition are to be found. Even if these gaps may complicate the correlation, they are nevertheless of great interest, as they can provide valuable criteria for the interpretation of the development of the lake itself. As a result of the present investigation, a main diagram from the deepest part of the lake is almost finished. With the help of this diagram, which includes an unbroken Post-glacial zone succession, it has been possible to carry out the zoning of the actual shore profile with a considerable degree of certainty.

According to this interpretation, there is a considerable gap between the Late-glacial clay and the immediately superposed Post-glacial detritus mud, corresponding to the Pre-boreal (zone PB), the Early Boreal (zone BO 1) as well as a great part of the Late Boreal period (zone BO 2). The Sub-boreal zones cover only a very small part of the sequence. A division of these (into zone SB 1 and SB 2) has not been considered possible, which also applies to the following Sub-atlantic zones (into zone SA 1 and SA 2). The additional profile material that will be available when the present investigation is finished may possibly lead to minor adjustments, but on the whole the correlations so far made would seem to be correct.

At the boring, a new type of sampler designed by the author (a description is in the press) was used. With the help of this sampler it was easy to obtain sample volumes large enough for the macro-fossil analysis. The free area of intersection of the model used amounts to 200 cm^2. Each macro-sample included 5 cm of the sequence; the volume thus amounted to 1000 cm^3. Washing was carried out immediately after the return to the laboratory (net 40 meshes per inch). The frequency of different macro-fossils has, as usual, been stated in absolute values. In the diagram only frequent or for some other reason important or interesting species are included.

The quantity of coarse detritus in the samples has been determined in accordance with the pattern of similar earlier investigations by FRÖMAN (1936), SELLING (1938, 1940), and WENNER (1939). As for practical reasons the determinations has been made after the sorting out of the macro-fossils, the term "coarse detritus" is perhaps — as SELLING (1939) has pointed out — not quite correct, as fruits and seeds must also be included in the fraction in question. SELLING therefore suggests the term "vegetative macro-fossils" for the part of the washed material that remains after the sorting of fruits and seeds. Normally, this fraction diverges only slightly from the absolute amount of coarse detritus. In spite of this, the author has chosen to use the more easily handled term "coarse detritus", supplemented with a reference to how the determination has been made.

The determination of quantity includes both volume and dry weight. The volume was determined after the material had settled for 24 hours in water-filled bottles. The reliability of the values obtained in this way was discussed earlier by WENNER (1939) and SELLING (1940). Here it needs only be mentioned that the author has changed the method in the present investigation so far as the material, prior to measuring, is also exposed to a certain pressure with the help of a simple construction — for the purpose of reducing the effect that the nature of the material ("fibrousness") certainly has at uninfluenced sedimentation (cf. WENNER 1939, SELLING 1940).

The coarse detritus curve and the different fruit and seed curves are intended to interpret the development of the lake. A prerequisite for investigations of this kind giving good results is that they are carried out very intensively with several borings in a profile from the shore towards the central and deeper part of the lake. Separate borings can, of course, give interesting information, but they rarely give a complete picture of the development. The water depth at a given point and its relation to the range of the different vegetation belts during a fluctuation of the water level are some of the factors decisive for the way in which this change has been registered in the sequence of layers. The conditions prevailing during different periods in the history of the lake may have differed, and there is rarely more than part of the development collected in the sequence at one and the same point. Near the shore apparently unitary changes can turn out to be of a complex nature when followed up in a profundal direction — among other things because traces of earlier development have here been entirely or partially removed due to erosion during periods of low water level.

Changes in the range of the vegetation belts, which happen occasionally unconnected with fluctuations in the water level can further give rise to misinterpretations if only one or a few borings are considered.

As previously mentioned, the profile described here was made for the purpose of reconnoitring, and this must be born in mind when interpreting it. The description will only contain the main features.

The extensive gap between the Late-glacial clay and the immediately superposed Post-glacial mud must certainly be connected with the low water level period, which has proved to be generally registered in the sequence of lakes and bogs during the older part of the Post-glacial period (cf. among others SUNDELIN 1917, LUNDQVIST 1925, T. NILSSON 1935). During this period the bottom at the boring point came to lie above the limit of sedimentation. The deposition of mud was interrupted and erosion of earlier deposited layers may also have occurred. A closer dating of this period is not possible here. However, this may very well be possible if, as is intended, the investigation is followed up in a profundal direction to a water depth which even during the culmination of the lowering of the water level permitted the deposition of mud, and where the fluctuation in question ought in principle to be registered not as a gap in the sequence, but, on the contrary, by turns of the different curves in the macro-fossil diagram.

A comparatively high proportion of coarse detritus and mineral matter indicates a location rather near the shore during the time immediately after the beginning of mud deposition.

The decrease in the quantity of coarse detritus and mineral matter after that can probably be interpreted as caused by a rise in the water level proceeding into the Late Atlantic period. The question of what is behind the marked turn of the detritus curve, as well as of several of the other macro-fossil curves, around the level of 1.55—1.60 m, must be left open for the present.

The interpretation of a rise in the water level, in the way mentioned above, is generally easy and indisputable. It is considerably more difficult to decide whether an increase in the quantity of coarse detritus is to be connected on the same grounds with a lowering of the water level. This may be the case, but the cause may also be the normal development of the lake, with a gradually reduced water depth due to the proceeding sedimentation and filling-up, without any connection whatever with changes in the water level. A combination of these two events is, of course, also possible. A follow-up in a littoral and profundal direction is also necessary here.

Therefore the cause of the marked increase in the coarse detritus fraction during the latter part of the Late Atlantic period must also for the present be left undetermined. The slight mud deposition in the following Sub-boreal period indicates, at all events, that during the corresponding time the bottom came up near the limit of sedimentation, with the result that the deposition of mud could no longer take place or proceeded only sporadically. Erosion may, of course, also have occurred.

The marked decrease in the amount of coarse detritus that occurred after a culmination some time in the Sub-boreal period is certainly connected with a new rise in the water level. A general observation may be justified here. As has been pointed out, all frequences in the macro-fossil diagram are expressed in absolute values. They will consequently depend on the rate of accumulation, but also on the degree of consolidation of the sediment and its water content. A certain reduction in all frequencies in the upper part of the sequence which is very soft and not yet consolidated is thus always to be expected, and this is also the case with the profile described here. It is true that an increase in the water content begins to be noticeable around the level of 0.90—1.00 m. However, the change is small at the beginning and proceeds slowly; it can possibly have contributed to, but not be by any means the main cause of, the marked decrease in the proportion of coarse detritus and contemporary changes in the occurrence of some of the macro-fossils.

The interpretation of the other curves in the macro-fossil diagram, i.e. the curves for different fruits and seeds and other determinable objects, will also be dealt with. The *Scirpus* curve reflects quite distinctly the two shallow water periods mentioned above; the question about the marked turn during the first part of the Early Atlantic period must be left open for the time being, as has previously been pointed out. The *Equisetum* curve reflects only the younger period.

During the corresponding time reeds of the species in question have spread over or occurred in the immediate vicinity of the boring point. The retreat of these reeds enforced by the increased water depth in connection with the rising water level in the late part of the Post-glacial period shows up specially well in the diagram. Since it has not been possible to obtain samples of the uppermost mud, the later development is, unfortunately, not known. As mentioned before, the boring point is at present situated within the ephydate belt.

Concerning the curves of the ephydates (*Trapa natans, Potamogeton natans, Nymphaea alba,* and *Nuphar luteum*), these ought to have had a course alternating with the hyperhydates. However, this is not the case, which may be explained at least partly by the fact that the sampling point is situated rather close to the shore. Sediments deposited within the shore zone itself or just outside a dense reed belt will often contain in addition to fruits and seeds from the vegetation of the very place, also a variable amount originating from the drift. It may be that similar circumstances have had an unsettling effect also on the present profile.

The presence of *Trapa natans* (Fig. 7) always attracts special attention because of its evidence of the climate during different parts of the Post-glacial period. Already in the oldest Post-glacial samples its fruits appear with increasing frequency. They occur most abundantly in layers from the Early Atlantic and the first half of the Late Atlantic period. This occurrence certainly registers a local habitat, even if it is perhaps partly composed of fruits from the drift, as mentioned above. The oldest occurrence dates back to some part of the Late Boreal period. Because of the existing gap in the sequence nothing can yet be said about the development prior to that.

During the investigation of the plaur a fairly large amount of charcoal was found in the mud. In connection with the macro-fossil analysis all the charcoal has been sorted and its dry weight recorded. As can be seen, the occurrence is concentrated to the lowest part of the mud sequence. The charcoal most certainly originates from a dwelling-place situated near the shore, from which it was washed out. The author will not be able to give positive information about the age of this dwelling-place until the present investigation is finished.

A very interesting point is that separate completely or partially "roasted" fragments of *Trapa* fruits have been found in the same layer where charcoal occurs. The explanation must be that these fragments originate from fruits which were collected for food and brought home to the dwelling-place, from where they were washed out at the same time as the charcoal. The idea that the highly nutritious fruits were used for food has been put forward several times before (cf. among others JÄGGI 1884, SUNDELIN 1920), and there is no reason to doubt this, even if only a few direct proofs of it have so far been published.

A description of the recent plaur ("floating island") in Lake Trummen has been given in this paper by BJÖRK. In this connection it may finally be mentioned that in recent years separate fossil "floating islands" have been discovered (TROELS-SMITH 1951, 1953, 1960, MAGNUSSON 1962, JØRGENSEN 1963). In all cases their formation has been

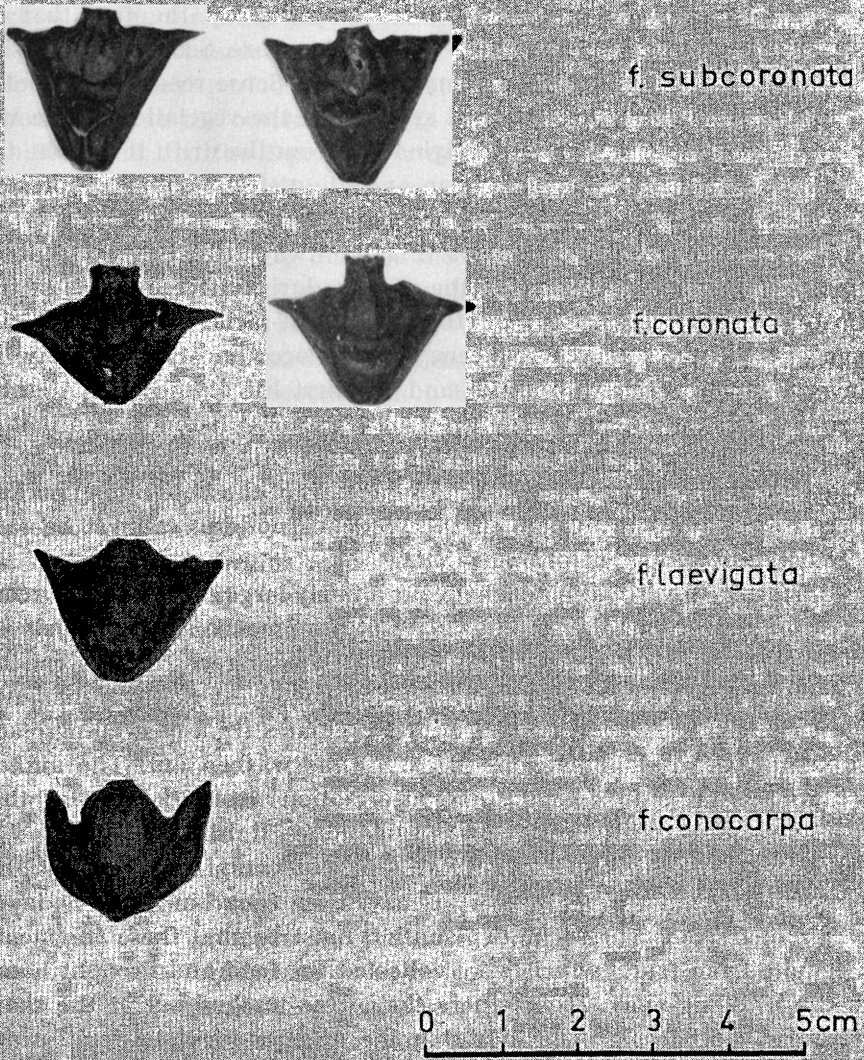

Fig. 7. Subfossil fruits of *Trapa natans* found in Lake Trummen.


Depth, m below water level
Number of pollen sample
Stratigraphy
AP (sum of calculation = sum of pollen from trees and terrestrial shrubs = ΣA)
Alnus □ Betula ○ Corylus ▣
Pinus ● Salix ⊗
Σ Fraxinus, Quercus, Tilia, Ulmus, Acer ■
Fraxinus
Quercus
Tilia
Ulmus
Fagus
Carpinus
Picea
ΣA
Zones (T. Nilsson 1935, 1961)
NAP and Spores (sum of calculation for each species or group of species = ΣA + sum of pollen from the species or the group of in question)
Cerealea
Plantago lanceolata
Rumex Acetosa-type
Artemisia spp.
Gramineae (excl. Cerealea)
Limnophyta (excl. Isoëtes lacustris)
Isoëtes lacustris
Amphiphyta Telmatophyta excl. Cyperac.
Cyperaceae
Other Microfossils
Spicula (fresh water sponges)
SA
SB
AT 2
AT 1
BO 2
Late-glac.
Number of macrofossil sample
per 1000 cm³
Quantity of coarse-detritus (excl. seeds fruits and "other macrofossils"): volume ——; dry weight - - -
Seeds and Fruits
Trapa natans
Whole fruits
spines
crowns
basal parts
Potamogeton natans
Nymphaea alba
Nuphar luteum
Ranunculus sect. Batrach.
Sparganium spp.
Equisetum fluviatile node diaphragms
Scirpus lacustris
Carex spp.
Limnophyta
Amphiphyta and Telmatophyta
Other Macrofossils
Trichoptera larval cases
Charcoal (dry weight)
①
②
③
The value of the curves
0 10 20 30 40%
Analysed by G. Digerfeldt 196

considered to be conditioned by a rise in the water level, an explanation which it has also been possible to fit into the picture of the development given by pollen diagrams and other conditions. Nevertheless, in the account of the general conditions for the formation of a "floating island" terms have often been used that can easily lead the reader to believe that the cause is always (TROELS-SMITH 1960, p. 590) or in most cases (TROELS-SMITH 1951 p. 178) a rise in the water level. However, as has been shown, the causes can vary. Consequently, the evolutionary interpretation must be made with a certain degree of caution. In no circumstance can the formation be placed in connection with water level fluctuations without other conditions being taken into account.

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Smärre uppsatser och meddelanden

Ny inlandslokal i Västergötland för Elymus arenarius

Under en bilfärd mellan Jönköping och Falköping den 23/8 1963 fick jag från bilen se ett bestånd av strandråg strax ö. om Leaby, Karleby s:n, Västergötland. Den 23/7 1964 gjorde jag en närmare undersökning av lokalen. Denna utgör nu en rest av den gamla vägen Jönköping—Falköping, där denna går över en åldrig valvbro över ett tillflöde till Slafsan. Genom en tidigare vägomläggning har denna gamla väg kommit att ligga s. om den till 1963 använda. Genom ny vägomläggning 1964 ligger lokalen helt n. om den nya vägen Jönköping—Falköping. Största delen av *Elymus*-beståndet befinner sig på ömse sidor om valvbron. Jag räknade c:a 260 blommande, och minst 50 äldre, icke blommande ax på en areal av omkr. 15 kvm. Marken hör till gården Klövhålan, c:a 300 m sö. om valvbron. Vid mitt samtal med ägaren till gården, Fru ELNA KRALL, framgick det, att hon observerat detta gräs på platsen sedan c:a 20 år tillbaka. Hon visade mig också på ett gräs, som hon trodde vara detsamma, växande c:a 50 m ö. om gården vid den nu privata väg, som går omedelbart intill gården, men som tidigare var den allmänna vägen Jönköping—Falköping och fortsatte över valvbron. Det var ett mindre bestånd av *Elymus* på vardera vägkanten med c:a 50 blommande och lika många gamla icke blommande ax.

Elymus arenarius förekommer vid Valstad, c:a 10 km från nyssnämnda lokal, men är där enl. kyrkoherde L. FRIDÉN, god kännare av traktens flora, inplanterad för att binda flygsand. Någon sådan förekommer ej vid Leabylokalen, ej heller har man behövt transportera vägmaterial ss. sand och grus från annat håll, då sådant stått till buds på platsen. Man får väl i alla fall antaga, att *Elymus* hamnat på de båda lokalerna vid Klövhålan genom antropochor spridning.

Lokalen vid Valstad finns med en prick angiven i HULTÉNS Atlas över växternas utbredning i Norden. Enligt uppgift från Riksmuséet är materialet för denna markering uteslutande från Valstad och ej från Leabylokalen, som annars inneslutes av kartpricken.

A. JYLLMAN

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Riksmuseets botaniska avdelning. Docent Tycho Norlindh har förordnats till professor och föreståndare för Riksmuseets botaniska avdelning.

Docentförordnande. Till docent i paleobotanik vid Lunds Universitet har förordnats fil. dr. Hans Tralau.

Forskningsanslag. Statens naturvetenskapliga forskningsråd har vid sammanträde den 10 maj 1965 utdelat bl.a. följande anslag: till doc. O. Almborn, Lund, 25.137 kr. för utarbetande av en flora över Sydafrikas lavar; till doc. Karin Aschan-Åberg, Uppsala, 22.436 kr. för studium av imperfekta dermatofyter; till prof. K. Björling, Uppsala, 22.860 kr. för fortsatta undersökningar av spontana och nitritinducerade mutationer av tobaksmosaikvirus; till försöksledare S. Blixt, Landskrona, 10.000 kr. för genanalytiska undersökningar av ärt, samt 10.000 kr. för den Lamprechtska *Pisum*-kollektionens bevarande; till prof. H. Burström, Lund, 29.300 kr. för undersökningar över verkningssättet av naturliga och syntetiska tillväxtämnen; till doc. T. Denward, Lund, 17.036 kr. för studier över *Trifolium pratense* och *Phytophthora infestans,* samt 6.650 kr. för in-vitro-odling av växtceller och -vävnad för virusförsök; till prof. H. Erdtman, Stockholm, 60.000 kr. för kemotaxonomiska studier inom barrträdsgruppen; till prof. F. Fagerlind, Stockholm, 14.500 kr. för växtmorfologisk forskning; till doc. P. Fransson, Lund, 2.130 kr. för studier över naturliga växthormoner; till doc. Lisbeth Fries, Uppsala, 16.456 kr. för undersökning över rödalgernas näringsfysiologi under kontrollerade betingelser; till prof. N. Fries, Uppsala, 14.352 kr. för studier över vävnads- och cellkulturer hos fröväxter; till doc. S. Fröst, Lund, 11.300 kr. för undersökning av accessoriska kromosomer och undersökning av inavlad råg; till doc. P. Halldal, Göteborg, 43.538 kr. för undersökning av fotosyntes hos alger; till doc. O. Hedberg, Uppsala, 26.496 kr. för växtsystematiska undersökningar; till doc. Angelica von Hofsten, Uppsala, 15.000 kr. för elektronmikroskopiska undersökningar av svampar; till doc. L. Holm, Uppsala, 3.000 kr. för fortsatt elektronmikroskopisk undersökning av aecidiospormembranen hos vissa rostsvampar; till agr. dr. G. Julén, Svalöf, 7.000 kr. för fortsatta undersökningar rörande yttre förhållandens inverkan på den embryologiska utvecklingen hos *Poa pratensis*; till doc. A. Kylin, Stockholm, 13.296 kr. för undersökning av växternas jonupptagning; till prof. H. Lundegårdh, Penningby, 7.000 kr. för undersökningar över de energikonverterande enzymsystemen i mitokondrier och kloroplaster; till doc. Britta Lundblad, Stockholm, 640 kr. för insamling av växtfossil av mesozoisk ålder i Skåne; till laborator N. Malmer, Lund, 9.124 kr. för växtekologiska undersökningar i Sydsverige; till prof. J. A. Nannfeldt, Uppsala, 10.000 kr. för genomgång av fil. dr. A. H. Magnussons lavsamling för att göra den tillgänglig för forskningen; till laborator T. Nilsson, Lund, 16.074 kr. för forskning rörande senkvartär vegetationshistoria i sydöstra Sverige; till amanuens T. NITZELIUS, Göteborg, 4.000 kr. för taxonomiska och växtgeografiska undersökningar även som insamling av vissa mediterrana lignoser; till fil. lic. GERTRUD NORDBORG, Lund, 2.766 kr. för studium av släktavgränsning och sektionsindelning i *Sanguisorba*; till doc. HEDDA NORDENSKIÖLD, Uppsala, 11.952 kr. för studium av fertilitetsstörningar hos nyframställda tetraploider av korn samt deras uppträdande hos stammar av olika ursprung; till doc. B. NORÉN, Lund, 15.443 kr. för studier över antocyanfärgämnenas sammansättning hos släktena *Rubus* och *Ribes*; till doc. Å. PERSSON, Lund, 9.124 kr. för växtekologiska undersökningar i Skäralidsdalen i Skåne; till doc. B. PETTERSSON, Uppsala, 38.028 kr. för forskning inom ekologisk botanik; till doc. H. RUNEMARK, Lund, 14.652 kr. för cytologisk bearbetning av botaniskt material från Grekland; till prof. F. SANDBERG, Stockholm, 27.775 kr. för fytokemisk undersökning över afrikanska *Strychnos*-arter; till doc. R. SANTESSON, Uppsala 4.495 kr. för lichenologiska och mykologiska studier i USA okt.-nov. 1965; till fil. lic. S.-O. STRANDHEDE, Lund, 2.565 kr. för fält- och museistudier av *Eleocharis*; till fil. dr. GUNHILD WEIMARCK, Lund, 23.829 kr. för skogsvetenskapliga forskningar inom Örkeneds socken; till prof. D. VON WETTSTEIN och laborator H. ZECH, Stockholm, 28.162 kr. för elektronmikroskopiska undersökningar över tobaksmosaikvirusreproduktion, samt till doc. G. ZETTERBERG, Uppsala, 29.629 kr. för studier över enzymmutationer hos *Neurospora* och *Ophiostoma*.