Botaniska Notiser 1839–1980

GUNNAR WEIMARCK

This issue of *Botaniska Notiser* is the last in the long history of the journal, at least as far as can be judged at the moment of writing. By the end of 1980 four Scandinavian botanical journals will have ceased to appear to give way to a new joint Scandinavian journal, '*Nordic Journal of Botany*'. The final decision to initiate the new enterprise, '*Nordic Journal of Botany*', was taken as late as March 5th, 1980, as a result of cooperation between representatives of Denmark, Finland, Norway and Sweden.

The Swedish *Botaniska Notiser* departs from the scene after appearing in 133 volumes (the journal did not appear regularly until 1871), the Danish *Botanisk Tidsskrift* ceases after 75 volumes, the likewise Danish journal, *Friesia,* after 10 volumes and the fourth journal, *Norwegian Journal of Botany,* after 27 volumes.

The Editors of *Botaniska Notiser* and the Editorial Board have decided to devote this issue to botanical research, past and present, as related to Lund and including the history of *Botaniska Notiser*. A generous extra grant for this issue from the sponsor, the Swedish Natural Science Research Council, is gratefully acknowledged.

The history of the journal has been varied and reflects much of the development of botanical science. Some of the changes in scope or organization grew out of the wishes of the readers and contributors, others were in the nature of compulsory changes enforced by the sponsor. During the first 120 years or so of its existence *Botaniska Notiser* has been a mainly national enterprise. From being popular or semi-popular the journal has gradually become entirely scientific. For the last twelve years or so *Botaniska Notiser* has been international in scope and the language used mainly English. Dr G. Weimarck, the Editor from 1972 to 1975 and during 1980, recounts the history of *Botaniska Notiser* from 1839 to our days and points to some trends in its contents (pp. 415–442).

Botaniska Notiser has long attracted the interest of subscribers and contributors from many countries. The Editors have had the pleasure of seeing an increase in the number and quality of papers submitted by authors from most parts of the world.

Why, then, should a flourishing journal cease to appear? The reasons are complex and of long standing. Professor A. Kylin, who for many years has held a leading position in the world of botanical publishing in Sweden and Scandinavia, presents the background (pp. 443–450).

And why should the final issue of an international botanical journal be mainly devoted to botanical research at Lund, just one of the Swedish universities?

Botaniska Notiser has been edited almost entirely in Lund, from 1839 to 1846 and from 1871 onwards — 118 out of the 133 volumes. For long periods research in Lund was the major source of contributions. Dr O. Almborn surveys three centuries of botanical research at Lund (pp. 451–474).

The main part of this issue comprises original botanical research papers with a relevance to Lund. All (first) authors but one are botanists presently working in Lund or who are graduates of Lund but with Chairs at other universities. The contribution by Professor H. Lange-Bertalot, Frankfurt-am-Main, (pp. 585–594) is particularly welcome, closely related as it is to a line of research that has been in the forefront since the days of the Agardhs. All book reviewers are also from Lund.

The time and space available have, regrettably, had a restrictive influence. Many more papers could have been included under other circumstances. We hope, however, that this concluding issue will be considered a suitable tribute to mark the passing of a venerable journal.

It is not in place here to deplore the disappearance of Botaniska Notiser, whatever our feelings may be. Instead we extend a welcome to our readers and contributors to participate in making the coming *'Nordic Journal of Botany'* a successful undertaking.

Special offer: General Index of Botaniska Notiser 1959–1980

A General Index of *Botaniska Notiser* for the period 1959–1980 is in preparation. It is to be published during the second half of 1981.

The General Index is to comprise an index of writers, a list of reviews of literature, a list of announcements, a subject index, an index of species and subspecific taxa, and corrigenda. The volume is expected to comprise about 300 pages.

The contents of *Botaniska Notiser* are largely of permanent interest. As pointed out by Weimarck (this issue, p. 428) the General Indexes previously published have already been found to be of great value for information retrieval. The new Index will also greatly increase the commercial value of a series of *Botaniska Notiser* from the point of view of future collectors of botanical literature.

We therefore urge all subscribers to take advantage of the reduced price offered below and order the New General Index now.

The price has been set at 290 SEK provided the order is received before May 1st, 1981, after which the price will be 490 SEK. Orders should be sent to the Editorial Service, Swedish Natural Science Research Council, P.O. Box 23 136, S-104 35 Stockholm, Sweden.

A limited number of the two previous General Indexes of *Botaniska Notiser* are still available: for 1839–1938 (1,007 pp., 15 SEK) and for 1939–1958 (294 pp., 30 SEK).

The enclosed order form may be used.

Botaniska Notiser 1839–1980 and developments in Botany reflected in its contents

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Botaniska Notiser was established in Lund in 1839 and ceases to appear with this issue. From 1839 to 1868 the journal did not always appear with regularity, and during certain periods it was edited in Stockholm or Uppsala. Since 1871 it has appeared regularly and has been edited in Lund. From 1922 onwards *Botaniska Notiser* has been owned by the Lund Botanical Society. From being semi-popular it has gradually become a scientific journal. Since 1970 only phytotaxonomical papers in a broad sense, of international interest, and written in English, German or French have been accepted. The proportion of non-Swedish contributions has increased considerably since the Second World War. From the 1840's till the present day the amount of material published per year has increased roughly sixfold. A selection of papers that have contributed to the development of botanical research is presented.

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The fact that *Botaniska Notiser* will cease to appear after a long and commendable existence calls for retrospection not only regarding the history of the journal but also regarding the science to which it has been devoted.

Among still-existing botanical journals that have appeared with reasonable regularity *Botaniska Notiser* would seem to be second in age to *Flora oder allgemeine botanische Zeitung* only, Regensburg/Marburg/Jena (1818–). (*The Botanical Magazine,* or *Curtis's Botanical Magazine* that has appeared in London from 1793 onwards, is not a journal in the proper sense of the word.)

The purpose of this contribution is threefold. First, to give a historical survey of the journal itself with emphasis on two men of note: the first Editor, A. E. Lindblom, and C. F. O. Nordstedt who was Editor for 51 years. Secondly, to sketch some trends in the contents of *Botaniska Notiser* during various periods. Thirdly, to present some fields of particular interest where developments in botanical research are reflected in contributions to *Botaniska Notiser.*

In preparing this paper I have drawn on many sources, in particular Danielsson (1965, 1967), Eriksson (1962) and Lindroth (1954). Major sources of information on the history of *Botaniska Notiser* and of botanical research at Lund have been surveys, biographies and obituaries in this journal, mainly those by Almborn (1980 pp. 451–474), Gertz (1924 pp. 97–125; 1939 pp. 273–290), Hjelmqvist (1958 pp. 5–33), Kylin (1980 pp. 443–450) and Norlindh (1955 pp. 1–5). References to papers in *Botaniska Notiser* do not appear separately in the list of References at the end of this paper.

Figures 3–5 are based on a classification of the contents of *Botaniska Notiser* volume by volume, almost 48,500 pages in all. Tables of contents, blank pages, indexes or plates with separate pagination or without pagination have been excluded. Each article was classified under one of 16 headings representing different fields of Botany (Fig. 3). The (approximate) number of pages devoted to each of these fields was expressed in per cent of the number of pages in the respective volume. The value for each year is given as the arithmetic mean of three volumes viz., the volume of any given year and the preceding and following volumes. This use of gliding three-year means should partly compensate for excessive effects of chance in the material. The precise delimitation of any given volume from that immediately preceding it and from the following one is to some extent determined by random factors such as the space available, the Editor's decisions on layout and the like.

Reports from societies have been classified under Miscellaneous (no. 15) when consisting of brief notes and communications only, but under the appropriate heading (1–14) when, for example, a lecture has been documented in the form of an original paper with the lecturer as the author (this was not uncommon during the period from 1886 to 1921).

The percentual distribution of contributions by authors from various parts of the world (Fig. 4) and that of the languages in which the main text of the papers is written (Fig. 5) are also presented as gliding three-year means and calculated from material under the headings 1–14 only.

The number of printed pages per volume is shown in Fig. 6, and the mean number of pages per contribution (gliding three-year means) in Fig. 7. Since the amount of text appearing on one page has varied widely at different times correction has been made from an estimate of the number of characters and spaces per page of the main text.

The three-year means for 1979 are approximate since the figures for Vol. 133, Issue 4 (this issue), were still preliminary when Figures 3–7 were prepared.

History of Botaniska Notiser

Introductory stage

During the first decades of the 19th century the natural sciences had no prominent place in the mind of the educated public in Sweden. Rather, emphasis was laid on art, poetry and other arts subjects, and the influence of romantic philosophy was great. In this cultural climate, however, the Linnaean biological tradition was able to flourish, with field botany perhaps in the lead. Many of these early 19th century field botanists were naturalists rather than research workers (see Lindroth 1954 pp. 162–164).

Botanical activity was also intense outside the universities of Uppsala and Lund and the Royal Academy of Science in Stockholm which at that time were the centres of scientific study in Sweden. Many schoolteachers and, even more, country clergymen were competent amateur botanists.

With this background in mind it is not surprising that a journal such as *Botaniska Notiser* should come into being. Among field botanists dispersed over the whole of Sweden and the other Scandinavian countries the difficulties of communication were a severe obstacle. Scandinavian botanists also found it difficult to keep in touch with developments in Botany abroad.

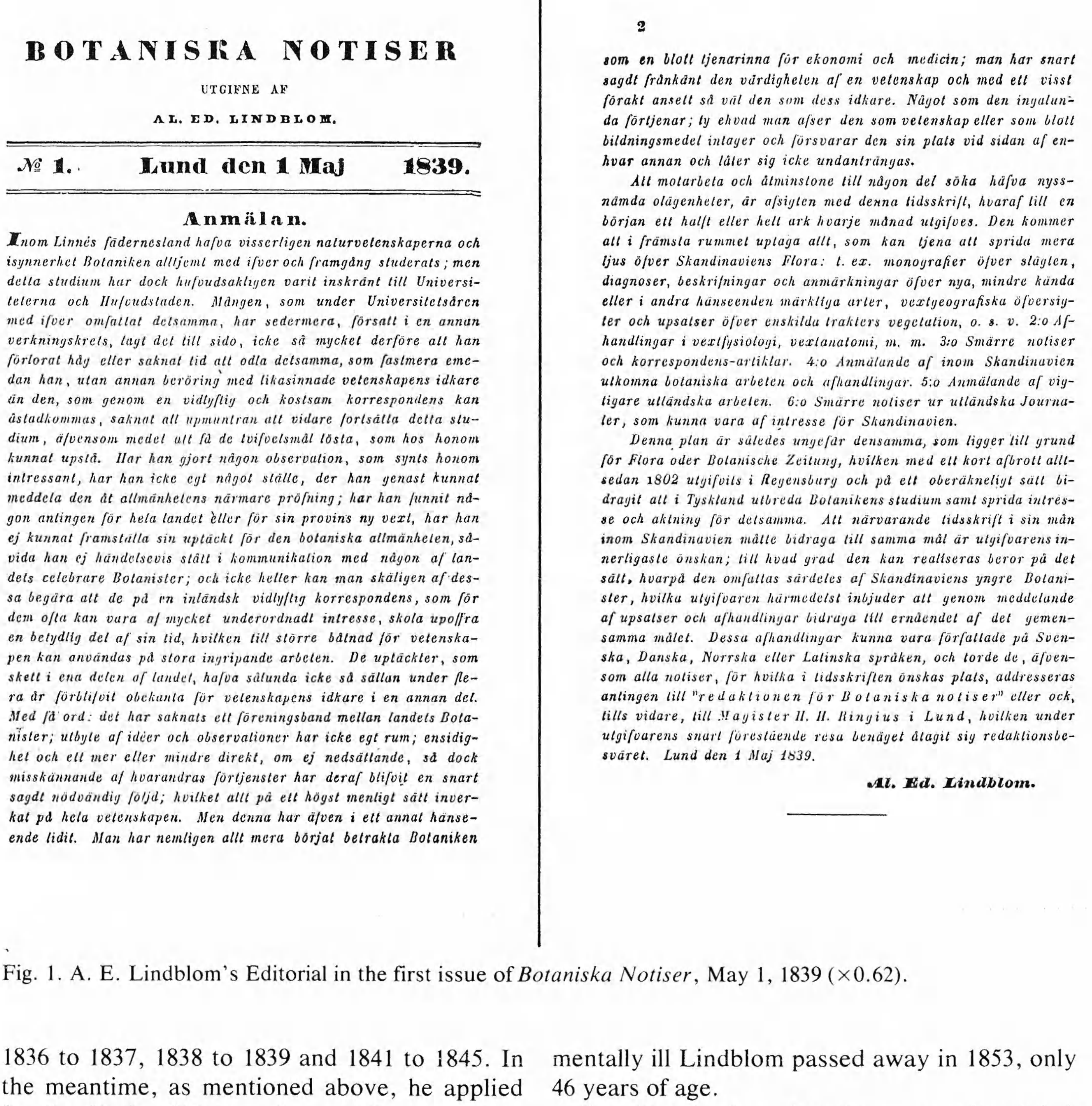
According to available documents the initiative was taken in 1838 by Elias Fries. Fries, the renowned mycologist, had started his academic career in Lund under the likewise prominent phycologist C. A. Agardh and had been appointed Professor of Practical Economy in Uppsala in 1834. He addressed his appeal to A. E. Lindblom, at that time one of the applicants for the Chair of Botany in Lund that had been vacant since C. A. Agardh had left to become a bishop. Lindblom, who was full of enthusiasm, published the first issue of the journal on May 1, 1839. The journal was run as a private enterprise.

The first, unsettled period (1839–1868)

Lindblom defined the scope of *Botaniska Notiser* in an introductory editorial in the first issue (Fig. 1). The journal was to contain (1) monographs, descriptions, floristic notes, phytogeographic surveys, etc., concerning the flora of Scandinavia; (2) papers on physiology, anatomy, etc.; (3) brief reports and correspondence; (4) reviews of Scandinavian treatises; (5) reviews of important foreign treatises; and (6) brief excerpts of interest in Scandinavia from foreign journals. This general scope was maintained with some variation by subsequent Editors up to the end of 1921.

From the beginning till as late as the 1960's the scientific contents were combined with at least some contributions written in a more popular style. The semi-popular nature of some contributions often makes it difficult or even impossible to distinguish between original papers and reviews or excerpts. This applies in particular to the volumes up to 1868 as papers by foreign botanists were frequently translated into Swedish from an original published elsewhere, and republished in *Botaniska Notiser* more or less in full.

Botaniska Notiser turned out to be a success as a scientific project though not economically. However, the journal ceased to appear at the end of 1846. The reason was a personal tragedy. Lindblom had started his career in Lund in a very promising way. He was born in 1807 and defended his thesis under C. A. Agardh at the age of only nineteen. However, he never attained a post as a botanist. He was a student of Fries's rather than of Agardh's, and these two prominent men were at that time engaged in a bitter conflict (Eriksson 1962 p. 219). Perhaps Lindblom was the victim of this enmity; anyhow he changed over to Philosophy in 1830 and the following year was appointed 'Adjunkt' (Theoretical and Practical Philosophy). He was Acting Professor of Theoretical Philosophy from 1833 to 1835 and of Practical Philosophy from



BOTANISKA NOTISER

UTGIFNE AF

AL. ED. LINDBLOM.

№ 1. **Lund den 1 Maj** **1839.**

Anmälan.

Inom Linnés fädernesland hafva visserligen naturvetenskaperna och isynnerhet Botaniken alltjemt med ifver och framgång studerats; men detta studium har dock hufvudsakligen varit inskränt till Universiteterna och Hufvudstaden. Mången, som under Universitetsåren med ifver omfattat detsamma, har sedermera, försatt i en annan verkningskrets, lagt det till sido, icke så mycket derföre att han förlorat håg eller saknat tid att odla detsamma, som fastmera emedan han, utan annan beröring med likasinnade vetenskapens idkare än den, som genom en vidlyftig och kostsam korrespondens kan åstadkommas, saknat all upmuntran att vidare fortsätta detta studium, äfvensom medel att få de tvifvelsmål lösta, som hos honom kunnat upstå. Har han gjort någon observation, som synts honom intressant, har han icke egt något ställe, der han genast kunnat meddela den åt allmänhetens närmare pröfning; har han funnit någon antingen för hela landet eller för sin provins ny vext, har han ej kunnat framställa sin uptäckt för den botaniska allmänheten, såvida han ej händelsevis stått i kommunikation med någon af landets celebrare Botanister; och icke heller kan man skäligen af dessa begära att de på en inländsk vidlyftig korrespondens, som för dem ofta kan vara af mycket underordnadt intresse, skola upoffra en betydlig del af sin tid, hvilken till större båtnad för vetenskapen kan användas på stora ingripande arbeten. De uptäckter, som skett i ena delen af landet, hafva sålunda icke så sällan under flera år förblifvit obekanta för vetenskapens idkare i en annan del. Med få ord: det har saknats ett föreningsband mellan landets Botanister; utbyte af idéer och observationer har icke egt rum; ensidighet och ett mer eller mindre direkt, om ej nedsättande, så dock misskännande af hvarandras förtjenster har deraf blifvit en snart sagdt nödvändig följd; hvilket allt på ett högst menligt sätt inverkat på hela vetenskapen. Men denna har äfven i ett annat hänseende lidit. Man har nemligen allt mera börjat betrakta Botaniken

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som en blott tjenarinna för ekonomi och medicin; man har snart sagdt frånkänt den värdigheten af en vetenskap och med ett visst förakt ansett så väl den som dess idkare. Något som den ingalunda förtjenar; ty ehvad man afser den som vetenskap eller som blott bildningsmedel intager och försvarar den sin plats vid sidan af enhvar annan och låter sig icke undanträngas.

Att motarbeta och åtminstone till någon del söka häfva nyssnämda olägenheter, är afsigten med denna tidsskrift, hvaraf till en början ett halft eller helt ark hvarje månad utgifves. Den kommer att i främsta rummet uptaga allt, som kan tjena att sprida mera ljus öfver Skandinaviens Flora: t. ex. monografier öfver slägten, diagnoser, beskrifningar och anmärkningar öfver nya, mindre kända eller i andra hänseenden märkliga arter, vextgeografiska öfversigter och upsatser öfver enskilda trakters vegetation, o. s. v. 2:o Afhandlingar i vextfysiologi, vextanatomi, m. m. 3:o Smärre notiser och korrespondens-artiklar. 4:o Anmälande af inom Skandinavien utkomna botaniska arbeten och afhandlingar. 5:o Anmälande af vigtigare utländska arbeten. 6:o Smärre notiser ur utländska Journaler, som kunna vara af intresse för Skandinavien.

Denna plan är således ungefär densamma, som ligger till grund för Flora oder Botanische Zeitung, hvilken med ett kort afbrott alltsedan 1802 utgifvits i Regensburg och på ett oberäkneligt sätt bidragit att i Tyskland utbreda Botanikens studium samt sprida intresse och aktning för detsamma. Att närvarande tidsskrift i sin mån inom Skandinavien måtte bidraga till samma mål är utgifvarens innerligaste önskan; till hvad grad den kan realiseras beror på det sätt, hvarpå den omfattas särdeles af Skandinaviens yngre Botanister, hvilka utgifvaren härmedelst inbjuder att genom meddelande af upsatser och afhandlingar bidraga till ernåendet af det gemensamma målet. Dessa afhandlingar kunna vara författade på Svenska, Danska, Norrska eller Latinska språken, och torde de, äfvensom alla notiser, för hvilka i tidsskriften önskas plats, addresseras antingen till "redaktionen för Botaniska notiser" eller ock, tills vidare, till Magister H. H. Ringius i Lund, hvilken under utgifvarens snart förestående resa benäget åtagit sig redaktionsbesväret. Lund den 1 Maj 1839.

Al. Ed. Lindblom.

Fig. 1. A. E. Lindblom's Editorial in the first issue of *Botaniska Notiser*, May 1, 1839 (×0.62).

1836 to 1837, 1838 to 1839 and 1841 to 1845. In the meantime, as mentioned above, he applied for the Chair of Botany, but another applicant, J. W. Zetterstedt, who was C. A. Agardh's candidate, was appointed in 1839. Lindblom also applied for the permanent Chair of Practical Philosophy at Lund, but another applicant was appointed in 1847. By this time Lindblom was already a broken man. Since 1845 his physical health had been on the decline, and in the autumn of 1846 he was forced to give up editing *Botaniska Notiser*. An assistant Editor took over but passed away shortly afterwards. There was no possibility of publishing *Botaniska Notiser* during 1847. Paralyzed, blind and finally also mentally ill Lindblom passed away in 1853, only 46 years of age.

Scandinavian botanists, however, missed their journal. In 1849 it reappeared under the name *Nya* (New) *Botaniska Notiser,* and till 1851 was edited in Stockholm by N. J. Andersson (1821–1880, Keeper of the Museum of Natural History in Stockholm from 1856). However, he soon left for a voyage round the world. The journal was taken over by K. F. Thedenius (1814–1894, at that time a pharmacist in Stockholm, high school teacher there from 1859). He first acted as Andersson's assistant but was Editor from 1852 to 1856. In an Editorial written in 1851 (pp. 222–224) he expressed his hesitation in taking over the heavy burden of editorship (certainly not a unique sentiment).

T. M. Fries (1832–1913, the son of E. Fries and Professor of Botany and Practical Economy in Uppsala from 1877) was Editor in 1857 and 1858. He published the journal in Uppsala under its original name, *Botaniska Notiser,* which has since been retained.

N. J. Andersson returned as Editor in 1863 but edited one volume only in Stockholm. From 1865 to 1868 *Botaniska Notiser* was again published in Uppsala by T. M. Fries.

Thus, *Botaniska Notiser* did not appear in 1847 and 1848, from 1859 to 1862 and in 1864, 1869 and 1870.

During this period (1839–1868) the journal generally appeared in monthly issues except for a gap in the summer of certain years.

The Nordstedt period (1871–1921)

In 1871 *Botaniska Notiser* was re-established in Lund by A. Falck (1844–1871) and C. F. O. Nordstedt (1838–1924) and for the 110 years since then has been edited in Lund.

The beginning was attended by tragedy. The first issue is dated January 2, 1871, and the following day Falck passed away. Nordstedt, on the other hand, remained at the helm all the longer.

Nordstedt's achievement must be almost unique in the history of publication. When he retired at the end of 1921, almost 84 years of age, he had edited 51 volumes of *Botaniska Notiser,* in all c. 13,350 pages.

Nordstedt (Fig. 2) was a remote descendant of Linnaeus. After medical studies in Lund he switched to Botany and studied under the phycologist J. G. Agardh, C. A. Agardh's son, who had succeeded Zetterstedt in 1854. Nordstedt was one of the founders of the Lund Botanical Society in 1858. He was one of the only two of J. G. Agardh's Swedish students to specialize in Phycology. Though he did not take a degree he became a prominent specialist on freshwater algae and was also highly competent in the fields of floristics, phanerogam taxonomy, nomenclature and the history of Botany. Reviews of literature covering various fields were largely written by Nordstedt.

Like his predecessors, Nordstedt ran the journal as a private enterprise. In 1915, after 45 years as Editor, he stated in an Editorial that economic problems would soon make it impossible to publish *Botaniska Notiser* and that as *Svensk Botanisk Tidskrift* had now begun to appear (since 1907) *Botaniska Notiser* would, moreover, soon be superfluous. He proved to have been too pessimistic. He himself was to edit *Botaniska Notiser* for a further six years and the journal has survived until 1980.

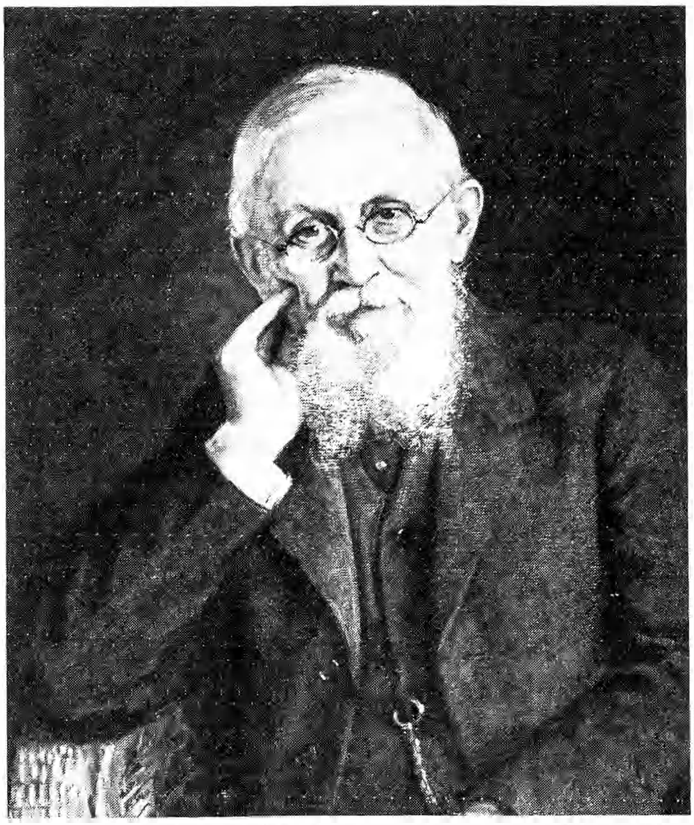

Fig. 2. C. F. O. Nordstedt. Oil painting by A. Stenbäck, c. 1905(?), Botanical Museum, Lund.

During the whole of Nordstedt's period *Botaniska Notiser* appeared every second month.

The period of honorary Editors under the Lund Botanical Society (1922–1975)

Since the end of 1921 *Botaniska Notiser* has been owned by the Lund Botanical Society who still owns it. In 1922 the format was changed. Still greater emphasis was laid on the scientific content. Most of the extensive literature reviews disappeared, and reports from the Society were given more space. Reports from other societies both in Sweden and in other Scandinavian countries had gradually become fewer as new journals appeared.

The first Editor who was not also the personal owner of the journal was H. Kylin (1879–1949, Professor of Plant Physiology in Lund from 1920). He was succeeded in 1929 by N. Sylvén (1880–1969, Head of the Institute for Breeding Forest Trees in Ekebo, Svalöv, from 1938 and Honorary Professor from 1940).

H. Weimarck (1903–1980, Professor of Systematic Botany in Lund from 1950) became Editor in 1938. The page size was increased in 1939 and this volume also has the greatest number of pages (856) ever in the history of *Botaniska Notiser* (see below, Special issues).

H. Hjelmqvist (b. 1905, Honorary Professor from 1977) was Editor from 1950 to 1953, and T. Norlindh (b. 1906, then Keeper of the Botanical Museum, Lund, Professor of Systematic Botany in Stockholm from 1965) was Editor during 1954 and 1955. H. Weimarck returned as Editor during 1956 and 1957 and H. Hjelmqvist from 1958 to 1964.

B. Nordenstam (b. 1936, Professor of Systematic Botany in Stockholm from 1980) was Editor during 1965 and 1966. He was followed by R. Dahlgren (b. 1932, Professor at the Botanical Museum, Copenhagen, from 1972), Editor during 1967 and 1968. The layout was somewhat modernized at the beginning of 1967.

I. Björkqvist (b. 1931, 'Universitetslektor', Department of Plant Taxonomy in Lund) was Editor during 1969 and 1970 and A. Strid (b. 1943, Professor of Systematic Botany in Copenhagen from 1972) was Editor from 1971 till the first issue of 1972. Some further changes in layout were made at the beginning of 1971, the most important being the introduction of two columns instead of one. The sponsor, the Swedish Natural Science Research Council, stipulated that *Botaniska Notiser* should be an international forum for phytotaxonomy (see Kylin 1980 p. 445). From 1971 papers in Swedish and papers dealing with the fields of Ecology, Phytosociology and Scandinavian Floristics were no longer to be published.

G. Weimarck (b. 1936, 'Docent', Department of Plant Taxonomy in Lund) was Editor from the second issue in 1972 till 1975).

Botaniska Notiser generally appeared every second month until 1938 (sometimes two or three issues were distributed jointly). In 1939 five issues were published. From 1940 onwards the journal has been quarterly.

The period of professional Editors (1976–1980)

At the end of 1975 an important change in organization was inaugurated. For the first time one Editor and one, later two, Assistant Editors received a salary from the Swedish Natural Science Research Council instead of working on an honorary basis (see Kylin 1980 p. 448), a most promising development now to be brought to an end as regards *Botaniska Notiser*.

In 1976 T. Karlsson (b. 1945) was appointed part-time Editor of *Botaniska Notiser* (and of the monograph series *Opera Botanica,* the journal *Svensk Botanisk Tidskrift* and its associated series of provincial Floras). He continued to edit *Botaniska Notiser* till the end of 1979 and is now Editor of *Svensk Botanisk Tidskrift* and the provincial Floras.

G. Weimarck returned as Editor of *Botaniska Notiser* during 1980.

Economic restrictions have now led to the amalgamation of *Botaniska Notiser* and other journals into the coming *Nordic Journal of Botany* from 1981. The owner of *Botaniska Notiser,* the Lund Botanical Society, has had to accept that the journal ceases to appear but has passed a resolution to the effect that it is not to be given up irrevocably.

Printers

During the first unsettled period *Botaniska Notiser* changed printer repeatedly. From 1871 onwards two printers in Lund stand out. Fifty-eight volumes have been printed at Berling's, from 1839 to 1841, from 1871 to 1921 and from 1976 (when the change-over to offset was made) to 1979. Fifty-four volumes have been printed at Blom's, from 1922 to 1975. As a matter of interest can be mentioned that Blom himself led the business for almost the whole of this period; see *In memoriam Carl Blom 1888–1972* (1972 p. 541). By contrast, the satisfactory dealings with Borgström's, Motala, are unfortunately to cease after one year only.

Contents of Botaniska Notiser

The analysis of trends in Botany based on Figures 3–7 is a difficult and somewhat intricate task. Mere quantitative estimates of what has been published in various fields give no hint of the possible qualitative value of the contributions, nor of their bearing on scientific development. It should also be borne in mind that much botanical research undertaken in Scandinavia has been published in other serials belonging to academies, universities or societies both in Scandinavia and other countries or in the form of monographs that have at most been reviewed in *Botaniska Notiser*.

In Sweden many other botanical journals and monograph series have appeared: *Acta Horti Bergiani*, Stockholm (1890–1966), *Acta Horti Got(h)oburgensis*, Göteborg (1924–1966), *Acta Phytogeographica Suecica,* Uppsala (1929–), *Arkiv för Botanik,* Uppsala (1903–1949, *Ser. 2* 1949–1974), *Botanica Gothoburgensia,* Göteborg (1963–), *Grana Palynologica,* Uppsala (1954–, from 1970 under the name of *Grana*), *Kungl. Vetenskaps- och Vitterhetssamhället. Acta Botanica*, Göteborg (1972–), *Svensk Botanisk Tidskrift,* Stockholm/Uppsala (1907–), *Svenska Växtsociologiska Sällskapets Handlingar,* Uppsala (1923–1926), *Symbolae Botanicae Upsalienses,* Uppsala (1932–), and *Wahlenbergia. Acta Botanica Umensia,* Umeå (1975–). In addition a number of mimeographed series have been and still are published by Departments and provincial authorities. A number of 'mixed' series accepting botanical papers among others have also been published.

From 1823 onwards several journals accepting botanical papers have followed one another in Norway, the latest being *Norwegian Journal of Botany. Botanisk Tidsskrift* appeared in Denmark from 1866 onwards. Finland also had and still has a number of journals that publish botanical papers.

The pan-Scandinavian journals *Hereditas* (1920–), *Physiologia Plantarum* (1948–), *Oikos* (1949–), *Holarctic Ecology* (1978–), *Boreas* (1972–) and *Lethaia* (1968–) accept contributions on Genetics and Chromosome Research, Plant Physiology, Ecology and Phytosociology, Quaternary Biology, and Palaeontology and Stratigraphy (including Palaeobotany), respectively.

Thus *Botaniska Notiser* has been only one of many possibilities offering within the subject of Botany in Scandinavia. However, some obvious trends can be noted, some of which will be mentioned here.

Fields (Fig. 3)

(1) *Systematics and Nomenclature of phanerogams*. With the exception of the period between c. 1875 and 1885 this field has generally been one of the more prominent in *Botaniska Notiser*. The conspicuous rise from about 1960 onwards is largely due to contributions from botanical activity at Lund. During the latest 5–10 years schools at Göteborg, Uppsala and Stockholm, and also authors from abroad, have added considerably to this field.

(2) *Systematics and Nomenclature of cryptogams*. A peak in the 1850's corresponds with an awakening interest in lichenology and bryology, perhaps connected with Thedenius's period as Editor. Other peaks in the 1870's, 1880's and 1890's may be partly ascribed to C. F. O. Nordstedt's and, perhaps, J. G. Agardh's personal contacts, and in the 1930's, 1940's and 1950's partly to the activity of H. Kylin's students (see Almborn 1980 p. 460). The expansion noted during the last five or six years can be largely attributed to contributions from Göteborg, Uppsala and, to some extent, from North American authors.

(3) *Morphology, Anatomy, Cytology and Embryology of phanerogams*. A great interest in vegetative morphology, under the influence of German botanists, such as H. von Mohl, can be noted from about 1875 to 1895. Later, Swedish authors contributed a considerable number of embryological papers as have also members of the Maheshwari school in India during the 1960's and 1970's.

(4) *Morphology, Anatomy and Cytology of cryptogams*. In general this has been a minor field in *Botaniska Notiser*.

(5) *Genetics and Chromosome research*. The birth of modern Genetics in 1900 gave almost immediately rise to a spate of articles in *Botaniska Notiser*. After a decline in the 1920's (the journal *Hereditas* first appeared in 1920) contributions to this field again appeared in *Botaniska Notiser* from about 1929. The field has generally been one of the major ones, in particular from about 1936 to 1946 when several plant geneticists at Lund published frequently, and from about 1968 to 1975 when a number of taxonomists, likewise at Lund, were very active

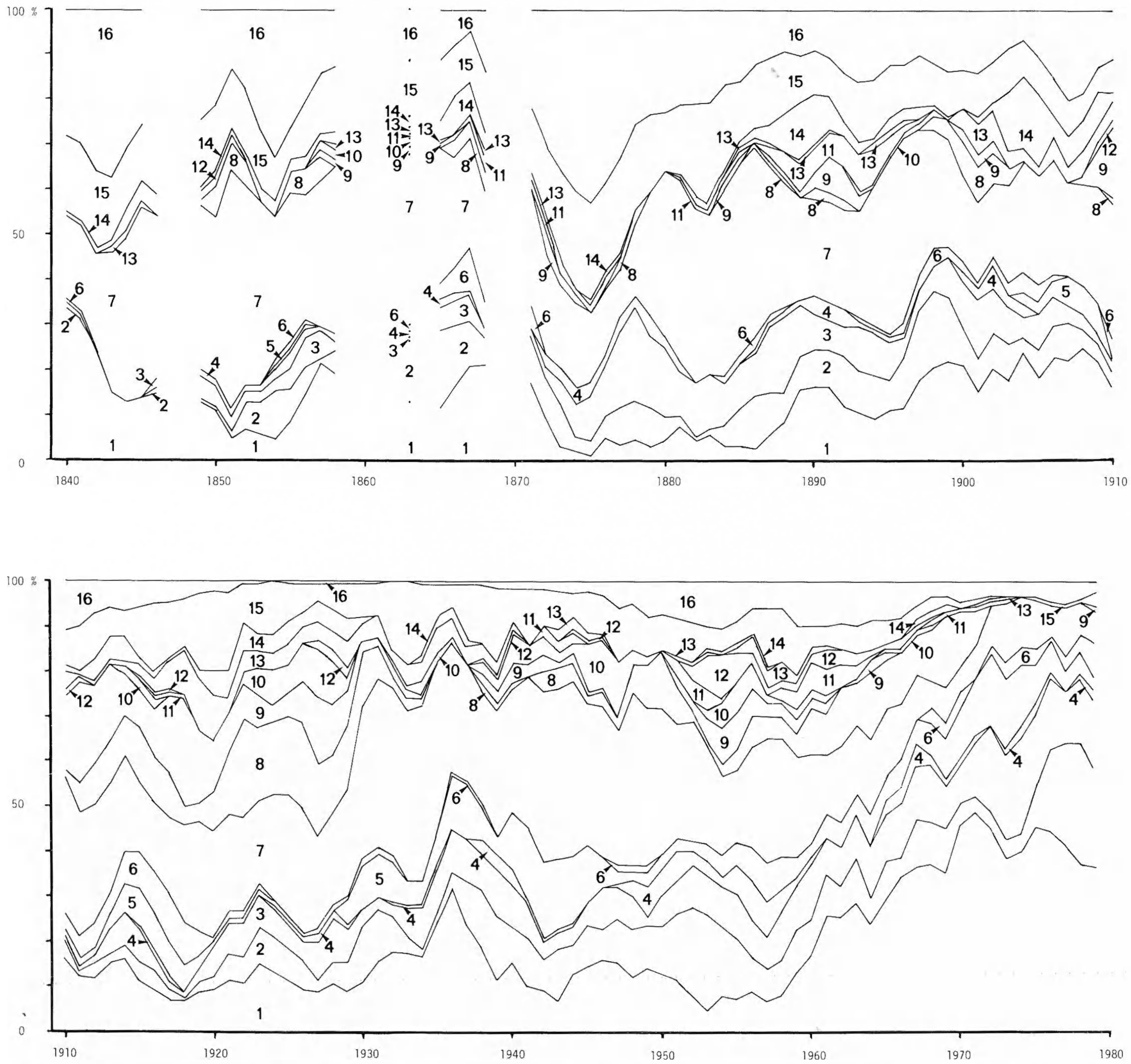

Fig. 3. Percentual distribution of the contents of *Botaniska Notiser* classified under 16 headings: (1) Systematics and Nomenclature of phanerogams, (2) Systematics and Nomenclature of cryptogams, (3) Morphology, Anatomy, Cytology and Embryology of phanerogams, (4) Morphology, Anatomy and Cytology of cryptogams, (5) Genetics and Chromosome research, including chromosome number reports, (6) Biology of reproduction and dispersal, and Population Biology, (7) Floristics and Phytogeography, (8) Ecology, Phytosociology and Soil Science, (9) Physiology and Phytochemistry of phanerogams, (10) Physiology and Phytochemistry of cryptogams, (11) Quaternary Biology and Palaeo-ethnobotany, (12) Pre-Quaternary Palaeobotany, (13) Terathology, Pathology and Applied Botany, (14) Polemics, (15) Miscellaneous, including reports from societies, biographical notes and the history of Botany, (16) Bibliographies and literature reviews. Number of pages in relation to total; gliding three-year arithmetic means.

in chromosome research with applications to Systematics.

(6) *Biology of reproduction and dispersal, and Population Biology*. This field, though only occasionally represented, contains much of scientific interest. A first peak in the 1860's is clearly connected with the interest in the field initiated by Darwin. The period from about 1911 to 1918 is notable for a series of papers on the

mechanisms of dispersal. In recent years the main interest has focussed on the evolutionary effects of isolation and on pollination biology.

(7) *Floristics and Phytogeography*. For long periods this field has dominated quantitatively, which could be expected with a view to the scope of the journal up to about 1970. Amateurs and professionals with an interest in floristics have usually been accorded a liberal amount of space. Floristics had its last peak in *Botaniska Notiser* from about 1939 to 1952. This was a period of great floristic activity at Lund (above all the flora of Skåne, the southernmost province of Sweden, was investigated in detail). An additional factor that increased the emphasis on local problems during the first half of the 1940's was the fact that war made field work and herbarium studies abroad difficult or impossible, and contributions from foreign botanists were virtually non-existent.

From 1971 floristic material from Scandinavia ceased to appear in *Botaniska Notiser* in accordance with the wishes of the sponsor, the Swedish Natural Science Research Council (see Kylin 1980 p. 445). Floristic papers published in *Botaniska Notiser* after 1971 deal with extra-Scandinavian, mainly Mediterranean, material. The present very keen interest in the flora of Scandinavia is now instead an important source of material for *Svensk Botanisk Tidskrift* and its associated series of Floras.

(8) *Ecology, Phytosociology and Soil Science*. The first major peak within this field in *Botaniska Notiser*, in the 1920's, coincides with a period of rapid development within Phytosociology in Sweden, mainly at Uppsala but also at Stockholm and Lund (see below). The increase in the number of pages published from about 1960 arose almost entirely out of activities at Lund which led to the establishment of a separate Department of Ecological Botany (see Almborn 1980 p. 468). That contributions ceased abruptly in 1971 was, however, the result of the abovementioned change in the scope of *Botaniska Notiser* enforced by the sponsor.

(9), (10) *Physiology of phanerogams and cryptogams, and Phytochemistry*. As regards phanerogams the two major periods (from about 1909 to 1914 and from 1917 to 1920) coincide with the periods of office of B. Jönsson and B. Lidforss, both Professors at Lund, and with the period of competition when the Chair of Botany became vacant after H. Nilsson-Ehle (see Almborn 1980 p. 470). The major period for both phanerogams and cryptogams, from about 1922 to 1929, saw many papers by the first generation of H. Kylin's students.

The peaks in the mid 1940's and the mid 1950's represent few but comprehensive papers; the first of the two peaks immediately precedes the establishment of *Physiologia Plantarum* in 1948, and the papers causing the second were perhaps in general too long for this journal. Physiology has contributed little to *Botaniska Notiser* since about 1960.

A few contributions to Phytochemistry have appeared in the last two decades.

(11), (12) *Quaternary Biology, Palaeo-ethnobotany and Pre-Quaternary Palaeobotany*. These fields have not taken up much space in *Botaniska Notiser*. A period of active publishing in Quaternary Biology from about 1888 to 1895 is mainly connected with the pioneering Sernander school at Uppsala.

(13) *Terathology, Pathology and Applied Botany*. None of these fields have taken up much space and for long periods they were only occasionally represented. A long series of papers, however, by O. Gertz at Lund on zoocecidia and morphological anomalies can be traced from about 1915 to 1930.

(14) *Polemics*. Though nowadays non-existent in the pages of *Botaniska Notiser* polemics have at times been quite prominent. Such articles naturally tend to appear in series of attacks and replies appearing in several issues and volumes.

One such batch around 1890 concerned Physiology and functional Morphology and another, around 1905, the Phytogeography of North Atlantic marine algae. A long period of controversy lasted through the 1920's and concerned phytosociological methodology (see below pp. 438, 439).

(15) *Miscellaneous*. Reports from society meetings, obituaries, announcements, etc. occupied a considerable amount of space up to about 1960. From 1970 onwards this material has almost disappeared. Biographical data and historical surveys are responsible for the peaks in 1933, 1938, 1958 and 1980 when special issues were publis-

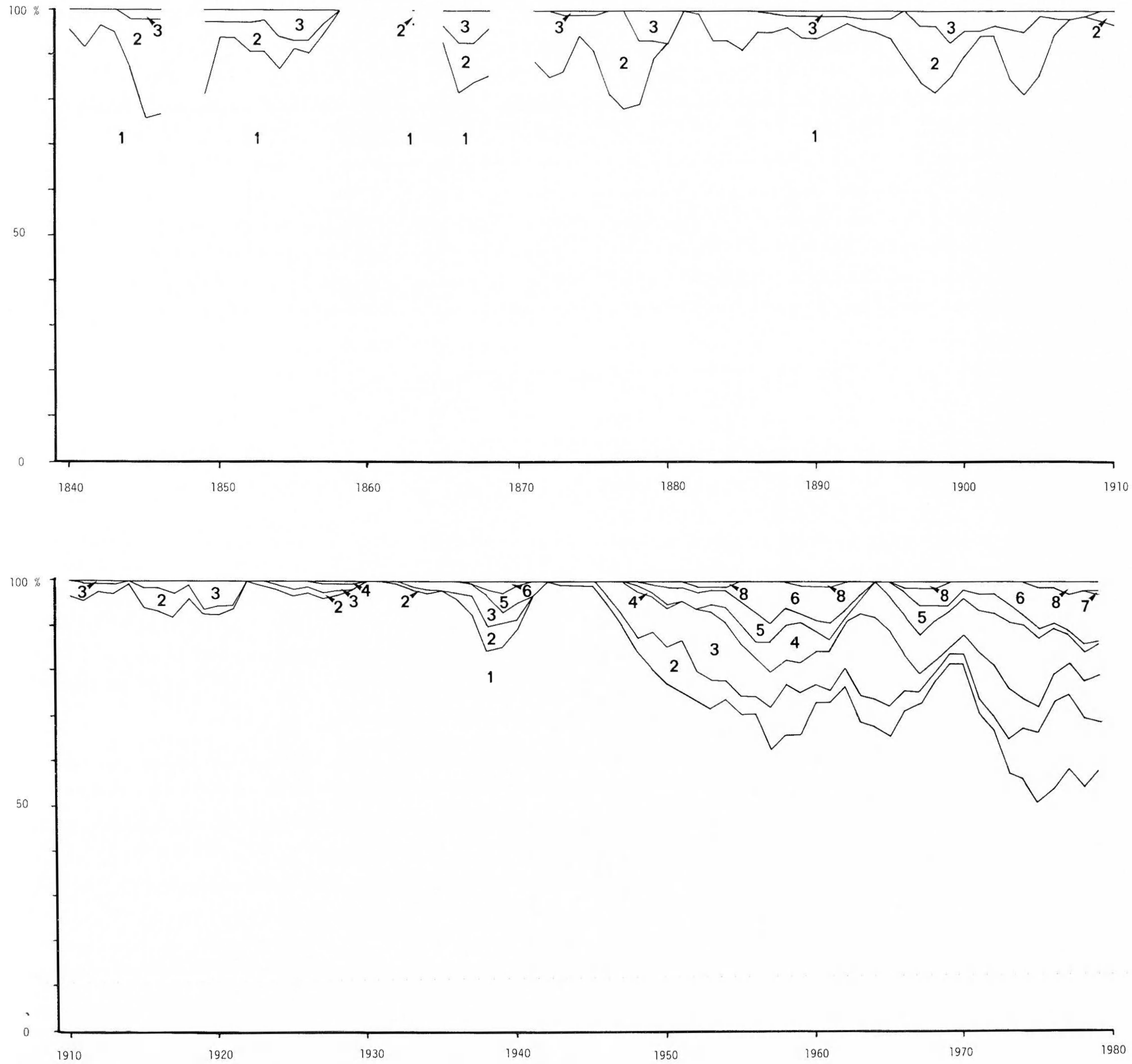

Fig. 4. Percentual distribution of contributions by authors from (1) Sweden, (2) Denmark, Finland, Iceland or Norway, (3) the rest of Europe, (4) Asia, (5) Africa, (6) North America, (7) South America, (8) Australia. Number of pages in relation to total; gliding three-year arithmetic means. Only contributions under headings 1–14 included (see Fig. 3).

hed (see p. 427). In 1920 a comprehensive Appendix was published (see p. 427).

(16) *Bibliographies and literature reviews.* The extent to which these are included depends largely on the Editor. From the beginning one of the major purposes of *Botaniska Notiser* was to publish literature reviews which for a long time occupied a fair amount of space. The reviewing activity gradually declined during Nordstedt's last ten years (1912–1921) and did not increase again appreciably until after 1945.

Authors (Fig. 4)

Generally, most of the contributions to *Botaniska Notiser* have been by Swedish authors, in some years all of them. Authors from Denmark, Finland, Iceland and Norway have contributed up to a third at most, usually far less. Until after

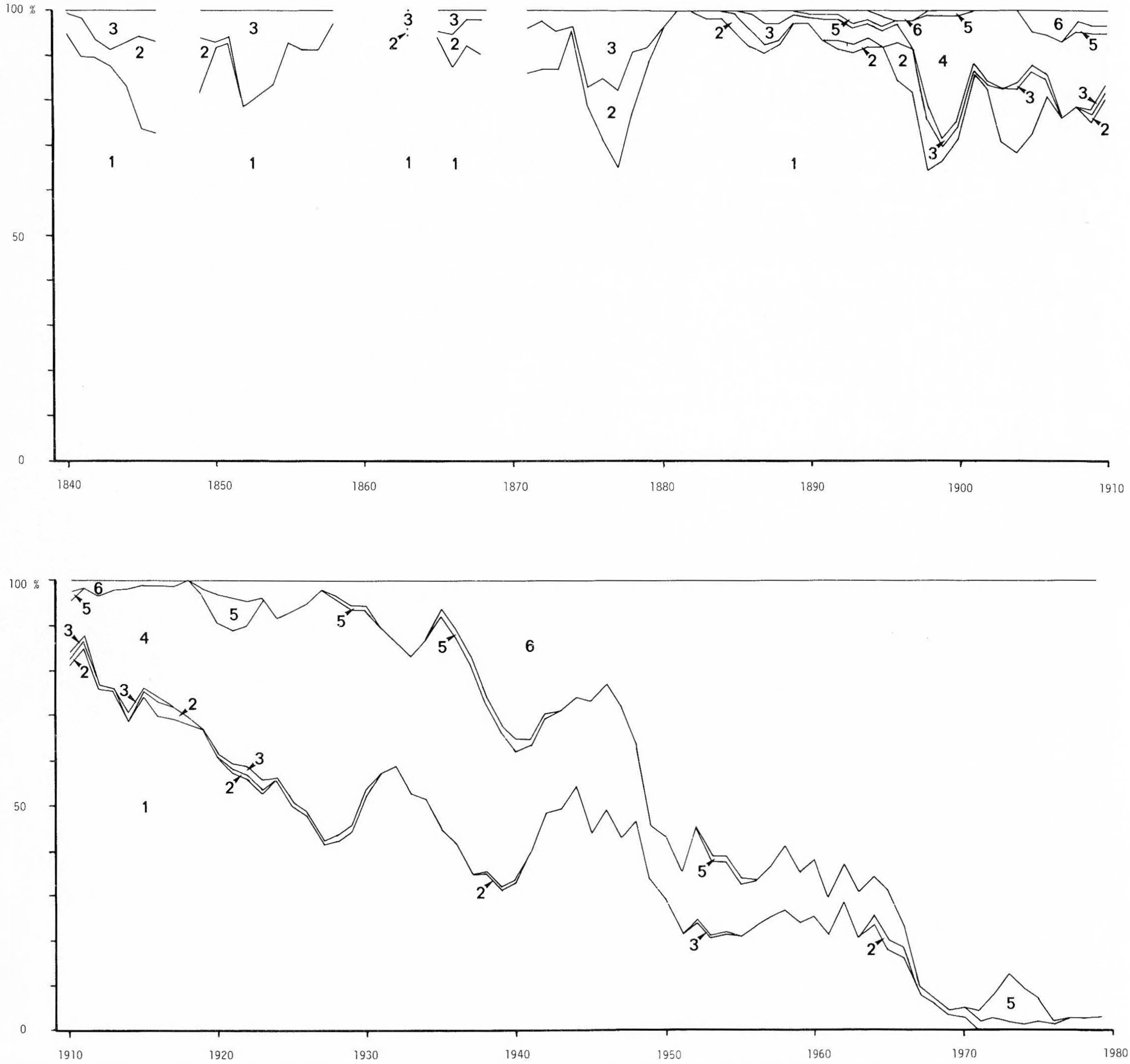

Fig. 5. Percentual distribution of contributions written in (1) Swedish, (2) Danish or Norwegian, (3) Latin, (4) German, (5) French, (6) English. Number of pages in relation to total; gliding three-year arithmetic means. Only contributions under headings 1–14 included (see Fig. 3).

the Second World War contributions from the rest of the world were rare. Some papers, especially from the 19th century, are in the form of translations from original papers published elsewhere. The special issues appearing in 1938 and 1939 contain a number of solicited papers from abroad.

Contributions of a high quality from abroad have long been welcome and have added to the repute of the journal. The fact that there has been a positive response from foreign authors is evident, in particular during the last ten years.

Language (Fig. 5)

Originally *Botaniska Notiser* accepted papers written in Swedish, Danish, Norwegian or Latin. Till about 1920 Swedish was by far the commonest language, written by Swedes and Swedo-Finns. There were some contributions in

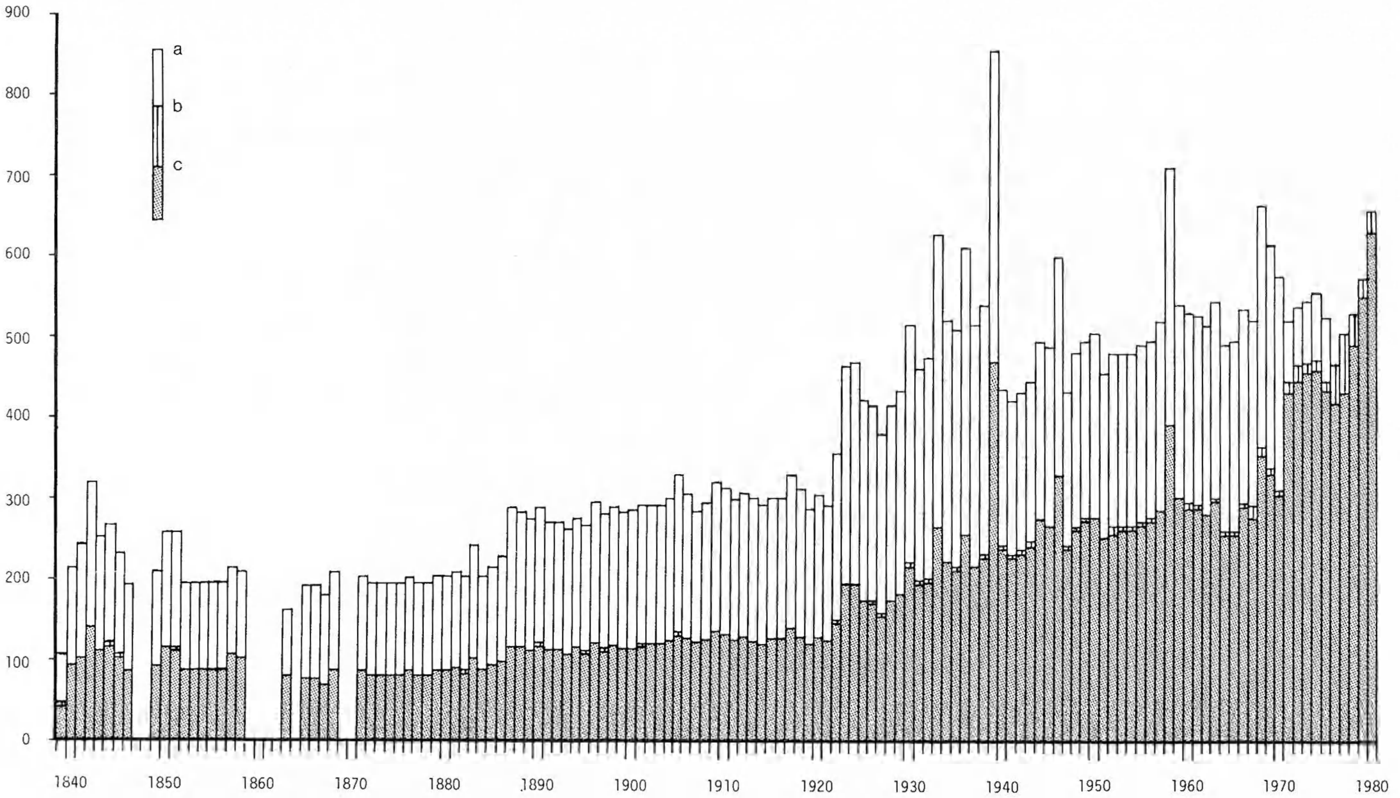

Fig. 6. Number of printed pages per volume. Symbols: (a) total number of pages exclusive of tables of contents, indexes or plates with separate pagination or without pagination, (b) as (a) but after multiplication by a correction factor for varying number of characters and spaces per printed page of the main text during different periods—the factor is set at 1.00 for 1976–1980, (c) as (b) but after excluding blank pages.

Danish or Norwegian. Latin was favoured by a few authors, mostly for papers on Systematics or Morphology, very rarely for Floristics. This was natural as it can be presumed that systematists or morphologists were proficient in Latin. Moreover, the papers were of international interest. Latin was indisputably the scientific language of the mid 19th century; even the controversy (1857 pp. 164–174) between W. Nylander and T. M. Fries on a lichenological monograph written by the latter was published in Latin.

German, French and English did not appear till 1887, 1891 and 1896 respectively. German, the second major language from about the turn of the century (at times even surpassing Swedish), was less frequently used after the Second World War, quite a number of Swedish and other non-English-speaking authors changing from German or Swedish to English.

Contributions written in French have not been common; the peak in the 1970's is almost exclusively due to a series of papers by a single author.

By the 1960's Swedish had almost disappeared except in floristic reports which were of mainly national interest. By the stipulation of the sponsor (the Swedish Natural Science Research Council) no more papers in Swedish have appeared since 1971.

Thus, in *Botaniska Notiser* the trends in language used have been largely the same as in *Geologiska Föreningens i Stockholm Förhandlingar,* a Swedish journal whose history is in many respects comparable with that of *Botaniska Notiser* (cf. Bengtson 1980 p. 413).

It is quite obvious that many of the papers in *Botaniska Notiser* have in fact contributed to scientific development (see below). The impact, however, was not so great when they were written in a Scandinavian language—they have been unduly ignored and will, regrettably, remain so.

Number of pages per volume (Fig. 6)

No decrease in the number of pages published in *Botaniska Notiser* occurred when *Svensk Botanisk Tidskrift* was established in 1907, nor when other journals (see p. 420) appeared. There was obviously sufficient material for all the journals.

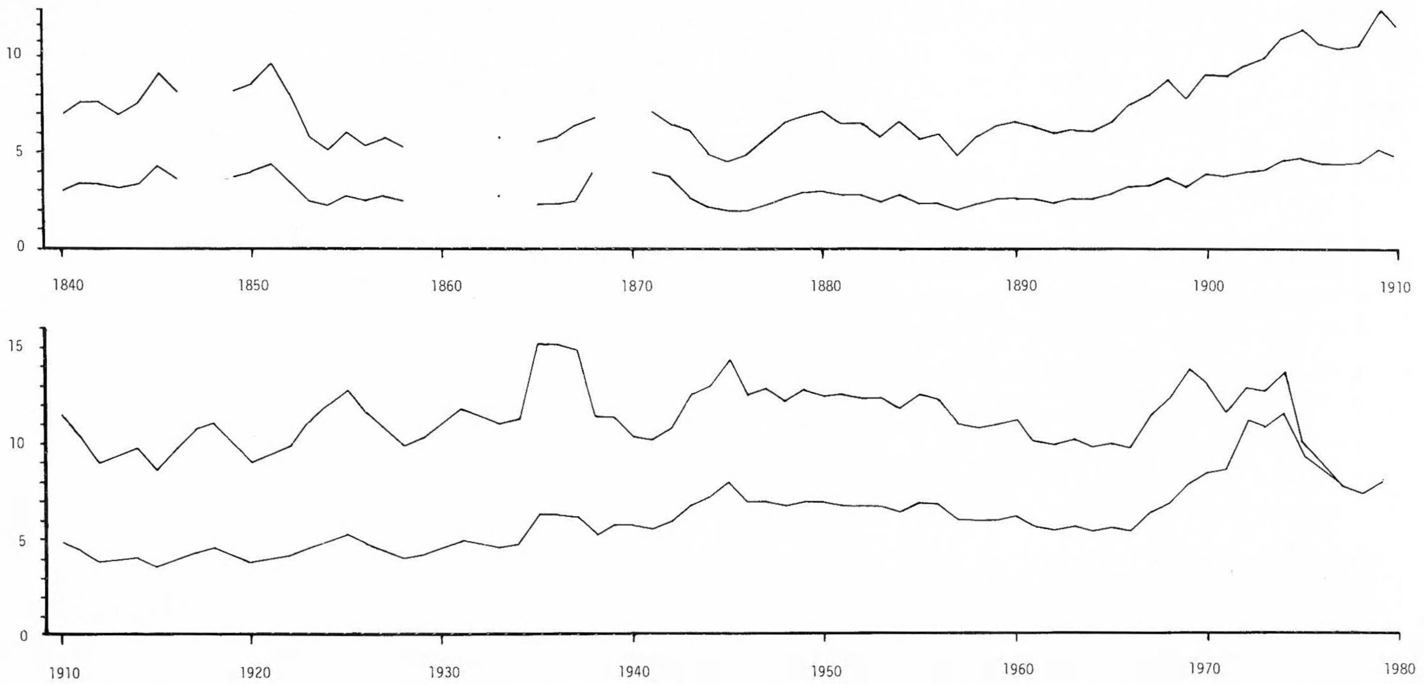

Fig. 7. Mean number of pages per contribution. Upper curve: without correction for varying number of characters and spaces per printed page of the main text during different periods. Lower curve: after multiplication by a correction factor—the factor is set at 1.00 for 1976–1980. Gliding three-year arithmetic means.

One has to admit, however, that many of the papers were rather lengthy.

The number of pages in a volume has increased about 2.8 times from the period 1839–1880 to the present day. The amount of printed material (estimated from the number of characters and spaces) has increased about 6.2 times, thanks to a more rational use of space (changes of layout in 1865 and 1882 were, however, changes in the opposite direction). The most effective change was made in 1971. The change made in 1976 may seemingly imply a lack of economy as the number of blank pages increased (see hatched area in Fig. 6). However, as T. Karlsson pointed out in an Editorial (1976 pp. 1–4) the gain in this case lies in the more rational production of offprints since all papers now begin on a right-hand page.

The present volume (Vol. 133, 1980) is the largest ever in terms of printed material.

Number of pages per contribution (Fig. 7)

Before 1868 the average number of printed pages per contribution was low (about 3 after correction for varying numbers of characters and spaces per page). This is to some extent an artificial assessment as many comprehensive papers were divided into short sections, each issue usually comprising 16 pages only. From about 1875 to 1945 there was a slight rise in the average of number of pages (after correction), then a gradual decrease perhaps related to the fact that the longest contributions could be published in *Botaniska Notiser Supplement* from 1947 to 1954 and after that in *Opera Botanica*; the arithmetic mean is sensitive to highly deviating values even when they are not very frequent. For some reason the average length of the papers began to increase in 1966 and by 1972 had reached the double. The general reader, however, prefers a number of short papers in each issue rather than the reverse and counter-measures were introduced. In addition, from 1976 the scientific, internationally relevant material that would previously have been published in *Svensk Botanisk Tidskrift* was submitted to *Botaniska Notiser* (see Kylin 1980 p. 445), and much more stringent measures became possible (and necessary). The number of pages per contribution has still only come down to the 1945 level in spite of editorial exertions and the strict adherence to a 32-page limit, papers exceeding this limit to be published in *Opera Botanica*.

Special issues

Special issues in *Botaniska Notiser* have appeared as follows:

1933 (1–3, issued jointly): celebrating the 75th anniversary of the Lund Botanical Society.

1938 (1–3, issued jointly): in memory of the former Editor of *Botaniska Notiser,* C. F. O. Nordstedt, on the 100th anniversary of his birth.

1939 (1): dedicated to H. Kylin, Professor of Plant Physiology, Lund, on his 60th birthday.

1939 (2): celebrating the 100th anniversary of *Botaniska Notiser.*

1939 (4): dedicated to S. Murbeck, Emeritus Professor of Plant Systematics, Lund, on his 80th birthday.

1943 (2): dedicated to Heribert Nilsson, Professor of Plant Systematics, Lund, on his 60th birthday.

1958 (the entire volume): celebrating the 100th anniversary of the Lund Botanical Society.

1963 (2): dedicated to H. Weimarck, Professor of Plant Systematics, Lund, on his 60th birthday.

1966 (2): dedicated to T. Norlindh, Professor of Plant Systematics, Stockholm, on his 60th birthday.

1972 (4): dedicated to Vivi Täckholm, Professor of Botany, Cairo, Egypt, on her 75th birthday.

1980 (4): devoted to botanical research as related to Lund and including the history of *Botaniska Notiser.*

It should be kept in mind that as a special issue contains at least some solicited contributions this affects the distribution of material as illustrated in Figs. 3–5.

Appendices

Comprehensive appendices with separate pagination have accompanied *Botaniska Notiser* on four occasions: surveys of literature appeared in 1842–1844 in this form (110, 62 and 70 pp. respectively), and in 1920 the catalogue *Prima Loca Plantarum Suecicarum* (IV + 95 pp.) by C. F. O. Nordstedt. This catalogue, with amendments in 1921 (p. 282), lists the first literature record for wild or naturalized plant species in Sweden.

Drawings of Scandinavian plants

A series of papers under the common heading of *Drawings of Scandinavian plants* was initiated in 1967. Scandinavian representatives of selected, 'difficult' genera were presented in line drawings accompanied by descriptions, additional notes and keys. The series comprises *Rosa* (nos. 1–8) by Ö. Nilsson (1967 pp. 1–8, 137–143, 249–254, 393–408); *Eleocharis* (nos. 9–16) by S.-O. Strandhede and R. Dahlgren (1968 pp. 1–10, 145–152, 305–311, 465–470); *Rubus* subgen. *Rubus* (nos. 17–44) by A. Oredsson (1969 pp. 1–8, 153–159, 315–321, 449–456; 1970 pp. 1–7, 213–219, 363–370, 447–454); *Juncus* (nos. 45–80) by Ö. Nilsson and S. Snogerup (1971 pp. 1–8, 179–186, 311–316, 435–441; 1972 pp. 1–8, 131–138, 203–211); *Chenopodium* (nos. 81–100) by L. Engstrand and M. Gustafsson (1972 pp. 283–286; 1973 pp. 1–6, 135–141, 273–276, 393–397; 1974 pp. 1–6, 159–164, 291–296, 457–463); and *Epilobium* sect. *Epilobium* (nos. 101–117) by A. Oredsson and S. Snogerup (1975 pp. 1–7, 203–207, 279–285, 375–379; 1976 pp. 5–9, 193–197; 1977 pp. 205–211).

Bibliographies

Bibliographies have from time to time been published in *Botaniska Notiser* covering literature published by Swedish botanists and in the earlier days also by Danish, Finnish and Norwegian botanists. The best-known series of bibliographies is T. O. B. N. Krok's covering Swedish botanical literature from 1858 till 1906 (published 1864–1907). These bibliographies also form part of the basis of Krok's *Bibliotheca Botanica Suecana* published in 1925 and covering Swedish botanical literature till 1918.

Bibliographies were again published in *Botaniska Notiser* from 1946 to 1966, covering the period from 1945 to 1965.

After a new hiatus similar bibliographies were published in *Svensk Botanisk Tidskrift* (1976–1978) for the years 1974–1976.

General Indexes

Two General Indexes have hitherto been published: one for the period 1839–1938 (X + 1107 pp., published in 1939) and one for the period 1939–1958 (294 pp., published in 1959).

A concluding General Index for the period 1959–1980 is in preparation and will be published separately in 1981.

The General Indexes have proved to be of great value for information retrieval. Many of the papers in *Botaniska Notiser* are of permanent interest, and modern computerized information retrieval does not go far back.

Supplements

The need for a supplementary series for comprehensive papers such as monographs resulted in the establishment of the new series *Botaniska Notiser Supplement* in 1947. By 1954 three volumes, in all eight papers (c. 1,350 pages), had been published.

The new series *Opera Botanica* first appeared in 1953. By the end of 1980 fifty-nine volumes (c. 10,000 pages) will have been published, each comprising one paper (or, up to 1966, more than one). *Botaniska Notiser Supplement* was, and *Opera Botanica* still is, owned by the Lund Botanical Society.

Miscellaneous

From the beginning and up to the turn of the century *Botaniska Notiser* was but sparsely illustrated, and the illustrations were generally in the form of separate plates, printing techniques and the quality of paper obviously not permitting of good text figures. The first text figures were floral diagrams (1850 pp. 130, 134, 137, 139). The first half-tone photographs in the text appeared in Astrid Cleve's paper on *Linum* (1897 pp. 61–64).

The first colour illustration I have found in *Botaniska Notiser* is a hand-painted plate in the 1855 volume, belonging to an article appearing in pp. 187–189, and illustrating *Pulsatilla patens* and *P. hackelii*. The first lithographic plates printed in colour are found in 1891, thereafter again in 1903. After 70 years without colour reproductions several have been published from 1973 to 1980.

The Edison electric bulb was recommended for microscopy in 1885 (pp. 106–108), remarkably early since Edison did not succeed with his bulb until 1879.

The first woman botanist I have found in *Botaniska Notiser* was Miss M. Levin, who is briefly mentioned in the proceedings of the Botanical Society of Stockholm (1888 p. 38). The first woman authors in the journal were Alida Olbers, who described a monstrosity (1895 pp. 119, 120) and Astrid Cleve, who reported an epiphytic alga in the same volume (1895 p. 247). Astrid Cleve appeared again in 1897 (pp. 61–64) with a paper on annual versus biennial *Linum catharticum*. She appears, however, as 'Hr' (=Mr) A. Cleve on the title page of the volume.

Advances in botanical research reflected in Botaniska Notiser

Any selection of papers is liable to be arbitrary. In the main I have tried to choose papers that have not merely contributed new information but that have also been instrumental in developing botanical research.

Systematics

The search for a natural system. The first issue of the 1839 volume of *Botaniska Notiser* comprises, apart from the Editorial, an essay on the approach of the spring. The author is Elias Fries, then Professor at Uppsala, but formerly active in Lund and from 1847 a member of the Swedish Academy. He presents a text that combines exact observation with almost poetic romanticism. Some sentences include philosophical statements such as "... in Nature, the most regular of realms, nothing happens by chance ...", "Nature is the greatest genius ..." (translated from the Swedish). Later contributions by Fries and others reveal the same thought, typical of the times, that the realm of Nature is governed by strict laws and is constantly striving towards perfection (see also a review of Fries's philosophical essay *Öfver naturens perfectibilitet* (On the perfectibility of Nature) by N. J. Andersson (1850 pp. 82–86). For Fries and many of his contemporaries this implied that organisms were arranged according to a 'natural system'. It remained for Man to discover the system and present it. Fries had attempted this is 1835 in his *Flora Scanica*.

After Fries not much can be read of the development of macrosystematics in the pages of *Botaniska Notiser*. References to the Engler system and to subsequent systems are occasionally found. J. G. Agardh, who presented a new classification of the algae which was adhered to for many decades, did not present it in *Botaniska Notiser*.

It is only of late years that macrosystematics has reappeared in the journal. The first version of R. Dahlgren's angiosperm system was published in *Botaniska Notiser* (1975 pp. 119–147). The system was presented and developed in a series of papers in the journal by Dahlgren (with collaborators) and by other authors (1975 pp. 148–180, 181–197; 1976 pp. 287–295; 1977 pp. 383–402; 1978 pp. 473–486; 1979 pp. 1–30, 319–324; 1980 pp. 337–341) as well as in other journals and a textbook. It is largely original but shares certain details with the earlier angiosperm systems of Thorne, Cronquist, Takhtajan and others and has been used to present diagrammatically the occurrence of a great number of characters many of which include chemical information. An interesting feature is that plants with a peculiar subtype of sieve-element plastids are placed in the superorder Caryophyllanae including Caryophyllaceae (H.-D. Behnke & R. Dahlgren 1976 pp. 289–291). The presence of this character warrants keeping this superorder intact though Caryophyllaceae does not share the occurrence of betalains with the other families of the superorder.

Early concepts of species and hybrids. On the basis of the presumed existence of a 'natural system' E. Fries and his confrères claimed that although a multitude of closely allied species obviously exist, hybrids between species are either non-existent or of no significance (see H. Weimarck 1958 pp. 81–122). In a series of articles in 1840 Fries (pp. 53–59, 85–92, 97–102) expounded his views on varieties, subspecies and hybrids. Written long before anything was known of evolution and genetics his contributions are of considerable historical interest.

At the time discussions on the species concept could not be conclusive as concerns genera where hybridism, polyploidy and apomixis occurs: *Salix* (E. Fries 1840 pp. 56–58, 90; N. J. Andersson 1846 pp. 97–103; A. N. Lundström 1875 pp. 146–149), *Rosa* (J. A. Leffler 1872 pp. 79–91, 150–156; 1873 pp. 114–117; 1874 pp. 38–39) and *Hieracium* (N. J. Andersson 1849 pp. 4–12, 25–28, in a survey of Fries's comprehensive treatise), etc. During the mid 19th century species-splitting was on the whole favoured rather than the reverse.

Now and then new finds gave rise to doubts concerning the old theories. W. Nylander reported (1854 pp. 62, 63) a claim from France that *Aegilops ovata* that had been cultivated for some years had changed into *Triticum sativum*. A debate was initiated (1854 pp. 128, 188, 189; 1855 pp. 77–82) and various explanations were proposed: the claim could be based on a mistake, the *Aegilops* could have been a generic hybrid from the start and reverted to one of its parents, or the two taxa involved could be conspecific. The Flood and the species chosen by Noah to be rescued in the Ark were discussed, as were the species concept and the relevance of hybridism.

The acceptance of Darwin's theories. Elias Fries (1840 pp. 97–99) was of the opinion that 'plastic Nature' adapts itself to external conditions and that the modification is retained after propagation. Among his illustrations he mentions reputed cases of dogs whose parents had had their tails docked, having been born without a tail. The idea underlying this was based on Lamarck's theories and was natural at a time when nothing was known of genetics and evolution.

The first author to mention Darwin's *On the origin of species* in *Botaniska Notiser* was N. J. Andersson (1863 pp. 3–7, 52–60) in an article dealing with J. D. Hooker's species concept and views on phytogeography and evolution. The concept of evolution as occurring by variation, competition and natural selection is presented in positive terms and its implications briefly explained. Andersson returned to similar problems in a review of Darwin's paper *On the movements and habits of climbing plants* (1866 pp. 41–48, 70–76).

Darwinism was also to affect the species concept and Quaternary Biology, etc. (see below).

The nature of lichens. An important achievement was reported in a review in 1872 (pp. 54–56). Rees had succeeded in synthesizing a *Collema* from its ascospores and a *Nostoc* culture, thus confirming Schwendener's view presented in 1868 and 1869 that lichens are a combination of a fungal mycelium and an alga, a concept that most lichenologists refused at first to accept.

The rapid progress made in this field is reflected in subsequent volumes of *Botaniska No-*

tiser. Treub's attempts at synthesizing a heteromerous lichen were reviewed in 1873 (pp. 180–182) and the problem was again presented by J. Eriksson in 1875 (pp. 93–96) in a survey article. Further experiments were reviewed in 1878 (pp. 34, 35).

A new approach to taxonomy at the specific level. S. Murbeck, Professor of Botany at Lund from 1902 to 1924, was one of the first to introduce new kinds of problems and new techniques for solving them. In a series of papers in *Botaniska Notiser* he attacked problems concerning several groups of Scandinavian plants considered to be taxonomically 'difficult'. The longest papers are on *Potentilla,* group *Axilliflorae* (1890 pp. 193–235), *Agrostis* (1898 pp. 1–14), *Cerastium* (1898 pp. 241–268), *Rumex* (1899 pp. 1–42) and *Stellaria* (1899 pp. 193–218).

Murbeck's paper on the *Potentilla erecta-anglica-reptans* group is extremely interesting in the light of what we now know about the affinities between these taxa; see e.g., the comprehensive survey by Jones (1955). It is astonishing to see how closely Murbeck's interpretation approaches the current view (whether 'correct' or not). Murbeck treated the three species *P. erecta, anglica* (=*procumbens*) and *reptans,* and all three hybrid combinations. The treatment was based on herbarium material, field observations and material cultivated under experimental conditions. Seedsetting and pollen quality were studied. The hybrid *erecta* ♂ × *anglica* ♀ was produced artificially. *P. erecta* and *anglica* were found to be connected by continuous, variable and frequent hybrid swarms, *P. reptans* and *anglica* by swarms that are less so. The hybrid *P. erecta* × *reptans* varies little and does not connect the two species. Murbeck ascribed these differences to differences in backcrossing ability (though 'backcrossing' does not appear in his paper, neither does 'introgression' although he described the phenomenon as such, some fifty years before Edgar Anderson).

Murbeck did not accept Zimmeter's theory that *P. anglica* may be a hybrid ('*P. super erecta* × *reptans*'), partly because it is fertile. He knew, of course, nothing about polyploidy which is the main clue to the problem. I cannot, however, refrain from reproducing Murbeck's diagram showing the affinities between the taxa (Fig. 8); the only information lacking seems to be the chromosome numbers 2n = 28 for *P. erecta* and *P. reptans* and 2n = 56 for *P. procumbens.*

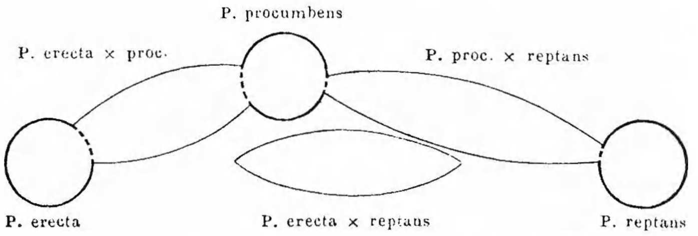

Fig. 8. Diagram showing affinities in *Potentilla* Group *Axilliflorae* (from Murbeck 1890 p. 226).

On the basis of information derived from the above experiments and from studies of *Arctium, Viola* and *Epilobium* Murbeck formulated two statements: (1) At the generic or subgeneric level the sexual reproductive affinity between taxa is directly related to the systematic affinity. (2) At the generic or subgeneric level the sexual reproductive capacity of hybrids is directly related to the systematic and sexual reproductive affinities between their parents. These statements were later to be called Murbeck's laws. He admitted that there were numerous exceptions but was convinced that the laws held good for many plant groups. Murbeck returned to the problem as late as 1943 (pp. 314–332).

The influence of early Genetics on the species concept. In the early 1900's the new advancements in Genetics caused chaos as regards the species concept. If one was to accept mutation and recombination, was it also possible to believe in morphologically definable Linnaean species? Romantic biology had proposed an 'idealistic' species concept, each species representing one 'idea' in Nature. Darwinistic biology had stressed a phyletic concept where similarity was interpreted as a token of relationship. A certain amount of variation within a species could be tolerated. Classification according to either concept agreed reasonably well.

Both concepts apparently broke down when Genetics showed that phenotypic similarity did not necessarily imply genetic similarity and vice versa. A strictly genetic species concept would, however, entail experimentation on an impracticably large scale. Moreover mutation was not properly understood and caused much confusion until the anomalous *Oenothera* system was explained by Renner in 1917 and Cleland in 1924. Before that de Vries's *Oenothera* observations published in 1901 were used as an example of speciation by mutation.

The subject was much debated in the pages of *Botaniska Notiser.*

B. Lidforss, *Rubus* specialist and plant physiologist at Lund, criticized (1907 pp. 241–261) some then current Swedish contributions to Botany. *Rosa, Capsella bursa-pastoris* and *Linnaea borealis* had become taxonomically 'pulverized'. Lidforss considered this to be a misuse of the concept of 'elementary species' current at that time. According to him Taxonomy could run the risk of reverting to the use of an outmoded species concept as the direct result of the progress in Genetics. For the classification of polymorphous genera he advocated detailed experiment. He had himself practised this as regards *Rubus,* with promising results. For example, one of his *Rubus* crossings had yielded a new, stable derivative, which he interpreted as an example of speciation by hybridization. (Moreover, in the same volume of *Botaniska Notiser* (1907 pp. 27–46, 49–61) T. Hedlund had strongly supported the view of speciation by hybridization, though some of his examples would now be rejected as they involve amphidiploidy, facultative apomixis, etc.) Even so, at that time Lidforss seems to have been more inclined to believe in speciation by mutation but he later abandoned this view.

We now know that the pattern of variation in all the plants involved above could hardly be understood at that time, even in the light of Lidforss's experiments. As we now know, *Rosa* owes its remarkable pattern of variation to the anomalous behaviour of the chromosomes during meiosis, *Capsella* to the occurrence of pure lines after autogamy, *Linnaea* to extensive cloning and *Rubus* to facultative apomixis. Lidforss was prevented from carrying out his intentions by his premature death. Others, in particular Å. Gustafsson, Professor of Genetics in Stockholm from 1947, in Lund from 1968, were to carry on the research.

H. Nilsson-Ehle, who was engaged in research which included plant breeding at Lund and Svalöv and who later became the first Professor of Genetics in Sweden, contributed a paper (1907 pp. 113–140) on biotype variation mainly in the autogamous cereal *Avena sativa.* He pointed out that the existence of autogamy, vegetative cloning or apomixis makes botanists more inclined to discern minor differences between biotypes (or elementary species, pure lines, pedigree sorts, etc.) and to give them names. Each biotype of an allogamous organism is generally made up of a single individual only, so that the biotype is much more difficult to discern in practice.

The two above-mentioned papers should be considered together. Nilsson-Ehle, who was mainly concerned with the practical application of research, could foresee the effects on variation of various modes of reproduction, but did not apply them taxonomically. Lidforss, who did mainly pure research, arrived at sound taxonomic conclusions though the full facts were not then available. Taken separately each of these two papers in *Botaniska Notiser* for 1907 thus to some extent miss the point. Taken together they provide a landmark in Botany though written independently. Simply, the time was ripe for such ideas to emerge.

In a later paper (1908 pp. 257–294) Nilsson-Ehle reported on further experiments with cereals. Using examples from wheat and oats he could show that it is not only those characters represented by two discontinuous character states (e.g., presence/absence of a feature) that are inherited according to Mendel's laws. Characters displaying seemingly continuous variation are also inherited according to these laws but are regulated by several or many hereditary factors. Even relatively few such factors may be responsible for a very great number of homozygous combinations, each representing one recognizable biotype (elementary species, etc.).These Mendelian factors may or may not affect external morphology and may be of importance for adaptation within species to variation in environment. A larger number of such factors can be presumed to be responsible for the differences between Linnaean species.

Shortly after these revolutionary theories had appeared in *Botaniska Notiser* Nilsson-Ehle published them in a more comprehensive form elsewhere.

Heribert Nilsson (1910 pp. 265–302), Professor of Systematic Botany at Lund from 1934, interpreted crossing experiments between *Arctium lappa* and *A. tomentosum* in the light of Mendel's laws. He could confirm Nilsson-Ehle's predictions regarding the polygenic segregation of species-specific characters in the hybrid offspring. By way of introduction he criticized excessive splitting as, for example, in *Rosa*. He also claimed that variation in apomictic *Hieracium* was due to segregation after occasional hybridism rather than to mutation. On the whole Heribert Nilsson has been characterized as an orthodox Mendelist but hardly as an evolutionist, and he was very sceptical about the concept of mutation, the only type of mutations that he accepted being loss-mutations.

The Dutch scientist J. P. Lotsy was later to use the term 'species' for constant, homozygous entities only, by contrast to the heterogeneous Linnaean species (review in *Botaniska Notiser* 1917 pp. 39–40). This attitude when applied to an extreme led to an unacceptable classification of species.

In 1922 G. Turesson, Professor of Systematic Botany and Genetics at Uppsala from 1935, was to suggest in his doctoral thesis published in *Hereditas* that the concept of taxonomic species, definable in terms of morphological discontinuity, should be separated from the biological entities, definable in terms of gene exchange and adaptation. In this way additional biological knowledge would not interfere with classification. As early as 1917 he anticipated this theory in a paper published in *Botaniska Notiser* (pp. 273–296) where he reports on physiological experiments with some seashore plants, chiefly *Atriplex*. He found that the branches of the experimental plants were plagiogeotropic in full light, thus producing the prostrate habit typical of the species concerned. Moreover, he had found that the prostrate habit in *Atriplex* can occur either as a hereditary characteristic in one 'race' or as a mere environmental modification in another, otherwise erect, 'race'.

This occurrence, within one and the same taxonomic species, of 'races' with genetically fixed morphological and physiological properties of adaptive value was later investigated by Turesson in greater detail in the above-mentioned thesis, where he coined the term 'ecotype' for them.

In *Botaniska Notiser* 1943 (pp. 413–427) Turesson proposed a parallel terminology for apomicts.

The difficulties in *Rosa* were eventually explained. The pattern of variation, especially that in the *canina*-roses, had puzzled botanists and led many of them to believe that apomixis occurred in the genus. For a long time this theory seemed to be supported by experimental evidence. G. Täckholm, in 1920 and later in his doctoral thesis in 1923, and also K. B. Blackburn and J. W. Heslop Harrison in 1921, reported 7 bivalents and 21, 28 or 35 univalents at meiosis in several *Rosa* species. A plausible explanation of this would be that hybridism had occurred between parents with different chromosome numbers, and that the hybrids had thus been made permanent by apomixis. However, in *Botaniska Notiser* (1931 pp. 21–30, 350–354) Å. Gustafsson presented the results of isolation and emasculation experiments made by himself and by C. Hammarlund. He concluded that the results of earlier observations presumed to indicate autonomous apomixis were either erroneous or had been misinterpreted. According to Gustafsson the *Rosa* species in question are either pseudogamous apomicts, or they are sexual. The latter theory would be fully compatible with the concept of their being heterogamous, permanent complex hybrids, as had been suggested by Blackburn and Heslop Harrison in 1921. In a later paper in *Botaniska Notiser* (1937 pp. 323–331) Gustafsson, however, favoured the former theory. The debate started anew, mainly in other journals.

Conclusive evidence in favour of sexuality was not presented until 1942 and then almost simultaneously by F. Fagerlind, Stockholm, in *Hereditas* and by Gustafsson and A. Håkansson, Honorary Professor at Lund from 1948, in *Botaniska Notiser* (pp. 331–343). Gustafsson and Håkansson were able to explain the extremely complex polymorphism of the *canina*-roses by the co-occurrence of three homoeologous sets of chromosomes. Hence a solution had at last been found to an unusually complicated problem that had been under debate in the pages of *Botaniska Notiser* since the first years of its existence.

Developments during the last few decades. In 1958 the first members of a new generation of taxonomists at Lund made their début (S.-O. Strandhede pp. 228–236; H. Andersson pp. 237–240; G. Nordborg (-Dahlgren) pp. 241–248; S. Snogerup pp. 249–250). They belonged to an experimental taxonomical 'school' initiated a few years earlier by H. Weimarck, Professor of Systematic Botany from 1950. Together with others who joined them somewhat later they mainly investigated evolutionary problems in N

European species groups complicated by polyploidy, aneuploidy, hybridism and (in some cases) apomixis.

In 1960 another 'school' at Lund came into being with a new series of papers under the heading of *Studies in the Aegean Flora*. The first paper, by H. Runemark, Professor of Systematic Botany at Lund from 1970, and collaborators (1960 pp. 421–450), was a floristic communication with some phytogeographical comments on the Aegean archipelago. The second, by B. Nordenstam, Professor in Stockholm from 1980 (1960 pp. 451–457), was a short taxonomic report. A major aim of the research in the Aegean has been to study karyotype diversification and morphological differentiation in small-population systems using experimental methods.

Both 'schools' still flourish side by side. During the 60's and 70's their combined productivity within the field of biosystematics has probably not been surpassed elsewhere. Conditions of mutual inspiration have perhaps acted as a spur. Most of the reports have been published in *Botaniska Notiser* and in *Opera Botanica* (Vols. 9(2), 10(2), 11(2), 13, 14, 16, 17, 19, 28, 32–35, 39, 41). A selection of problems dealt with follows:

Differentiation within complex aggregates in relation to polyploidy has been studied by I. Björkqvist in *Alisma* (1961 pp. 281–299); by G. Nordborg (-Dahlgren) in *Sanguisorba* (1963 pp. 267–288; 1967 pp. 109–119) where in addition facultative apomixis occurs; and by G. Weimarck in *Hierochloë* (1967 pp. 209–235, 448–455; 1970 pp. 231–268, 495–504; 1971 pp. 129–175; 1973 pp. 7–36) where the taxa studied vary in level of polyploidy, occurrence of apomixis and degree of clonal propagation.

Differentiation in relation to polyploidy and aneuploidy has been studied by S.-O. Strandhede in *Eleocharis* (1961 pp. 417–434; 1965 pp. 243–253; 1967 pp. 355–368), with holokinetic chromosomes; and by S. Snogerup in *Juncus* (1963 pp. 142–156).

Differentiation in morphology and chromosome structure in small populations of taxa with differing breeding systems in the E. Mediterranean area has been studied by A. Strid in *Nigella* (1965 pp. 139–165; 1968 pp. 153–164; 1969 pp. 9–19, 380–397); by W. K. Heneen and H. Runemark in *Elymus* (1972 pp. 419–429); by B. Bentzer in *Leopoldia* (1969 pp. 457–480; 1972 pp. 180–185, 329–330, 406–418; 1973 pp. 69–132; 1974 pp. 69–86); by R. von Bothmer in *Allium* (1970 pp. 518–550; 1972 pp. 62–76); and by M. Gustafsson et al. in *Brassica* (1976 pp. 73–84). A significant contribution to this field was also made by S. Snogerup for *Cheiranthus* but it was published in *Opera Botanica* in its entirety.

Differentiation in relation to varying breeding systems has been studied by Ö. Nilsson in *Montia, Claytonia* and related genera (1966 pp. 265–285, 464–468; 1970 pp. 119–148; 1971 pp. 87–121, 187–207).

Problems concerning adaptive variation in combination with hybridization and chromosome structural differentiation in *Atriplex* have been elucidated by M. Gustafsson (1973 pp. 345–392, 398–416; 1974 pp. 125–148).

Parallel variation in *Euphrasia* as an adaptation to climate and to various natural or man-made habitats has been neatly demonstrated by T. Karlsson (1976 pp. 49–60) who also stressed the importance of hemiparasitism in this context (1974 pp. 527–539).

Chemical variation has also been investigated: by K. Brunsberg in *Lathyrus* (1965 pp. 377–402); U. Olsson in *Mentha* (1967 pp. 255–267); and G. Weimarck in *Hierochloë* (1970 pp. 231–268) and in various taxa selected to represent different reproductive systems (1974 pp. 224–244). These studies have all made use of leaf phenolics. Allozyme variation in *Quercus* has been studied by U. Olsson (1975 pp. 408–411).

During the 1960's and 1970's B. Peterson, R. Dahlgren, B. Nordenstam and A. Strid studied the taxonomy and phytogeography of South African phanerogams (thus upholding a South African tradition from the 1930's and 1940's when T. Norlindh and H. Weimarck contributed to this field in *Botaniska Notiser* and elsewhere). Most of their results have, however, been published in *Opera Botanica*. In *Botaniska Notiser* can be noted papers by B. Nordenstam (1968 pp. 209–232) on evolution in *Euryops*, and R. Dahlgren (1970 pp. 551–568; 1971 pp. 292–304) on convergence, parallelism and analogy in *Leguminosae*, particularly *Aspalathus*, and in *Cliffortia*.

Investigations on embryo sac formation, including the mechanisms of apomixis

Double fertilization revealed. Considerable advances were made in Embryology round the turn of the century. Double fertilization in angiosperms was detected (review in *Botaniska Notiser* 1899 pp. 135, 136 of Navashin's and Guignard's observations; further comments 1900 p. 189).

Early research on apomixis. Another advance was the discovery of apomixis and the investigation of its mechanisms. Again we find Murbeck among the pioneers. He had already pointed out the peculiar mode of variation in *Alchemilla* in a preliminary notice (1895 pp. 264–266). From a series of experiments on cultivated plants including determination of pollen quality, analysis of progenies and field and herbarium studies he concluded (1897 pp. 273–277) that seed setting in the *Alchemilla* species studied takes place without fertilization. He realized that the morphological constancy within all *Alchemilla* taxa is due to apomixis. In 1902 he described the development of the embryo sac in *Alchemilla* in a comprehensive paper published elsewhere.

At about the same time O. Juel in Uppsala had described the apomictic mechanism in *Antennaria alpina* (summary of a lecture, *Botaniska Notiser* 1900 pp. 102, 103). C. Raunkiaer had concluded from indirect evidence that apomixis occurs in *Taraxacum* (review in *Botaniska Notiser* 1903 pp. 197, 198), and C. H. Ostenfeld and Raunkiaer did the same for *Hieracium*. However, Murbeck (1904 pp. 285–296) was the first to describe the development of the embryo sac in both *Taraxacum* and *Hieracium*. He concluded that the great number of *Hieracium* taxa endemic to small areas within the Scandinavian peninsula must have arisen there after the latest glaciation and suggested that speciation still occurs. Ostenfeld and O. Rosenberg, and Rosenberg alone, further investigated apomixis in *Hieracium* (review in *Botaniska Notiser* 1906 pp. 254–256).

Ideas had indeed changed considerably during the sixty-five years since the establishment of *Botaniska Notiser* and the fifty-five years since N. J. Andersson's survey of Elias Fries's treatise on *Hieracium* (1849 pp. 4–12, 25–28). It is also notable that Murbeck, by contrast to several other botanists, drew conclusions of biological significance from cytological, morphological or embryological observations.

Later research on apomixis. Later research has also focussed on problems concerning the genetic background of apomixis, the balance between apomixis and amphimixis, and the possibility of recombination within completely apomictic plants. A. Müntzing, Professor of Genetics at Lund from 1938, and G. Müntzing reported (1941 pp. 237–278; 1945 pp. 49–71) that F_1 hybrids between apomictic and amphimictic diploid strains of *Potentilla argentea* were amphimictic and gave rise to a highly variable F_2 generation. F_1 hybrids with one hexaploid parent were partly apomictic and F_2 plants ranged from being completely apomictic to completely amphimictic, indicating that their parents were heterozygous for many genes. The authors concluded that apomixis is controlled by multiple factors and that the genic balance is easily upset by hybridization.

A new and interesting contribution to our knowledge of the mechanisms of apomixis was made by R. B. Knox and J. Heslop-Harrison (1963 pp. 127–141). In a series of experiments they found that the light regime governed the incidence of apomixis in a tetraploid *Dichantium aristatum*, continuous exposure to short days increasing the numbers of aposporous sacs.

G. Turesson (1943 pp. 413–427; 1956 pp. 400–404; 1957 pp. 413–422; 1958 pp. 159–164) reported remarkable variation in chromosome number, morphology, earliness and disease resistance among strains of obligately apomictic *Alchemilla* taxa when compared with clonal material of the same taxa. This concept of variability is to some extent contradictory to previous views. Turesson found autosegregation to be the most reasonable explanation to the phenomenon.

This problem of variation was also investigated by A. Lundh-Almestrand (1958 pp. 587–607).

Variation in embryo sac formation. H. Hjelmquist, Honorary Professor at Lund from 1977, and F. Grazi (1964 pp. 141–166; 1965 pp. 329–360) showed that variation in environmental conditions can in a number of species give rise to the development of reduced embryo sacs according to different types, and to different ratios between reduced and unreduced sacs.

Genetics and Chromosome Research

Early Genetics and Cytology. From the turn of the century onwards the readers of *Botaniska Notiser* were kept informed of progress in Genetics and Chromosome Research. Mendel had published his remarkable results on hereditary factors in controlled crossings as far back as 1866, but his findings were not fully understood until 1900 and were generally overlooked. Mendel's now classic booklet *Versuche über Pflanzen-Hybriden* had in fact been cited in a Swedish thesis by A. Blomberg in 1872 and in a publication by Focke in 1881. This was pointed out by R. Larsson in *Botaniska Notiser* (1915 pp. 35–38) in a paper commemorating the 50th anniversary of Mendel's lecture in Brno where he reported on the results of his experiments.

In *Botaniska Notiser* 1900 (pp. 187–189) there appears a review of a paper by H. de Vries, one of the three 'rediscoverers' of Mendel. A survey of de Vries's results is given together with a reference to Mendel and an interpretation of the bearing on Systematics of the phenomenon of segregation.

The Danish geneticist W. Johannsen's pioneering experiments with pure lines in *Phaseolus* and *Hordeum* were reviewed and discussed in *Botaniska Notiser* immediately after publication (1903 pp. 246, 247).

Quite a number of papers describing Mendelistic segregation of character states in various plants were published during the following years, but the genre largely disappeared from *Botaniska Notiser* when the new journal *Hereditas* was established in Lund in 1920.

The connection between the behaviour of chromosomes and Mendelistic segregation was not known until Morgan made his discoveries, and was questioned by several scientists even much later (for example by Heribert Nilsson as late as 1930, p. 64).

O. Rosenberg in Stockholm was the first to publish detailed chromosome analyses in *Botaniska Notiser* (1905 pp. 1–24), where he described the meiotic prophase in the embryo sac mother cells in several plant species.

A few years later M. O. Malte (1908 pp. 75–87), then at Lund but later to work as an agrostologist in Canada for many years, found that the number of (heterochromatic) chromatin condensations in the interphase nuclei of some Euphorbiaceae agreed with the somatic chromosome number of the respective species. He also discussed the nature of chromosomes at a time when the role of chromosomes as carriers of genetic information was about to be revealed.

Research on induced mutations. In 1936 Å. Gustafsson (pp. 488–512) introduced a new field of research to the pages of *Botaniska Notiser,* viz. work on mutations induced by X-rays. Further contributions by Gustafsson and others appeared in *Botaniska Notiser* till the late 1950's, and in *Hereditas.* He found, for example, that chromosomes displayed varying sensibility to X-rays at various stages of the cycle of division, at various water contents, etc.

What is a B chromosome? G. Östergren, Professor of Genetics at Uppsala from 1963, forwarded the hypothesis (1945 pp. 157–163) that 'extra fragment' or 'accessory' chromosomes (= B chromosomes) may in some cases be regarded as 'parasitic', i.e., their presence may be of significance to themselves only. Previous workers had tried to find out the possible advantages to the organism carrying B chromosomes, not rarely in vain; in some cases they appear to be clearly harmful to the carrier.

The biology of reproduction and dispersal

In Darwin's footsteps. Elias Fries was opposed to Darwin's theory of evolution and could not accept the effect it had on the species concept and macrosystematics. His son, T. M. Fries, was of the same opinion. He, however, wrote favourable reviews (1866 pp. 24–32; 1867 pp. 74–86) of Darwin's paper on the pollination of orchids and of a paper by Hildebrand on the significance of allogamy.

The effects of cross- and self-fertilization in the vegetable kingdom, published by Darwin in 1876, was reviewed in 1877 (pp. 51–56). Darwin had shown experimentally that inbreeding is generally inferior to outbreeding. He believed, however, that self-sterility was accidental, not adaptive. Further he concluded that the evolution of anemogamy in angiosperms preceded entomogamy. These views, together with certain applications to human society, have not held good.

No doubt Darwin's (and Hildebrand's) studies on pollination biology served to awaken a new interest in this subject. As far back as 1868 T.

Tullberg published an original contribution (pp. 7–15) in this field, and other contributions were to follow.

Pollination biology of today. The interest in pollination biology, which had largely lain dormant since the period after Darwin, has now been revived and is reflected in the pages of *Botaniska Notiser* from 1976 onwards. This year B. Kullenberg and G. Bergström surveyed the results of extensive studies of pollination in *Ophrys* orchids over three decades. L. A. Nilsson, who cooperates with the Kullenberg group, has published a series of papers on the pollination biology of some Swedish orchids (1978 pp. 35–51, 355–368; 1979 pp. 329–347, 537–549; 1980 pp. 367–385). These studies have elucidated the very complex interactions between plants and pollinating insects where there is an interplay between macro- and microstructures, chemical and optical stimuli on the one hand and the response of the insect on the other, in affecting the evolution and the structure of the breeding populations of the orchids. A most remarkable system has, for example, been found in *Dactylorhiza sambucina* which attracts newly emerged *Bombus* queens though not offering them nectar. Experienced queens avoid this orchid. The pollination system has obvious connections with the gregarious occurrence of *D. sambucina* and with characteristic variations in its fruitsetting.

M. Iwarsson reported (1979 pp. 349–355) on African sun-birds as pollen vectors and I. Elvers (1977 pp. 231–234; 1978 pp. 159, 160) on lizards that, remarkably enough, may play a similar part.

The effects on population structure, evolution and taxonomy in the *Helianthemum oelandicum* complex of the presence of one strategy of concentrated flowering and one where flowering is protracted has been elucidated by B. Widén (1980 pp. 99–115).

Agents of dispersal. A series of publications in *Botaniska Notiser* by A. Heintze is devoted to the study of the dispersal of fruits and seeds. Two of the papers are on winter dispersal, on the island of Öland (1911 pp. 165–185) and on snow in the Scandinavian mountains (1914 pp. 193–215). Three others (1915 pp. 251–291; 1916 pp. 139, 140; 1918 pp. 302–306) treat dispersal of seeds and fruits eaten by mammals and still other papers (1916 pp. 121–127; 1917 pp. 209–240, 297–300; 1918 pp. 1–47) treat dispersal of seeds and fruits eaten by birds (either directly, or indirectly by birds of prey). Heintze had examined a large number of diaspores, identified them and tested their germination capacity. He was able to disprove several earlier observations and could conclude that dispersal by mammals and birds is an important mechanism in nature.

G. E. Du Rietz (1931 pp. 31–44) observed the dispersal of lichen fragments by snow drift in the mountains.

Phytogeographic implications of dispersal. Heintze had shown that diaspores can be transported over long distances by animals. Whether widely scattered localities outside the main distribution area of a plant are in effect the result of such long-distance dispersal, or whether they represent relicts from a period with other climatic conditions was, and still is, an open question. The geographer, J. Frödin, supported the latter theory (1919 pp. 137, 138).

The problem of whether or not dispersal of diaspores is in general efficient in establishing a species in new areas was further elucidated by H. Runemark (1969 pp. 90–129). He stressed the part played by random factors, i.e. 'reproductive drift', in establishing an immigrant. This drift is of great significance in connection with long-distance dispersal of diaspores invading an already established community where, in competition with those of established species, they are in no way or only slightly superior. Thus successful long-range migration should be rare except when disturbed habitats or habitats without an established vegetation are available.

Floristics and Phytogeography

Floristic investigations. From the beginning up to the 1960's floristics occupied a large amount of space in *Botaniska Notiser*. During the 19th century Sweden, Norway, Denmark and to some extent Finland were floristically documented by botanists and naturalists who mainly compiled lists of species that they happened to come across. With the advent of national botanical journals in the other Scandinavian countries Swedish floristic material came to dominate in *Botaniska Notiser*.

To help to finance botanical excursions in Scandinavia N. J. Andersson (1850 pp. 15–20) proposed the formation of a travellers' association (an earlier but unfruitful proposal had been forwarded by A. E. Lindblom, 1844 pp. 43–48). This association was active for many years.

Preparations for provincial and local Floras. The need for provincial and local Floras dates far back. Elias Fries's *Flora Scanica* appeared in 1835 and other Floras were to follow. Progress in making reliable Floras was, however, slowed down by the sparse and unevenly collected information available. H. von Post, later a pioneer in Quaternary Geology, appealed in *Botaniska Notiser* (1842 pp. 97–105) to young Swedish botanists to join forces and explore the flora of provinces or lesser regions and to describe it according to a fixed model. The ensuing Floras were to follow a natural system, preferably that of E. Fries, and comprise a geographic section, a phytographic section and a list of plants including descriptions of new ones and localities for the rare ones. In a note accompanying the paper (pp. 105–107) the Editor, A. E. Lindblom, welcomed the publication of such Floras in *Botaniska Notiser* or in a supplementary series. No such series came into existence, but the whole idea applies, mutatis mutandis, to the present *Svensk Botanisk Tidskrift* with its associated series of provincial Floras.

H. von Post adopted and tried out his own model in a series of contributions (1844 pp. 113–142, 145–154; 1846 pp. 49–53). Later (1851 pp. 110–124, 161–186) he suggested a still more sophisticated method for the investigation of vegetation and the presentation of results, giving a comprehensive example. This was in reality an early attempt at phytosociological analysis. He argued against the aesthetic, poetic descriptions that were current and criticized the tendency to take an interest in the abnormal plants and the most deviating vegetation types, but to neglect the "common, regular or normal" status. This criticism is still indeed to the point.

A new series of publications under the joint heading of *Bidrag till Skånes Flora* (Contributions to the Flora of Skåne, S Sweden) was initiated in 1939 by H. Weimarck (pp. 357–392). More than 50 contributions to the series were to be published in *Botaniska Notiser* during the 1940's and 1950's. The papers in the series reported on results from the project *Skånes Flora* initiated in 1938. Work on the project was carried on despite the restrictions of the Second World War, and during some periods was one of the very few research activities that were in any way possible. By the beginning of the 1970's the bulk of the field work had been completed. The final reports, an Atlas with dot maps, and analyses of distribution types are still in preparation.

Regional Phytogeography. Thanks to continuous floristic investigations a reasonably adequate basis was available in the 1920's so that a provisional survey at least of the regional phytogeography of S and C Sweden could be undertaken. The area had admittedly only been covered in part and information was partly sparse. During the 1920's most contributions to this field were published elsewhere but two papers by F. Hård av Segerstad, Uppsala, appeared in *Botaniska Notiser* (1922 pp. 277–286; 1925 pp. 222–250). In these, Hård av Segerstad divided S Sweden into phytogeographic subdivisions. He laid emphasis not only on climatically conditioned areas of distribution, as had previously been the practice, but even more on those that were edaphically conditioned. The area was found to comprise three main regions, eutrophic, mesotrophic and oligotrophic, and a number of phytogeographic species groups were related to each of these regions. This classification aroused criticism: Turesson (1936 pp. 420–437), for example, pointed out the probability of ecotypical heterogeneity among some of the species studied. With a view to the large and heterogeneous area under study Hård av Segerstad was also criticized for not taking climatic factors sufficiently into account. E. Naumann (1928 pp. 31–48), however, pointed out that Hård av Segerstad's regions agreed well with his own previously published regional subdivision of S and C Sweden based on limnological evidence.

However, a better understanding of the relations between distributional areas and environmental conditions required much more detailed floristic investigations. The above-mentioned undertaking of the project *Skånes Flora* initiated in 1938 should be seen in this light. Early in the work it had been seen that the distribution of many species coincided remarkably well with environmental conditions, especially with regard to soil chemistry. Moreover, Skåne is small enough to be climatically fairly homogeneous.

The project *Skånes Flora* branched out to form part of the basis of the phytosociological and plant ecological tradition at Lund (see below). Among early contributions to this field published in *Botaniska Notiser* can be mentioned *Skånes myrtyper* (Summary: *Scanian mire-types;* Contribution no. 18 to the series *Bidrag till Skånes Flora*) by S. Waldheim, 'Laborator' at Lund from 1948, and H. Weimarck (1943 pp. 1–40). The system of classification for mires proposed in this paper has long been used in Scandinavian phytosociology. Other significant papers were published by Waldheim (in *Botaniska Notiser Supplement 1(1),* 1947) and H. Weimarck (1950 pp. 133–144).

Å. Gustafsson (1935 pp. 325–330) pointed out the value of studying apomictic taxa when mapping the migration routes of individual biotypes.

Methods for frequency mapping were developed by A. Oredsson and applied when mapping the occurrence of taxa within *Rubus fruticosus* sensu lato in S Sweden (1973 pp. 37–68; 1974 pp. 44–68; 1975 pp. 47–54).

Ecology and related subjects

The development of freshwater biology. Many limnological contributions appeared in *Botaniska Notiser* during the period from 1911 to 1934, the majority of them emanating from E. Naumann's hectic activity. Naumann, who began his career in the Department of Zoology but soon turned to Botany, was Professor of Limnology from 1929 to his premature death in 1934. A long series of papers deals with the sociology, periodicity and productivity of phytoplankton in relation to physical and chemical conditions in the water (1911 pp. 245–261; 1912 pp. 209–214, 215–222, 257–281; 1913 pp. 249–263; 1914 pp. 177–189; 1916 pp. 151–162; 1917 pp. 115–128; 1918 pp. 217–230; 1919 pp. 65–82, 221–224, 225–239; 1925 pp. 47–51). He wrote the first of these at the age of only twenty. He was one of the first to realize the important but previously largely overlooked role of nanoplankton, and probably the very first to show experimentally the effect of various pH values on the morphology of planktic organisms.

A further two papers treated problems in regional limnology, a field where Naumann was a pioneer (1927 pp. 81–103; 1928 pp. 31–48). In still other papers he treated the biology of fungi in polluted fresh water (1933 pp. 413–416, 577–580, 581–587, 588–592; 1934 pp. 141–144).

A great number of papers on various other topics such as terminology, sampling techniques, microtechniques and photographic techniques (and of course numerous publications elsewhere), complete an impressive picture of innovation and productivity in a rapidly developing field. Naumann's ambition to reach a public outside Scandinavia is obvious from the fact that from the beginning he added a German summary to all his papers that were written in Swedish (this was nothing new but had not yet become general practice). Though he worked on local material the problems and results were of international application.

Phytosociology. The process of mountain building is generally accompanied by earthquakes and volcanic activity. The processes leading to the formation of the new science of Phytosociology in the first three decades of this century was likewise attended by frequent and violent eruptions. The necessary methodology and terminology were developed by numerous researchers on the basis of floristics and floristic phytogeography. G. Turesson surveyed the status of phytosociology in *Botaniska Notiser* 1922 (pp. 49–68) from the evolutionist's point of view.

From 1920 till 1928 *Botaniska Notiser* was the scene of a controversy, though some of the papers did in addition promote scientific advancement. The battle was partly staged in the pages of *Svensk Botanisk Tidskrift* and this part will not be surveyed here, nor will a few papers that are concerned mainly with mere personal attacks or that fall outside the scope of the main theme.

In broad outline the conflict was concerned with the delimitation of phytosociological associations, the relation between these associations and environmental conditions, and the concept of constancy. On the one side were ranged members of the so-called Uppsala school of phytosociologists, viz., G. E. Du Rietz, T. C. E. Fries, H. Osvald and T. Å. Tengwall. Of these, Du Rietz (later Professor of Plant Biology at Uppsala) was the main spokesman (1922 pp. 17–36; 1923 pp. 235–256; 1924 pp. 425–439; 1928 pp. 1–30). On the other side were ranged H. Kylin, Professor of Plant Physiology at Lund (1923 pp. 161–234, 451–456; 1925 pp. 395–402; 1926 pp. 81–180) and S. D. Wicksell, later Professor of Statistics at Lund (1924 pp. 17–37). J. Frödin, Lund, also took part at the very beginning. L.-G. Romell (Honorary Professor in Stockholm from 1948) held a partly intermediate position (1925 pp. 253–308).

The Uppsala school was mainly inductive: general laws were arrived at empirically, on the basis of case studies in the field. This school emphasized the concept of constancy, implying that an association can be characterized by the occurrence of a group of 'constant' species fundamentally distinct from the rest of the species occurring. It had also been demonstrated that the number of 'constant' species and the total number of species rise with increasing size of sampling area up to a given limit (the 'minimum area'). Attempts had been made at finding a formula for the effect of varying size of sampling area though with moderate success. The species occurring together were believed to do so not only because they share a common reaction to the habitat but also because of mutual interaction. Emphasis was laid on the occurrence of clear boundaries between associations even where changes in environment were gradual. Consequently, by contrast to concepts on the Continent, the demand for uniform environmental conditions within an association was abandoned.

Kylin, a skilful mathematician, had a more deductive approach to phytosociological problems, making use of probability calculus and mathematical models. Kylin and Romell were supported by the statistician Wicksell. The members of the Uppsala school were shown to have founded their hypotheses on weak statistical grounds. Their opponents denied the distinctness of the 'constant' species and questioned the proposed mutual interaction between plants. They tried to deduce the dependence of 'constants' on size of sampling area from better formulae and rejected the concept of a minimum area. They also found that the concept of clear boundaries between associations in a gradually changing environment was questionable. The problem of determining homogeneity subjectively versus objectively, and the dependence of homogeneity on size of sampling area were discussed. The tendency within the Uppsala school to consider the associations as organisms, analogous to species, with relatively clear boundaries, was criticized, and variation in vegetation was believed to be more continuous.

Phytosociology was still only at the beginning of its development when these problems ceased to be ventilated in *Botaniska Notiser*. However, we can take for granted that science gained much from the accompanying brainstorming during which many basic concepts began to take shape. The confrontation—the Uppsala botanists with their vast experience of fieldwork, and their opponents with their mathematical approach—obviously had a stimulating effect.

It is, moreover, also conceivable that the conflict may have influenced feelings between representatives for various fields of Botany, and between botanists from Lund and Uppsala for a considerable time afterwards, and personal relationships were also complicated. Kylin had come to his Chair at Lund from Uppsala shortly before; Fries moved from Uppsala to a Chair at Lund at about the end of the period; later Frödin and Turesson both moved from Lund to Chairs at Uppsala; Du Rietz remained at Uppsala. The competition between the applicants had been keen.

Developments in Plant Ecology during the 1950's and 1960's. From the 1950's onwards interest in Plant Ecology has increased rapidly all over the world. New methods have been introduced and new facilities have become available. Plant ecologists active at Lund were responsible for most of the ecological contributions to *Botaniska Notiser* during the 1950's and 1960's. Following the earlier tradition in vegetation science they mainly investigated the development of different types of vegetation as related to the chemical and physical properties of the substrate, and the productivity and the turnover of organic matter and mineral nutrients in the ecosystem. Most of their investigations have dealt with woodlands, grasslands and wetlands in S Sweden, and with wetlands in the mountains of N Sweden, and have been characterized by intense methodological development and often by the use of sophisticated apparatus.

N. Malmer, later 'Laborator', Professor at Lund from 1969, and H. Sjörs, later Professor of Plant Ecology at Uppsala, analysed elementary constituents in samples of mire plants growing in various types of bogs and fens (1955 pp. 46–80): the importance of analysing both the substrate and the plants was stressed, and problems of tolerance and optimal conditions were considered. Similar problems were presented by Malmer (1958 pp. 274–288).

The effects of varying soil moisture on the development of grassland vegetation were demonstrated by F. Andersson, Professor of Terrestrial Ecology at Uppsala from 1979, and J. Ericson, together and separately (1963 pp. 257–266, 376–385, 386–395). Later, Andersson elucidated problems concerning biomass, production and turnover in a woodland and meadow ecosystem, using allometric equations (1970 pp. 8–51).

The effects of phosphorus and nitrogen were studied experimentally by G. Tyler (1967 pp. 433–447) who added mineral salts to plots of shore vegetation by brackish water, and calculated changes in production and in uptake by various species. Tyler also studied soil chemistry in the same type of habitat, mainly the adsorption properties and occurrence of metal cations in clay (1968 pp. 89–113). Other investigations on soil chemistry were published by T. Mörnsjö (1968 pp. 343–360) in a study of peatlands.

The influence of microclimate on the vegetation and soil on the slopes of an esker was demonstrated by L. Påhlsson (1966 pp. 401–418). The reverse, i.e. the influence of vegetation on microclimate, was demonstrated by B. Nihlgård (1969 pp. 333–352) for beech and spruce forests.

The causes of regional and local variation in mire vegetation in a mountainous area in N Sweden were studied by M. Sonesson, Professor at the Royal Academy of Science from 1974 (1967 pp. 272–296; 1969 pp. 481–511; 1970 pp. 67–111).

Several significant papers were also published in *Opera Botanica* (Vols. 6(1), 6(3), 7(1), 7(2), 24–27).

Research into the problem of contamination by heavy metals in nature was first presented in *Botaniska Notiser* by Å. Rühling and G. Tyler in 1968 (pp. 321–342). Further contributions by the same authors appeared in 1969 (pp. 248–259) and in a subsequent series of papers elsewhere (when *Botaniska Notiser* no longer accepted ecological contributions). Mosses were shown to accumulate large amounts of heavy metals. An alarming degree of lead pollution was found in the immediate vicinity of roads in S Sweden. The lead obviously originated from additions to petrol.

On a regional basis the lead concentration was found to increase with precipitation and with decreasing distance from large centres of population. Much of the lead found at a distance from roads presumably originates from outside the area investigated.

Analyses of mosses preserved in herbaria revealed that the lead content rose markedly for the first time at the end of the 19th century, probably in connection with industrial development. A second rise, during the last few decades, coincides with the increase in the use of petrol. In the same way a rise in the contents of copper, zinc, nickel and chromium was found to be connected with their use in industry.

Quaternary Biology

Behind the temporary appearance of the subject 'Quaternary Biology' around 1871 lies nothing less than a sensation. A young student, A. G. Nathorst, to be Professor at Stockholm from 1884, had found subfossil plant remains in a freshwater clay deposit in SW Skåne. They included *Dryas octopetala* and some *Salix* species, all presently occurring only in the Scandinavian mountain range far north of the find-spot. *Betula nana*, a northerly species in Scandinavia, was also found. The report in *Botaniska Notiser* (1871 pp. 3–8) was written by Nathorst's teacher at Lund, F. W. C. Areschoug. The first evidence of a Late-Glacial arctic vegetation in southernmost Sweden was of utmost importance for coming research in Quaternary Biology. The idea of extensive glaciation had fairly recently become accepted thanks to the research of Agassiz and the Swedish geological research workers H. von Post (mentioned above), A. Erdmann and O. Torell.

Areschoug forwarded the idea (not then generally accepted) that after the melting of the ice sheet the arctic species had first colonized the southern lowlands of Scandinavia. According to him this vegetation had later become restricted to the northern mountains, as its members could not compete with other species when temperatures rose in the lowlands, a clearly Darwinian theory. He held that this is also what had happened in the Alps, which would explain the arctic element in the flora there.

As an example of an earlier approach one can read a comprehensive survey (1850 pp. 1–14) of a paper by J. F. Schouw on the origin of the present-day plant kingdom. His paper discusses (1) whether each plant species has originated in one single place or in several places independently, (2) whether new species are still being created or not and (3) whether the present-day plants originated all at the same time or successively. In each case Schouw held the alternative view. On the basis of the different relative occurrences of plant groups that are more 'advanced', or less so, the author concluded that the flora of the Alps is 'younger' than that of the lowlands of Central Europe and of the Scandinavian mountains.

The first two problems were clearly viewed in a different light before and after Darwin had published his *Origin of species*, so that the phytogeographic conclusions drawn by Schouw were quite different from Areschoug's.

Pre-Quaternary Palaeobotany

From the few contributions that have appeared in *Botaniska Notiser* I have selected those of H. Merker on Psilophytes.

Merker suggested (1958 pp. 608–618; 1959 pp. 441–452; 1961 pp. 88–102) that the subterranean part ('rhizome') of the fossil *Hornea* and *Rhynia* represents the hitherto unknown gametophytic generation. This possibility seems to have been previously overlooked, the general opinion having been that the gametophyte was ephemeral and thus never preserved as a fossil. Merker also suggested a hypothetic life cycle for the Psilophytes. Whether this theory will be confirmed or not it provides a stimulus to creative thinking.

Applied Botany

An interesting observation was made by J. Eriksson (1895 pp. 251–253) regarding the host specificity of *Puccinia dispersa*, two races of which are specific to wheat and rye respectively. A *P. dispersa* attacking plants of ryewheat (a hybrid probably received from A. Rimpau, who had recently produced ryewheat artificially) was shown to belong to the wheat-specific race and did not attack rye. Eriksson took this as evidence that ryewheat is closer to wheat than to rye. This conclusion seems all the more logical to us since we now know that Rimpau's ryewheat had 42 wheat chromosomes and 14 rye chromosomes.

Concluding remarks

The history of *Botaniska Notiser* has now been surveyed from its inception to the present day. From being a national journal, though long with a pan-Scandinavian basis, *Botaniska Notiser* has gradually developed into something of a 'house magazine' at Lund as activities here increased sufficiently to supply the bulk of the material. Originally for both amateur and professional botanists it is now a journal mainly for internationally relevant Systematics and Morphology.

It has been possible to glean something of the history of Botany from its pages. As new branches of natural science such as Plant Physiology, Genetics and Ecology arose they contributed to the pages of *Botaniska Notiser,* only to disappear as specialization made it necessary to produce new journals with a narrower scope. Step by step economic restrictions have necessitated a more effective use of space, and have finally led to the amalgamation of *Botaniska Notiser* and other journals into the coming *Nordic Journal of Botany*.

The goodwill of our contributors and subscribers all round the world is a heritage to be passed on to *Nordic Journal of Botany*.

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The Mycological Society of America

The Mycological Society of America will celebrate the 50th Anniversary of its founding during August 16–21, 1981 at Indiana University, Bloomington, Indiana, U.S.A. Mycologists are invited to participate in the Anniversary program. It is anticipated that the Anniversary event will include addresses and symposia dealing with the past, present, and future of mycology and of the Society. The Society would welcome contributions and attendance from colleagues throughout the world.

Further information is obtainable from Jack D. Rogers, Chairman, Golden Anniversary Committee, Mycological Society of America, Department of Plant Pathology, Washington State University, Pullman, Washington 99164, U.S.A.

Publication policy in Swedish botany

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Swedish botanical journals and series have of tradition been connected with Societies, Academies or local institutions. They were primarily distributed as membership copies and supported by grants directly from the governmental budget. The responsibility for the support was taken over by the Natural Science Research Council and its Publication Board when they were formed in the late 1940's, but otherwise the structure persisted until the end of 1966, complemented mainly by the pan-Scandinavian *Physiologia Plantarum* (started in 1948) and *Oikos* (started in 1949). Increasing costs and the need for canalizing information properly then led to the almost complete eradication of the local series, at the same time as Scandinavian cooperation was facilitated by the formation of the *Nordic Publishing Board in Science* (NOP-N) in 1968. *Svensk Botanisk Tidskrift* and *Botaniska Notiser* with *Opera Botanica* were maintained, but structural changes in the market and the continuous increase in costs made a new analysis of the problems necessary. As from 1976 the analyses led to the establishment of a national 'Governing body' and a joint, professional editorial office. *Botaniska Notiser* and *Opera Botanica* were retained for 'professional readers', and *Svensk Botanisk Tidskrift* was adapted for 'advanced amateurs'. The joint package was big enough to obtain favourable printing terms, and *Svensk Botanisk Tidskrift* in particular has had a great marketing success. Scandinavian cooperation was solicited at an early stage. Discussions sponsored by NOP-N from 1977 to 1980 have now led to the end of *Botaniska Notiser* and the corresponding national journals in Denmark and Norway, and to the birth of the amalgamated *Nordic Journal of Botany*. It is hoped that this will lead to an increase in scientific standard by the possibility to engage specialized section editors; and to an increase in circulation of the articles, since the mother journals have had few subscribers in common. The experiences from the self-supporting *Physiologia Plantarum* and *Oikos* are pointed out; and some special aspects given concerning editors and the balance between cooperation and specialization.

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Publication policy in Swedish botany—has it ever existed? I am inclined to doubt it. There has been and is now a general policy for scientific publication but hardly anything specific for botany. However, it should be admitted that many of the steps taken during the development of the present policy have been initiated due to problems connected with the botanical journals and monograph series; so it may, after all, be appropriate to write an article on this subject for this issue of *Botaniska Notiser* now that the journal is to merge with the wider context of the new '*Nordic Journal of Botany*'.

A historical background

In the 'good old days' printing was comparatively cheap, and there was no need for a very conscious publication policy. Scientists published their results in a journal that was more or less affiliated with their department or that belonged to a society of which they were members. More often than not the journals or monograph series were largely distributed by exchange, which gave no hard cash and could create problems with the payment of even a moderate printer's bill. I have not followed the question back very closely, but from talks with older scientists I have received the impression that as early as in the 1920's and 1930's it became customary for scientific journals or the sponsoring organizations to receive a subsidy directly from the state budget; and that *Botaniska Notiser* was the pioneer in this field. With time, the procedure became formalized, so that the Department of Education included a special section devoted to the allocation of money to scientific journals.

This was of course not a task of such importance that it had to be handled at government level. When the Swedish Natural Science Research Council (NFR, *Statens Naturvetenskapliga Forskningsråd*) was formed by a decision in 1946 and organized during 1947, it was made to include a Board of Publication (*Publiceringsnämnden*, PN) as a special subcommittee which took over the task of distributing money for publication within the fields connected with the Council. The first by-laws of both the NFR and its Publication Board were sanctioned by the Government on 9 January 1948. Paragraph (3) of the by-laws of the Publication Board, probably formulated by Dr G. Funke, the first secretary of both the NFR and the PN, deserves to be translated:

"The following principles should guide the activities of the Board. The Board should promote rational forms for publication, demand a concentrated style, and counteract unnecessarily expensive lay-out. Support should in the first hand be given to journals that try to maintain an international standard and that are distributed internationally. However, one should not overlook the fact that certain areas of the natural sciences are primarily of local interest. Suitable forms for the storage of particularly extensive primary material should in certain cases be considered as an alternative to printing.

Local journals and publication series that are open only for certain institutions should be supported only to the extent that good justification can be given, the decisive criteria being efficiency of distribution and economy as compared with that of joint series of publication. As for journals distributed by subscription, the possibility of cooperation with the other Nordic countries should be investigated in order to facilitate distribution, especially abroad. In principle, one should try to divide up any deficits that may occur in connection with such journals in proportion to the number of pages taken up by the authors from each country".

The remainder of the paragraph concerns dissertations. I have not translated it, since this area became at an early stage transferred from the Publication Board of the NFR to the University System and appears to fall outside the scope of the article—I do not think Botany has had any specific influence on the policies for publication of dissertations.

The former publication structure

When I started my preparations for the present article by going back to the paragraph of 32 years ago, I was amazed by its foresight in the formulation of a policy which does not until now appear ripe for reasonably complete realization. At the same time one must be aware of the difference between scientific and social realities in 1948 and 1980, and it may be useful to recall the publication structure within botany at that time. Besides the two broad-spectrum series *Svensk Botanisk Tidskrift* and *Botaniska Notiser*, affiliated to botanical societies, there were the *Arkiv för Botanik* and the *Handlingar* series, both belonging to the Royal Swedish Academy of Science, and various monograph series belonging to the University Departments and/or the Botanical Gardens. There was also the possibility of publishing in series covering *all* 'Natural Sciences' and belonging to the Universities or to 'local Academies' such as the 'Kungliga Vetenskapssocieteten i Uppsala' or the 'Kungliga Fysiografiska Sällskapet' in Lund.

From the point of view of today it is amazing that it took almost two decades before anything really started to happen with this flora of journals of different types—how could they be maintained under the strict demand for rational forms for scientific publication? From debates far into the 1970's I can guess it was felt that the different criteria of the official policy were open to other interpretations than they are today. The tonegiving scientists—for botany first Professor J. A. Nannfeldt and later Professor N. Fries were members of the Publication Board at that time—still had reason to regard the scientific world as comparatively small, so that a personal knowledge of who was interested in what played a decisive part. It could be argued that rational distribution could best be effected by the exchange of reprints between individual scientists and by the exchange of local publication series between departments and libraries; so that the better economy per printed page that is obtainable by long printing series would be counteracted by less effective distribution—since a great number of the copies would never hit the target, they would increase the total cost of printing without a corresponding increase in efficiency.

Besides this argumentation, based on the bylaws in themselves, there were reasonably other types of considerations that entered the debates more or less openly. If one were to cooperate—who was to arrange exchanges and who was going to lose it? Which organization was to give up its publication series and which was to be allowed to maintain it? Conscientious people who have to consider both national and local interests will always hesitate and avoid driving developments too fast, until solutions are found that can be accepted by all parts.

Scandinavian cooperation

Two changes in structure should be mentioned, though—both of them increases in the number of publications straight in the beginning of the period. The recommendations to cooperate on a Scandinavian basis were heard by the plant physiologists, and the Scandinavian Society for Plant Physiology was formed in the autumn of 1947. The Society's journal *Physiologia Plantarum* started to appear in 1948 with Professor H. Burström as editor-in-chief, a post which he retained until the end of 1970. By the same token the ecologists, botanical as well as zoological, joined forces and started their pan-Scandinavian journal *Oikos* in 1949, with the zoologist Dr Helge Backlund as the first editor. From the point of view of the specialities this was an increase in strength, but the development was probably resented somewhat by the representatives of the 'old' journals, and the situation as a whole remained as chaotic as before.

New trends in the 1960's

In the beginning of the 1960's things started to happen. The driving persons behind the development were probably again Dr G. Funke, still secretary of both the Swedish Natural Science Research Council and of its Publication Board, together with the representative for Zoology, Professor P. Brinck, and with the assistance of Professor H. Virgin on the botanical side. Economic forces were also active—when there is not sufficient money for all, criteria for judging which journal is qualified and which one is not must be found. The problem was resolved by setting down the principles that publication should be supported but *not* libraries and *not* societies. Thus all series primarily intended for exchange were stopped—mainly the 'Academy' and the 'Department' series. For the societies a relationship between the production cost of the journal and the membership fee was enforced, so that money could not be drained from the Publication Board to the members in the form of 'cheap membership copies'.

Svensk Botanisk Tidskrift and Botaniska Notiser

As from 1967, the main subsidized national series within Swedish botany that survived these principles and 'Funke Doctrines', were *Svensk Botanisk Tidskrift*, owned by the 'Swedish Botanical Society', and *Botaniska Notiser* (with the monograph series *Opera Botanica*), owned by the 'Lund Botanical Society'. A few series survived outside the 'official' system, since they could be independently financed by sales and private funds. *Symbolae Botanicae Upsalienses, Acta Phytogeographica Suecica* and *Växtbiologiska Studier* are published in Uppsala, and *Wahlenbergia* was launched in Umeå.

Both *Botaniska Notiser* and *Svensk Botanisk Tidskrift* belonged to societies with a mixed membership of professionals and amateurs so that they published papers at all levels of sophistication. The Publication Board was, according to its instructions, primarily concerned with international publication, and there were also good experiences from the effects of the 'specialized profiles' of the pan-Scandinavian *Physiologia Plantarum* and *Oikos*. After some negotiations the 'Lund Botanical Society' yielded to pressure and turned *Botaniska Notiser* into a professionally and internationally directed journal for phytotaxonomy in a very broad sense. The 'Swedish Botanical Society' resisted and maintained *Svensk Botanisk Tidskrift* as a mixed journal for all levels of interest—this attitude could reasonably receive support from the phrase in the by-laws that it should not be overlooked that "certain areas of the natural sciences are primarily of local interest". For various reasons both lines of action led to an economically impossible situation within the following ten-year-period, a situation which in turn gave rise to further development of and consciousness about the publication policy and its consequences.

Physiologia Plantarum and Oikos

Before entering into this part of the story, I should like to go back to the two pan-Scandinavian journals *Physiologia Plantarum* and *Oikos*, which were initiated more or less in connection with the start of the NFR and its Publication Board. All through the first two decades of their existence they had to send in separate applications for grants to each of the Research Councils of the Nordic Countries; and each of the grant-givers could say 'yes' or 'no' independently of the others. The same applied to cooperative undertakings in other fields of science. In connection with the great changes in publication policy in Sweden in the 1960's initiatives were also taken to create a more efficient cooperation than before between the Scandinavian countries in allocating money for scientific publication. After negotiations during 1967 the Nordic Publishing Board in Science (NOP-N, *Nordiska Publiceringsnämnden för Naturvetenskap*) was officially started on January 1, 1968, as the sole, unified body for applications from pan-Scandinavian journals. The NOP-N adopted in the main the same publication policy as had been developed in Sweden, and this soon gave rise to a conflict between NOP-N and *Physiologia Plantarum*.

At bottom, the conflict concerned the consequences of the coupling between production cost and membership fee that had been developed to ear-mark publication money for publication purposes and prevent 'misuse' for other purposes within a Society. From the point of view of the journal the ruling of NOP-N meant a conflict between the scientific potential of *Physiologia Plantarum* (expressed as the number of good articles one could publish by using the willingness of scientific libraries to pay the full price for the printing of these articles) and the inability and unwillingness of the Society members to pay a correspondingly high price for *their* copies. A conflict of this type will increase with the size of the journal and with the number of subscribers and members. Thanks to the leadership of the editor, Professor Hans Burström, *Physiologia Plantarum* had, when he left the editorship by the end of 1970, come to be the second in the field, surpassed only by the American journal *Plant Physiology*. Attempts at compromise were unsuccessful, and since 1974 *Physiologia Plantarum* has been 'independent' preferring to exist by virtue of its own merits on the scientific market rather than shrink itself into the framework that was created by the rules of NOP-N and taken over from the Swedish Publication Board. *Oikos* followed suit a couple of years later—a little symbolic as its editor-in-chief, Professor Per Brinck, is in many respects the man who got the general journal development under way by the rationalization drive of the 1960's and who enforced the regulations during his time as chairman of NOP-N.

The preceding paragraph marks the point where I turn from 'objectivity' to 'subjectivity' in the sense that I had to take an active part in the game. I was forced to take over the editorship of *Physiologia Plantarum* from the beginning of 1971; and the line of action that made it possible to turn *Physiologia Plantarum* from a subsidized to a self-financing journal was worked out during the period 1971–73, when we realized that we could not persuade NOP-N to modify its stand-point. We, i.e. the Board of the Scandinavian Society for Plant Physiology, worked out *our* journal policy in close cooperation with the Munksgaard Publishing Company in Copenhagen, Denmark. By switching to a new printer, and later to a new printing technique, we could release money to pay for a professional editorial unit instead of relying on 'voluntary' or 'honorary' work with all its unevenesses. We based our economy on the great number of subscribing libraries—that is, we relied on our ability to maintain a high international standard—and we calculated the subscription price so that it would cover the cost of printing the 'library edition' and the costs for the editorial office. We could then calculate the price for membership copies as the very low price for run-off printing plus distribution cost plus a small safety margin—in the order of 20 % of the 'full price' instead of the 60 %

demanded by the NOP-N regulations. We solved the question of capital by turning the management into a 'joint venture' between the Munksgaard Publishing Company and the Society, with the important provisions that the Society is still the sole legal owner of the journal. Once this program was worked out and presented, we received a generous farewell grant from NOP-N to cover the extra expenses involved in switching over to the new system.

The problems of the 1970's

To return to the national problems of Sweden, it was mentioned above that the economic situation for the main botanical journals took a serious turn after the structural changes in the middle of the 1960's. One reason was the increasing costs of printing but structural changes in the buying market were also of importance. *Botaniska Notiser*, which had followed the suggestions of the Publication Board and switched to a purely 'within science' profile, lost the non-professional members of the Lund Botanical Society and was unable to compensate this loss by an increase on the hardening international market, so that the edition sold decreased from almost 1000 to less than 500. *Svensk Botanisk Tidskrift*, which had maintained the old profile (with "all levels of botany mixed") fared somewhat better though not well, since the older generation of amateurs who also accepted narrow professional articles was dwindling. All in all the subsidies necessary for maintaining the botanical journals increased to more than 50 % of the total costs. In absolute figures the grants rose to such magnitude as to create pressure from representatives for other sciences in the NFR and its Publication Board, who held that this was unreasonable and must be stopped. One could see the end of the expanding economy of the 1960's and could not really hope for a substantially greater amount of money from the Government to maintain the old structure of publication. In this situation Botany was taking an unproportionate amount of the common pool of resources.

An analysis of botanical publication in Sweden and its consequences

At the same time as NOP-N had taken a firm stand in their negotiations with *Physiologia Plantarum*, the grant-giving authorities were interested in the experiences gained and in the possibilities of developing journals. As I understand the situation, this was particularly true of the new secretary of the Publication Board of the Swedish Natural Science Research Council, Mr Hans Rundquist. When the position as Botany representative in the Publication Board had to be refilled at the beginning of 1973, he suggested that I should be appointed. He also obtained a decision by the Board to set down a committee to analyse the situation for the botanical journals and suggest solutions. In this committee, Mr Rundquist and myself represented the Publication Board, and the 'field' was represented by Professor O. Hedberg, Uppsala, and Professor H. Runemark, Lund. Our work is documented in the booklet *Botanical Publication in Sweden* (1974), and I think one may claim that the ideas we formulated during our negotiations are representative for the main line of official publication policy during the 1970's. We agreed on three main priorities, and I will try to follow them in their consequences one by one.

Our first priority was to forward the international publication of scientific results—the first duty of the Publication Board according to its by-laws. We realized that this would be difficult to achieve and maintain on a Swedish basis alone, so right at the beginning of the work—at a NOP-N meeting for editors in Sigtuna, Sweden in 1973—we asked whether the other Scandinavian countries would be willing and interested to cooperate. The answer at that time was a flat "no", and in consequence we set out to do the best we could on a national basis. Not until 1977—again at and after a NOP-N conference in Göteborg for botanical editors—came signs of readiness to start discussions on Nordic cooperation, primarily from Professor Morten Lange in Denmark. It took almost three years to bring the discussions to an end and a beginning—the end of *Botaniska Notiser* and its sister journals in Denmark and Norway and the beginning of the amalgamated *Nordic Journal of Botany*. In both the national and the pan-Scandinavian developments the question of scientific responsibility has been one of the crucial points—no conscientious society or any other owner of a journal will take lightly on that question or easily give the responsibility away to someone else on the same level. The solution has in both steps been the creation of a joint 'directorate' where all parts are represented: 'The Governing Body for Swedish Botanical Publication' with members elected by the Societies, the Universities and the Natural Science Council, and now the 'Council for Nordic Publications in Botany', chosen by the Nordic Universities and by NOP-N.

Our second priority was to use the money available as efficiently as possible. Of tradition the editorship and management of the journals had been a 'voluntary' and 'honorary' task, with a symbolic salary and with no official credit given for the work attached. By combining the symbolic salaries for the different journals we found it possible to employ a joint editor for *Svensk Botanisk Tidskrift* and *Botaniska Notiser* with *Opera Botanica* on a professional half time basis. The three journals as a package became an object of interest for the printing companies, and the printing economy could be substantially improved, so that all in all this side of the policy can be expressed as "taking money from the printing bills and invest them in editors". The 'Governing Body' later decided to place the editorial office in Lund and appoint Mr Thomas Karlsson as the first editor for the system. It should be noted that the original plans contained two editorial offices, one in Lund for the 'short-article journals', and one in Uppsala for the 'monograph series' which latter would then have been *Symbolae Botanicae Upsalienses, Acta Phytogeographica* and *Växtbiologiska Studier*. However, the Uppsala botanists preferred not to take national responsibility—a condition for grants from the Publication Board—but to keep these journals for themselves and their library exchange and maintain them by sales and private funds.

Our third priority was to find as much money as possible for the purpose. This could only to a limited extent be expected from the grant system; at the same time as it must be openly and gratefully admitted that the plans were met with interest and great generosity by the representatives responsible for other sciences within the NFR and its Publication Board—so much more noteworthy since the starting-point was the bankruptcy and high costs of the 'old' publication system for botany. What could be done was to build on the ideas of creating the 'proper profiles' that had been one of the main points in the reform work of the 1960's and utilize them to obtain market response. *Botaniska Notiser* already had a good profile directed towards professional scientists; and when the 'Governing Body', with Dr Stig Falk as its chairman, considered the situation it was decided to let *Svensk Botanisk Tidskrift* specialize for 'advanced amateurs', i.e. people who do not only want to read about botany but who also want to have botany as an active hobby. This profile has met with an enormous response, and with the help of the marketing ideas of the 'Editorial Service' of the NFR and the Publication Board the number of copies sold has increased from less than 1000 to several thousands during the four years the system has been active. *Botaniska Notiser* has also been actively marketed and has increased its sales by about 50 % during the period.

Some further aspects

Amateurs. The enormous interest shown by 'advanced amateurs' was a great surprise for us all and has, together with other events, acted as feed-back for us on the Publication Board. With the tasks given to the Natural Science Research Council we must continue to keep support to international publication as the first responsibility and priority; but one can realize more clearly than ever that we have a responsibility also for the creation and activation of 'spin-off' from the professional level to the interested general public—which after all, in its role of tax-payers, is the ultimate foundation for the scientific world itself. It is still not clear how this aspect will be handled and developed in the long run, but some concrete measures involve contacts and cooperation with *Statens Kulturråd* (the Swedish 'Culture Council') and with *Forskningsrådsnämnden* (FRN), the joint committee of the Research Councils which as a cooperative unit has expressively got communication with the general public on its program.

The editor. One aspect that has gained increasing recognition during the 1970's is the status and professionalism of the editors. It was deeply inherited from the days of the many small department journals and exchange series that editorship was regarded as an honorary position, where the work should be done in one's spare time and with no official credit in connection with applications for posts or the like. In a way this notion together with the highly competitive system for academic promotion, with 'research qualifications' as the sole merit to be considered, was one of the factors that were self-destructive in the old publication system. No one who really thought over the situation could be happy to give of his or her 'spare' (read 'research') time to help presumptive competitors-for-posts with their publication problems. This is an additional one of the many rationales for cooperation and build-up of greater and more efficient journals: we must create units which give a reasonable basis for professional editors. The question has also been taken up by the Publication Board and others—for instance at a meeting arranged by *Oikos* in early 1976—who have declared that qualified scientific editing should reasonably be regarded as equivalent to qualified scientific teaching and be evaluated as such. The question has by no means been finally solved, but the newly instituted responsibility for the Swedish universities to take care of the publication of scientific results may, hopefully, create a basis for further action.

Actually, the function of qualified scientific editors in the guidance of young scientists was discussed and appreciated at the meeting of NOS (the organ for cooperation between the main bodies of the Nordic Natural Science Research Councils) during a meeting in Reykjavik, Iceland, at the beginning of 1979. In countries outside the English language area, it will in practice be up to the journal editors to train the young scientists in international publishing; and the maintenance of competent people in this function was mentioned as one of the ultimate reasons for publication subsidies. Special courses in editorship have been offered both by NOP-N and by the Swedish University authorities during the last few years.

The 'profile' of a journal. Another question that may merit a paragraph is the one of 'profile'—specialization or not. To a great extent this is a question of balance between priorities. As long as one wishes to have 'local' or 'national' series one must cooperate between scientific specialities in order to appear at regular intervals. At the same time this may lead to lack of interest—a personal buyer will not find enough material within his or her speciality. The result may be a journal that is unefficient in distributing the new knowledge—the results obtained when the lists of subscribers on *Botaniska Notiser, Botanisk Tidsskrift* and *Norwegian Journal of Botany* were put side by side were telltaling and gave a kick forward in the negotiations that led to the *Nordic Journal of Botany*. Not even on a pan-Scandinavian basis was it regarded as realistic to create separate journals for each botanical subspeciality—this would in practice need all-European cooperation. The elegant solution with the 'reprint sections' of the new *Nordic Journal of Botany* was in the main worked out by Mr Thomas Karlsson, and I think we owe him much gratitude for it.

Nordic Journal of Botany

I would like to end the article by formulating the hopes behind the new *Nordic Journal of Botany*. The journal should be a means to increase the scientific standard of Nordic publishing in botany, since it will be possible to engage specialized section editors. The circulation of the articles should be increased as compared with the 'national' systems, since there was very little overlap between the subscribers of the mother journals. There should also be an extra potential through the combined impact of a complete edition directed towards availability and storage in the main libraries; and of 'reprint sections' directed towards personal users and specialized libraries. All in all, I am told that this will be the largest of all European journals of taxonomically directed botany; and in combination with a good scientific standard it should be possible to use this fact for marketing drives giving economic independence within a few years. I would like to see *Nordic Journal of Botany* as a link in a development, where scientists no longer regard 'science' and 'economy' as more or less opposing forces but discover that the two can be made to support each other. In fact they must, since it is scientific quality which ultimately sells a scientific journal; but no quality in the world can in the long run sell an article, which exist only in a mimeographed institutional series instead of in a well distributed international journal.

Acknowledgements—and a reservation. This article is completely unreliable since it is based on my personal memories and not on literature studies. I would like to express my sincere personal thanks to all colleagues and friends—a few mentioned above but no one forgotten—during my work with *Physiologia Plantarum* as well as on the Swedish Publication Board and on the Nordic Publishing Board for Science; to my wife and family, who allowed me to attend all these meetings; and to Mrs Lena Strandh, who made a manuscript out of my stray notes. Special discussions with Professor Per Brinck and Professor Hemming Virgin are gratefully acknowledged.

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The 1982 AETFAT Congress

The 1982 AETFAT Congress will be organized by the *Botanical Research Institute of the Department of Agriculture and Fisheries* (Secretariat of the *"Association pour l'Etude Taxonomique de la Flore d'Afrique Tropicale"* AETFAT) and the *"South African Association of Botanists"* (SAAB) assisted by the Symposium Secretariat of the *"Council for Scientific and Industrial Research"* (CSIR). The Congress will be held from 19 to 22 January 1982 at the CSIR Conference Centre, Pretoria, Republic of South Africa.

A symposium will be held on the origin, evolution and migrations of African floras. The symposium will be divided into three parts, viz. The fossil floras, The presentday floras and Past and present vegetation, landscapes and climates.

Further information is obtainable from The Symposium Secretariat S.229, CSIR, P.O. Box 395, Pretoria, 0001, Republic of South Africa.

Three centuries of Botany at the University of Lund, a short survey

OVE ALMBORN

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A survey is made of the main features in the history of Botany at the University of Lund from 1668, when the University was founded, till the present day. Special attention has been paid to the Professors of Botany, to the development of the various Chairs and to the pronounced diversification of research in Botany during the 20th century. Some attempt has been made to trace the influence of other Swedish universities on Lund and vice versa. The history of the buildings of the Departments has been sketched not forgetting the almost perpetual need for new premises. A selection of the many botanical theses presented for the doctor's degree published in Lund is given, in particular those of the present century. Limited space has otherwise permitted mention of only some few works considered to be of special importance.

O. Almborn, Botanical Museum, Ö. Vallgatan 20, S-223 61 Lund, Sweden.

The University of Lund was founded in 1668 with the main purpose of introducing Swedish culture into the former Danish provinces of Skåne (Scania), Blekinge, Halland and Bohuslän (Bahusia). These provinces had been conquered by the Swedish king in 1658.

The early days

Pre-Linnaean Botany

Botany was included in one of the two Chairs of Medicine. From a lecture time table from the 1670's we gather that the Professor of Theoretical Medicine, Christian Fossius, was to teach Botany during the spring and summer with a number of excursions to meadows and groves. Erasmus Sack-Sackensköld, his successor, had the title of 'Professor of Anatomy and Botany'.

Christopher Rostius, the first Professor of Practical Medicine, had a 'Herbarium vivum', one of the oldest plant collections known. It is now preserved in the Botanical Museum at Lund. It contains 353 species of vascular plants (many of them medicinal herbs) glued on to paper sheets and bound as a book. It bears the date 1610 but the plants were probably collected in Germany in the 1590's.

During the first decades there was no botanical garden. However, in 1690 the University received the so-called 'Kungshuset' (the King's Residence) which had been built for the Danish king in 1580. It was the main building of the University (including the University Library) for nearly two hundred years. It is still in use for lectures and 'disputations' (i.e. the defense of theses for the doctor's degree). North of the grounds round this building known as Lundagård was an old garden which in 1690 was given to the University to be used as a botanical garden.

There was no money available for the management of this University Garden. The first two decades of the 18th century was a period of extreme poverty in Sweden as a result of the wars of Charles XII. The activities of the University were few, and the Garden was described as choked with weeds and housing a large number of foraging pigs. About 1710 Professor Johan Jacob von Döbeln lectured to students on medicinal herbs and tried in vain to get the Garden restored.

Linnaeus in Lund

In 1727 Carl Linnaeus came to Lund to begin academic studies. He found, however, that there was no organized teaching in Botany and the Garden had few plants of interest. Yet Linnaeus's short stay at Lund (less than one year) was an important period in his development. He was lucky in renting a room in Stobaeus's house (south of the Cathedral) and in being allowed to make use of his large library and collections. Stobaeus was a physician and had no official teaching post at the University.

Linnaeus went on several excursions in the vicinity of Lund and in other parts of the province of Skåne. He made careful notes on plants, animals and natural features of interest, but these manuscripts remained unpublished till 1888 when they were issued with comments in Swedish by E. Ährling as *Catalogus plantarum rariorum Scaniae* (A list of rare plants in Skåne) and *Spolia botanica* (Botanical contributions). In August 1728 Linnaeus continued his studies at the University of Uppsala. He had hoped for better teachers in Botany and Medicine, but in a letter to Stobaeus he complained that the two Professors of Medicine were elderly and in poor health and that the *Hortus upsaliensis* was in a neglected condition. Fortunately Linnaeus soon became acting demonstrator in the Garden, a fact which opened up the way for his future career.

In 1729 Stobaeus was appointed Professor of *Philosophia naturalis et physica experimentalis* at Lund. He lectured on all branches of natural science. Among his students can be mentioned Johan Leche, who published *Primitiae Florae Scanicae* (1744) and Eberhard Rosén, the editor of *Observationes Botanicae* (1749). These are important early contributions to a knowledge of the flora of Skåne.

Stobaeus was promoted to a better-paid Chair of History in 1732. He was succeeded by Gustaf Harmens. This Chair soon came to include Medicine and *philosophia experimentalis*. Harmens lectured on the 'life of the plants' and published papers on such subjects as the transpiration of plants. He can be regarded as the first plant physiologist at Lund.

Linnaeus, now a professor at Uppsala, paid a short visit to Lund during his trip through Skåne in 1749. In his *Skånska Resa* (1751) he described the current state of the University of Lund in vivid colours. "The Garden ("Lunda-Gården") was peerlessly beautiful.—I revisited the *Flora Lundensis*, which twenty years ago had afforded me so many pleasant hours. I saw many changes during these few years.—*Pulicaria* (i.e. *Pulicaria vulgaris*) grew earlier only in a few places. Now it is common on the embankments.—La Voue (*Luteola,* i.e. *Reseda luteola*) is a herb which we import from France in great quantities. It is essential for producing yellow colour for the dyeing industry.—I found an abundance of it in Thomaegap north of the town where it grew trampled by cows, goats, horses and pigs.—I consider that the beds of tobacco should be replaced by cultivations of Voue". (Translated from the Swedish.) One of the main purposes of Linnaeus's trip, which was sponsored by the Riksdag (the Swedish Parliament), was to investigate whether imported economic plants could be replaced by indigenous ones.

Some years earlier the Garden had been restored on the initiative of Baron Carl Hårleman, one of the leading statesmen in the middle of the 18th century. A gardener was also appointed. The result was a splendid park, but less attention was paid to botanical aspects. The two professors in the Medical Faculty, Gustaf Harmens and Eberhard Rosén, seem to have shown little interest in the Garden.

Developments after 1750

E. G. Lidbeck

Linnaeus's visit to Lund in 1749 resulted in an unexpected acquisition for the University of Lund. On his suggestion the Chancellor established a post as 'adjunct' in the Medical Faculty with the special purpose of teaching Botany and natural science in general and of restoring the Garden. Despite the protests of the two Professors of Medicine Erik Gustaf Lidbeck was appointed in 1750. He was a pupil of Linnaeus and had been a lecturer ('docent') in economy at Uppsala. However, he had little knowledge of Medicine. In 1752 he became Head of the Garden and in 1756 the first holder of a new Chair of *historia naturalis*. His scientific merits were meagre. Nevertheless, the following decades saw a great many activities in the field of 'Economic Botany'. Lidbeck planted a large number of trees in the Garden, and in its northern part, where Palaestra is now situated, a building which was known as the orangery was erected. Apart from greenhouses and lecture rooms it included living quarters for the gardener. For one century (until the 1860's) the orangery housed all localities of the Department

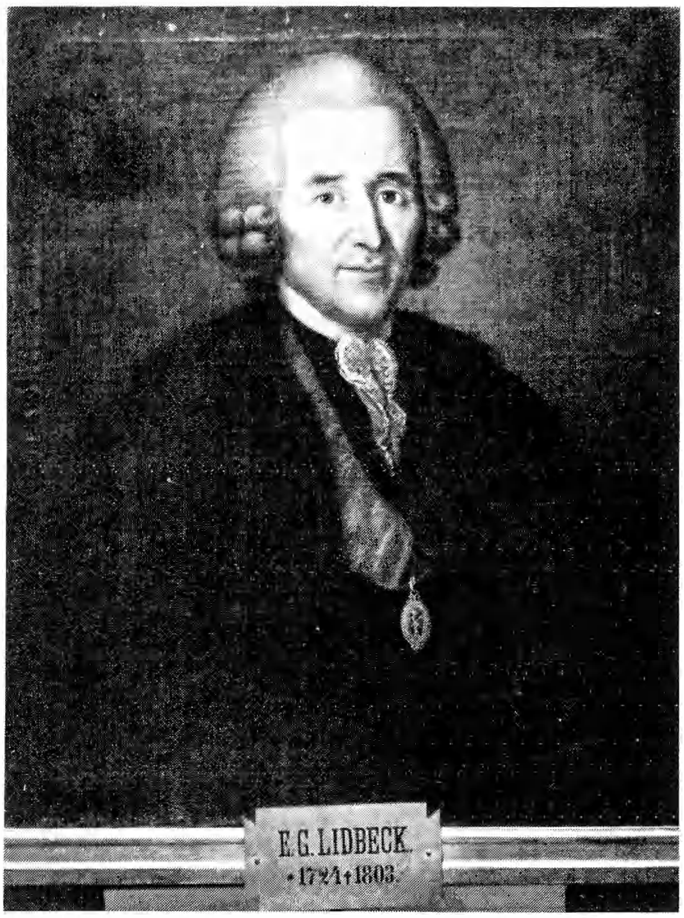

Fig. 1. E. G. Lidbeck. Oil painting by M. D. Roth 1787. University of Lund.

of Natural History and there was an anatomy room for medical studies.

Lidbeck is mainly known for an imposing but unsuccessful project for cultivating white mulberry trees (*Morus alba*) to provide food for silkworms. About 50,000 trees were planted in a field situated north of the Garden and great expectations for a Swedish silk industry were raised. Lidbeck proudly presented a large quantity of silk to King Gustavus III. Unfortunately several severe winters in the middle of the 1780's killed most of the mulberry trees as well as the silkworms and the Riksdag withdrew its support. The mulberry trees were replaced by a plantation of indigenous Swedish trees and cuttings of these were distributed on a large scale to farmers and townsmen in Skåne.

In the same field Lidbeck also cultived many other economic plants among them plants yielding dyes, e.g. madder, *Rubia tinctorium* and dyer's rocket (*Reseda luteola*) and medicinal plants. In accordance with his instructions Lidbeck also distributed these plants widely. With time most of this plantation was abandoned as the expected revenue failed to eventuate.

Lidbeck also paid much attention to planting trees to line avenues, or elsewhere, in many treeless areas of southern and western Skåne and on the coastal dunes. The white willow (*Salix alba*), which as pollards forms the characteristic silhuettes well-known from many avenues, was introduced at that time. Most of these trees originally came from Lidbeck's plant nursery in Lund. No doubt his tree-planting in the countryside of Skåne had far more lasting results than many of his other activities.

A. J. Retzius

In 1772 Anders Jahan Retzius was appointed to a new post as *botanices demonstrator.* Lidbeck had devoted hardly any time to teaching students or to scientific research. Eventually Retzius was allotted Zoology, Theoretical Botany, the Garden, the greenhouse and the scanty Natural History collections, whereas Lidbeck restricted himself mainly to Practical Botany combined with his position as 'plantagedirecteur'.

From 1795 Retzius took over wholly as Professor of *Historia Naturalis,* i.e., Botany, Zoology, Geology and Chemistry. He had a profound knowledge of all these disciplines. His botanical works include *Observationes botanicae* (6 folio volumes 1779–1791) where many new species were described, mainly from remote places including even India and China. He published *Florae Scandinaviae prodromus* (2 editions, 1779 and 1795) and *Flora oeconomica Sueciae* (1806). The latter is a critical survey of economic plants found growing wild in Sweden, especially medicinal herbs. This work is a result of the fact that the Chair also included 'Practical Economy'. In scope it resembles that of Carl Linnaeus, *Materia medica,* and draws on the mine of information (more or less reliable) found in the herbals of the 16th and 17th centuries.

Retzius had large natural history collections which he bequeathed to the University in 1811. The botanical part is the oldest herbarium in a modern sense still extant at Lund. It was later (1843) amalgamated with another collection which had belonged to Erik Acharius, a professor and provincial physician at Vadstena. The most important part of the Acharius herbarium, viz. the Lichens (c. 1,000 specimens, including many types) was sold to Helsinki. The remainder (c. 12,000 specimens, all other groups) is also valuable especially for several isotypes from Thunberg, Sparrman, Swartz and others. This historical collection from about 1770 to 1815 is now kept in a separate section in the Botanical Museum.

The Agardh period

C. A. Agardh

Retzius retired in 1812 but remained Head of the Botanical Garden till 1818. The Chair he had occupied was divided into three separate Chairs, Botany (incl. Practical Economy), Zoology and Chemistry (including Geology). The first holder of the Chair of Botany was Retzius's most outstanding student, Carl Adolph Agardh, then twenty-seven years of age. After receiving his doctor's degree at the age of twenty he acted as 'docent' in Mathematics, as *botanices demonstrator* and 'adjunct' in Practical Economy. He had a wide knowledge of the whole plant kingdom. He published important works on phanerogams, in particular economic plants, and also the first textbook of Botany in Swedish (*Lärobok i botanik* 1829–1832). Its two parts treat "Organography", i.e. the formation and function of plant organs explained by speculative theories founded on the ideas of contemporary German natural philosophers, chiefly Friedrich von Schelling, and Plant Biology dealing with plant physiology and plant chemistry, etc. Above all he is renowned as being the founder of Phycology. Some fundamental works are *Dispositio algarum Sueciae* (1810–1812), *Synopsis algarum Scandinaviae* (1817), *Species algarum* (1820–1828, not completed), *Systema algarum* (1824) and *Conspectus criticus diatomacearum* (1830–1832).

Notwithstanding his interest in theoretical speculations Agardh was extremely gifted as a practical organiser. He was a member of the Swedish Riksdag for several periods. He published an important textbook of Political Economy and founded a savings bank and a fire insurance company, both still in existence.

In his youth Agardh was known for his liberal ideas, but later he developed into a conservative statesman. In 1835 he was appointed Bishop of Karlstad in central Sweden. As a theologist he can be characterized as orthodox and intolerant.

Fig. 2. A. J. Retzius. Oil painting by M. D. Roth 1786. Botanical Museum.

E. Fries, J. E. Areschoug and J. W. Zetterstedt

C. A. Agardh had a number of students one of which, Elias Fries, was to become as renowned as his teacher. He was nine years younger than Agardh and like him received his doctor's degree at the age of twenty. He published major works on Swedish vascular plants, e.g. *Novitiae florae Suecicae* (1814–1824, 2nd enlarged edition 1828, additions 1832–1845) and *Flora hallandica* (1817–1819). *Flora scanica* (1835–1837) was the first major flora of the province of Skåne and the only one to include the cryptogams. In his early years he was an active lichenologist. He issued the exsiccata *Lichenes suecici* (1824–1828) and the important work *Lichenographia europaea reformata* (1831) where he presented a classification of the Lichens that differed widely from that developed by 'the father of Lichenology', Erik Acharius.

Fries is famed as the founder of Mycology. Some major works from his time at Lund are *Observationes mycologicae* (1815–1818), *Symbolae gasteromycorum* (1817–1818) and most notably *Systema mycologicum* (1821–1832). According to the *International Code of Botani-*

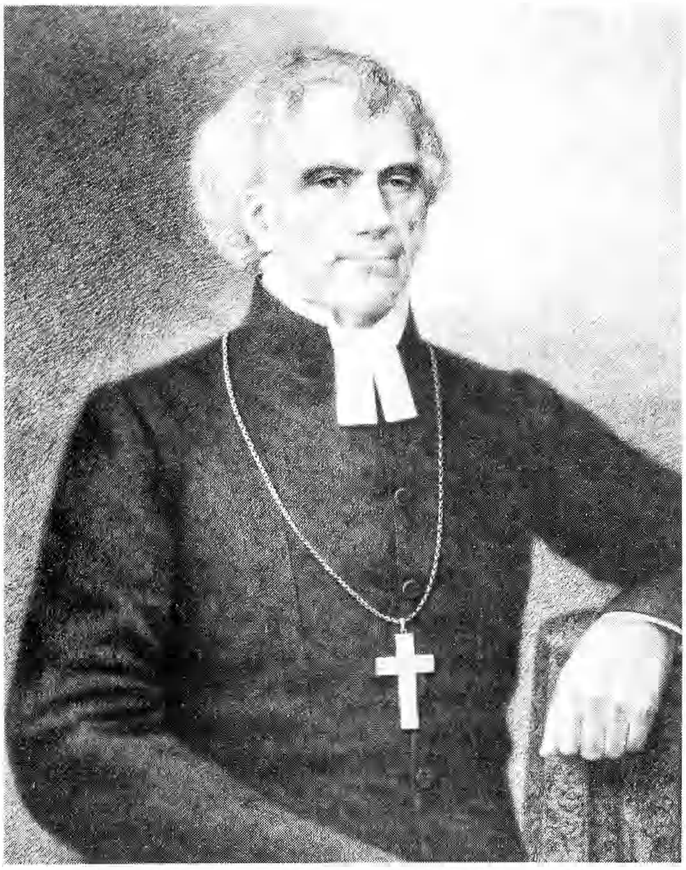

Fig. 3. C. A. Agardh. Pencil drawing c. 1850. Botanical Museum.

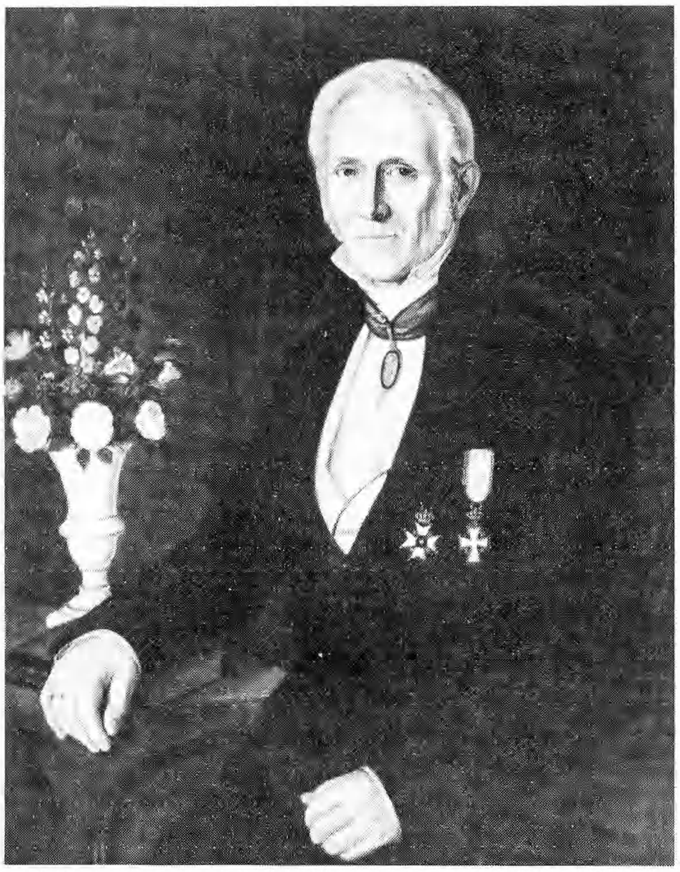

Fig. 4. J. W. Zetterstedt. Oil painting by C. D. F. Grandjean c. 1850. Botanical Museum.

cal Nomenclature this fundamental work is the nomenclatural starting point for many groups of Fungi ('Fungi caeteri').

In 1834 Fries was appointed Professor of Practical Economy at Uppsala. From 1851 he also became Professor of Botany and Head of the Garden there. In 1835 when the Chair at Lund became vacant after Agardh the University, and especially the students, tried in vain to persuade him to return to Lund.

One of C. A. Agardh's last students was John Erhard Areschoug. He defended his thesis *Symbolae algarum rariorum Florae Scandinavicae* in 1838. As the Chair of Botany was vacant, the Professor of Zoology, Sven Nilsson, acted as *praeses*. Areschoug succeeded Elias Fries as Professor at Uppsala from 1858 to 1876. He published a large number of papers on most groups of Algae. One of his most outstanding students was Frans Reinhold Kjellman who was a participant in the Vega Expedition, the author of important works in particular on Arctic Algae and Professor at Uppsala 1883–1907. Several of Kjellman's students became distinguished phycologists, for example Harald Kylin, Professor at Lund 1920–1944 (see below p. 460); Carl Skottsberg, Professor at Göteborg 1919–1948; and Nils Eberhard Svedelius, Professor at Uppsala 1914–1938. Thus the phycological tradition from C. A. Agardh was continued into the present century.

Eventually (in 1839) Johan Wilhelm Zetterstedt was appointed Agardh's successor at Lund. He had been *botanices demonstrator* and 'adjunkt' in Natural History for a long time, but his main interest was Entomology and he wrote some important papers in this field. For Botany, however, his tenure was a period of little progress.

J. G. Agardh

In 1854 Zetterstedt was succeeded by Jacob Georg Agardh, the son of Carl Adolph Agardh. Like his father he had been attached to the University since his early days. He received his doctor's degree at the age of nineteen and became 'docent' at twenty-one. He was soon considered a prominent phycologist and on his death enjoyed international repute as the leading authority in this field. His main phycological works are *Species, genera et ordines algarum* (1848–1901, not completed, the final part being issued posthumously), *Nya bidrag till algernas systematik* (New contributions to the systematics of the Algae, 1873–1890) and *Analecta algologica* (1892–1899).

The 'Agardh Herbarium', which was bequeathed to the University in 1895, comprises C. A. and J. G. Agardh's phycological collections including much material sent to them from colleagues in all parts of the world, altogether about 51,000 specimens, many of them types. Thanks to these unique collections Lund has remained an international centre of phycological research. The Agardh Herbarium is still consulted by a large number of botanists.

J. G. Agardh also published major works on vascular plants. In *Theoria systematis plantarum* (1858) he published a natural classification that differed fundamentally from the arrangement of the plant families deriving from Jussieu and generally accepted during the 19th century. In many respects J. G. Agardh was far ahead of his time. He used embryological characters, such as apotropous and epitropous ovules, as criteria of systematic affinity. These ideas were eventually accepted half a century later. On the whole, J. G. Agardh's *Theoria* was of little significance for the various phylogenetic systems developed by other botanists. He sometimes used expressions such as "evolutionary trends" in systematics. However, this does not imply that he accepted a theory of evolution in the sense of Darwin. In a comparison of Linnaeus's and Darwin's ideas of the origin and stability of the plant species (1885) he stated: "We can hardly avoid believing that the organisms have arisen by means of supernatural action. It will be most favourable for Science to accept an inevitable Wonder." (Translated from the Swedish.)

J. G. Agardh was one of the most outstanding contemporary botanists but had little contact with his students. He never lectured on his main field of research, marine Algae. Very few students were inspired to take up phycological studies. Among these can be mentioned Otto Nordstedt (1838–1924), a well-known expert on freshwater algae, especially Desmidiaceae, Curator and Librarian at the Department of Botany at Lund, and for more than fifty years Editor of *Botaniska Notiser*. He received an Honorary Doctor's degree from the University in 1881 and became Honorary Professor in 1903.

Fig. 5. J. G. Agardh. Oil painting by N. J. Ohlsson 1835. Botanical Museum.

J. G. Agardh had inherited considerable practical ability and a great interest for politics and political economy. He was a member of the Riksdag for several periods, chairman of the City Council of Lund and chairman of the boards of several banks and insurance companies.

However, J. G. Agardh's most important contribution to the practical promotion of Botany at Lund were new premises for the Department of Botany including a new building, a new botanical garden and new greenhouses during the period 1862–1868 in a field immediately east of the town boundary. The main building, which has remained unchanged externally, comprised a lecture room and living quarters for the gardener-in-charge on the ground floor and rooms for herbaria and for senior students on the first floor. It was later given the name of Agardhianum. It now comprises the office, and rooms for the Professor of Systematic Botany and for the Editor of Botaniska Notiser, and premises for cytotaxonomic research.

The exterior of the greenhouse has also remained largely as it was in the 1860's. The interior has recently been rebuilt to conform with modern requirements. In the Garden Agardh arranged the plant families according to the system developed in his *Theoria* and this layout remained largely unaltered till the 1960's.

In a memorandum to the University's Consistorium (September 1868) Agardh presented an account of the completed work. He estimated the number of plant species cultivated in the Garden and greenhouses to about 6,000 adding: "This number will be sufficient for the teaching of Botany at a minor University".

New fields of research are opened up

F. W. C. Areschoug

When J. G. Agardh retired in 1879, F. W. C. Areschoug was appointed his successor. With Areschoug began a period of intense botanical activity at Lund. Under the influence of modern ideas gathered from Germany in particular he introduced new branches of Botany, especially plant anatomy and, to some extent, plant physiology. Many of his students defended theses in descriptive anatomy using refined microscope techniques. He was less interested in physiological plant anatomy which was then developed mainly in Germany by Haberlandt and other German botanists.

Areschoug took a great interest in the taxonomy of vascular plants, not the least in 'critical' genera such as *Mentha, Rumex* and *Rubus*. His investigations on the blackberries were of great interest. He developed a theory (not supported by experiments) that forms of *Rubus* may have arisen through sudden changes often occurring simultaneously in several places.

He published '*Skånes Flora*' (ed. 1, 1866, ed. 2, 1881). The second edition, much enlarged, included elaborate descriptions of species, subspecies and varieties and fairly detailed lists of localities for less common species. Hybrids were also recognized to some extent. Many previous botanists in Sweden, especially the school led by Elias Fries, had argued that hybrids were of no significance in botanical taxonomy. Areschoug's *Skånes Flora* remained the standard work for more than eighty years, till the beginning of the 1960's.

Fig. 6. F. W. C. Areschoug. Oil painting (after a photograph) by K. Aspelin 1911. Department of Ecology.

Areschoug was receptive for many of the modern trends of thought of his time. A few words from his obituary of Charles Darwin (1883) can illustrate this: "Eventually have the voices of those naturalists become silent who have tried and defeat Darwin's genial theory, the only principle which can explain the origin and development of organic nature." (Translated from the Swedish.) It can be mentioned that Areschoug's colleague August Quennerstedt, who occupied the Chair of Zoology at Lund, continued to believe in a divine creation as described in the Bible.

The many botanical activities at Lund towards the end of the nineteenth century led to an urgent need for new premises. The small rooms of the Agardhianum used for teaching, research and laboratory work and which housed the museum collections, soon became over-crowded. In 1888 funds were granted for building a 'Botanical Laboratory'. The ground, the 'Eastern Promenade', immediately south of the Garden was presented to the University by the City Council. The new building, which was completed in 1892, included an auditorium that could seat 100 persons and a laboratory for plant physiology, both on the ground floor. On the first floor were rooms for plant anatomy and for the cryptogamic collections, the phanerogam herbarium and the library remaining in the Agardhianum.

Areschoug devoted a great deal of time to building up morphological collections of fruits, seeds, stems, roots, etc., either dry or preserved in alcohol. This 'morphological museum' contained several peculiar items such as a specimen of *Welwitschia mirabilis*, presented by the famous lion hunter Charles John Andersson and a gigantic specimen of the 'vegetable sheep' *Raoulia hemispherica* from New Zealand. For a long time this museum was housed in some rooms in the Botanical Laboratory and later on in the Agardhianum. In the 1960's, when these rooms were needed for other purposes, the museum collection was unfortunately split up. Parts of the dry collections are now stored in the attic of the Laboratory.

The Botanical Laboratory remained the site of the Department of Plant Physiology and Plant Anatomy till 1963 when a new building to house the Department of Plant Physiology was built outside the Garden. The former Botanical Laboratory now houses the Department of Plant Ecology.

Most of Areschoug's students who published their theses on plant anatomy became high school masters. Two of them who advanced in quite other directions outside Lund are mentioned here:

Jakob Eriksson (1874, *Studier öfver Leguminosernas rotknölar*, i.e. Studies on the root-nodules of the Leguminosae). This thesis was defended 'under Agardh' but in his acknowledgement Eriksson names Areschoug as his supervisor. It is a detailed morphological study, well illustrated and including plates of microscopical sections. However, he did not understand the real nature of these structures, and that they house nitrogen-fixing bacteria, which was revealed in the middle of the 1880's.

Eriksson soon moved to Stockholm. In 1876 he was employed as a botanist by the Academy of Agriculture, and from 1886 as Head of its Research Institute of Plant Physiology with the title of Professor. From 1906 to 1913 he was Professor and Head of the Central Institute for Agricultural Research. He became a mycologist of international repute, and published a large number of papers mainly on parasitic fungi of inportance in agriculture and horticulture.

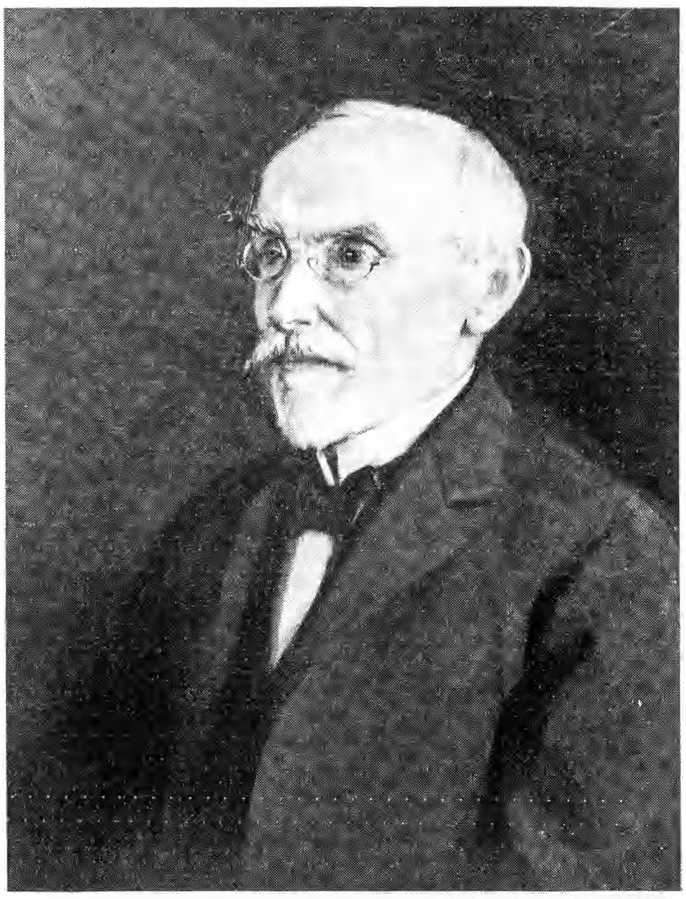

Fig. 7. S. Berggren. Oil painting by A. Stenbäck c. 1905. Botanical Museum.

Gunnar Andersson (1892, *Studier öfver örtartade, slingrande stammars anatomi. I. Humulus*, i.e. Studies on the anatomy of herbaceous climbing stems). He became 'docent' at the University College of Stockholm in 1893. Later (1909–1928) he was Professor of Geography at the College of Commerce in Stockholm. He was inspired by Alfred Nathorst (see below p. 471) to study the subfossil flora as represented in the Swedish peat bogs and published a number of papers on this topic. He and his brother, Selim Birger, were the authors of the important work *Den norrländska florans geografiska fördelning och invandringshistoria med särskild hänsyn till dess sydskandinaviska arter*, i.e. The geographical distribution and the history of immigration of the flora of Norrland with special regard to its south-Scandinavian species, published in 1912. Special attention was paid to the postglacial changes in climate which explain the wide distribution (to the middle of Norrland) of many plants, such as *Corylus* and *Quercus,* during the mild Atlantic period (c. 6000–4000 B.C.).

Areschoug's successors; the Department of Botany is divided up

In 1898 Areschoug was succeeded by Sven Berggren, a student of J. G. Agardh's. He had been 'docent' at Lund from 1866 till 1881 and after two years at Uppsala became Associate ('extraordinarie') Professor at Lund in 1883. Unlike most contemporary botanists at Lund he travelled to remote places such as Spitsbergen, Greenland, New Zealand and California and brought back important collections to Lund. Some of these were worked up fairly soon (e.g. the marine Algae, by J. G. Agardh), whereas many of the Bryophytes, Berggren's own chief interest, remained undetermined till after his death and some of them are still waiting to be revised.

As early as 1902 Berggren was succeeded by Bengt Jönsson who became Professor of "Botany especially Anatomy, Physiology and Biology". At the same time Svante Murbeck was appointed Associate Professor of "Botany, especially Systematics, Morphology and Plant Geography". In 1909 he was appointed Professor. These two Chairs still exist although their names have been changed to some extent.

Developments in Plant Physiology and Microbiology

Bengt Jönsson had been 'docent' since 1880. As one of Areschoug's first students he published several works on Plant Anatomy, but soon transferred his interest to Plant Physiology which he had studied in Germany, mainly in Jena (under Strasburger) and in Berlin (under Frank). In 1881 he published a comprehensive work, *Om embryosäckens utveckling hos Angiospermerna* (On the development of the embryo-sac in the Angiosperms). He was also interested in seed control and economic plants and published a widely used textbook *Gagnväxter* (Plants useful to man) (1910, 2nd completely revised edition by H. G. Simmons, 1935).

Fig. 8. B. Jönsson. Photograph c. 1900. Department of Ecology.

After Jönsson's premature death in 1911 Bengt Lidforss was appointed to the Chair of Botany. He had studied under Areschoug and Jönsson but also at the leading centres of Plant Physiology in Berlin and Jena. He published significant papers including some on the biology of pollen grains and on *Die wintergrüne Flora* (1907). He also began investigations on the genus *Rubus,* i.e. cultivation and crossings, to study the origin of new species and forms. His studies on the blackberries were influenced by Areschoug but also by the idea of mutations in plants developed by Hugo de Vries in Amsterdam. As an experimental taxonomist he was something of a pioneer, but his research was put to an abrupt end by his death in 1913, at the age of only forty-five.

Lidforss should also be remembered for his brilliant stylistic talent. His essays *Naturvetenskapliga kåserier* (1908–1913) played an important part in the distribution of modern concepts in the biological sciences. He was also the leader of a broad fraction of radical students at Lund and deeply concerned with political and cultural problems in general.

Lidforss was succeeded in 1915 by Herman Nilsson-Ehle as Professor of Botany, especially Anatomy, Physiology and Biology, He was internationally known in the field of Plant Genetics, in particular for his major work *Kreuzungsuntersuchungen an Hafer und Weizen* (1909–1911) where he showed that the recently re-discovered Mendelian laws are widely valid although their effects may sometimes be hidden by secondary complications, e.g. the 'polymeric factors' described by him. He was also one of the pioneers in using the theoretical results of heredity in practical plant breeding. From 1900 he had held a position at the Plant-Breeding station at Svalöv. The University soon applied for a Personal Chair in Genetics for Nilsson-Ehle, and this was granted by the Riksdag in 1917. The further development of this new Chair will be treated later.

In 1920 Harald Kylin was appointed, after much competition, to Nilsson-Ehle's former Chair of Botany. He had not been a student at Lund, as all previous professors of Botany at Lund had been since Lidbeck, but had received his degree at Uppsala. Kylin published major papers on most aspects of the Algae: anatomy, chemistry and taxonomy. With him the phycological tradition at Lund experienced a revival. However, his most important work, the comprehensive monograph *Die Gattungen der Rhodophyceen*, was published posthumously in 1956. It should be added that he showed less interest in Plant Physiology and there was little apparatus in his laboratory for such research though this branch was included in his Chair of Botany.

Kylin was particularly gifted as a teacher and spent much time supervising his many students. A great number of theses, especially on Algae, were published during his twenty-five years as Professor. Only a few of them are mentioned here:

Georg Borgström (1939, *The transverse reactions of plants. Outlines of a new interpretation on the significance of growth hormones for life-processes in plants*). 'Docent' at Lund, Head of the Institute for Plant Research and Refrigeration of Food at Nynäshamn 1941–1950. Head of the Swedish Institute for Food Preservation Research 1950–55, Honorary Professor 1953, Professor of Food Research at the State University of Michigan, East Lansing, Mich., U.S.A.

Fig. 9. B. Lidforss. Pencil drawing by C. W. Hormuth 1910. Botanical Museum.

Tore Levring (1940, *Studien über die Algenvegetation von Blekinge, Südschweden*). 'Docent' at Lund, 'Laborator', later Professor, of Marine Botany at the University of Göteborg, 1950-1979).

Karl Björling (1942, *Undersökningar rörande klöverrötan. Studier av utvecklingshistoria och variation hos Sclerotinia trifoliorum*. i.e. Investigations on clover stem rot. Studies on development and variation in *Sclerotinia trifoliorum*). 'Docent' at Lund, Assistent at the State Institute of Plant Pathology, Åkarp unit, 1938–1947, Head of the Botany Department of this Institute in Stockholm 1947–1949, Professor of Plant Pathology at the College of Agriculture at Ultuna, Uppsala, 1949–1975.

Kylin's rival was Henrik Lundegårdh. He had received his doctor's degree at Stockholm (a thesis on the cytology and karyology of vascular plants), but his main fields of research, in particular after he was appointed 'docent' at

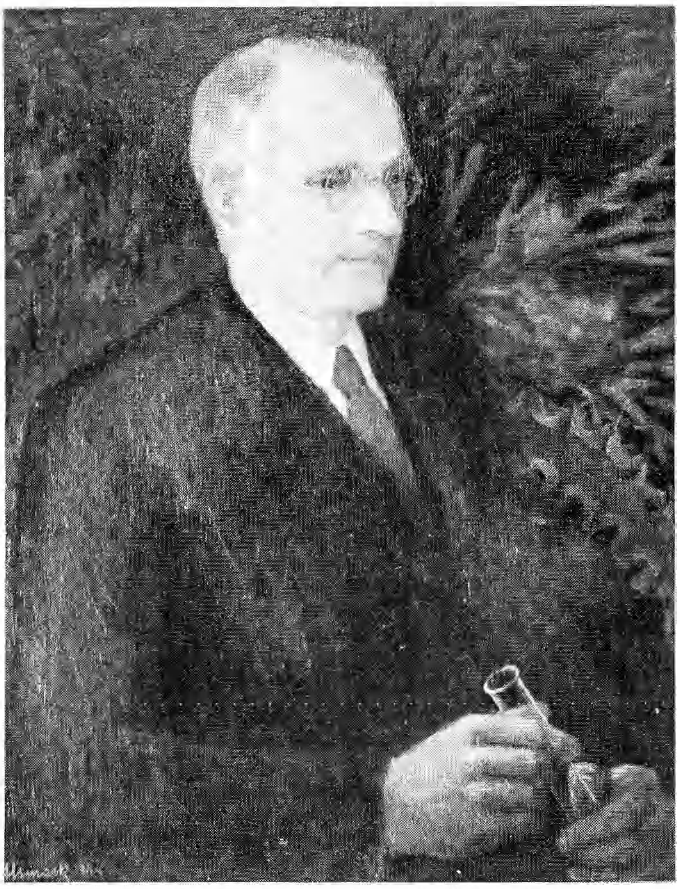

Fig. 10. H. Kylin. Oil painting by E. Alsmark 1944. Department of Ecology.

Lund in 1915, were Plant Physiology (mainly tropisms) and Plant Ecology. He was especially gifted as a constructor of apparatus. In 1917 he founded a station for ecological research on Hallands Väderö, which was in use till the end of the 1920's. In 1926 he was appointed Professor at the Central Institute of Agricultural Research in Stockholm. From 1935 to 1955 he was Professor at the College of Agriculture at Ultuna, Uppsala. A major work first published during his time at Lund is *Klima und Boden in ihrer Wirkung auf das Pflanzenleben* (1925; many later editions in several languages).

When Kylin retired in 1944 Hans Burström succeeded him as Professor of Botany, especially Physiology and Anatomy. He had received his doctor's degree in Stockholm and was known as a leading plant physiologist, particularly in the field of growth and metabolism. After the end of World War II, when the finances of the University had somewhat improved, Burström received funds for urgent improvements to the Botanical Laboratory. As a result of the extensive scientific activity and the rapidly increasing number of students the premises soon became too confined. In 1963 a building was erected to house the Department of Plant Physiology, and was provided with all facilities for modern research.

In 1951 Hemming Virgin, who had also graduated from Stockholm, became 'docent' at Lund. He was an acknowledged expert on cell physiology including photosynthesis. He became 'Laborator' (Associate Professor) at the College of Agriculture at Uppsala in 1958. In 1962 he was appointed Professor of Physiological Botany at the University of Göteborg.

Per Halldal, a graduate from Oslo, became 'docent' at Lund in 1958. He has published significant works in particular on phototaxis and related problems in Algae, especially on unicellular organisms. In 1963 he became 'Lektor' (Senior Lecturer) at the University of Göteborg, and in 1967 Professor of Physiological Botany at the University of Umeå. In 1972 he returned to the University of Oslo as Professor of the same subject.

At the end of the 1960's Burström initiated a project for utilizing the large amount of leaf protein produced by certain plants, such as species of *Atriplex* and *Amaranthus*, growing on soils rich in nitrate. The products obtained may prove to be important either for human consumption, particularly in the under-developed countries, or for feeding non-ruminant animals.

The following is a selection of the theses published during Burström's time as Professor at Lund.

Anders Kylin (1960, *Active and passive uptake of sulphate by green tissues of plants*). 'Docent' at the University of Stockholm 1960–1973, Professor of Physiological Botany at the College of Agriculture in Copenhagen 1973–1976, Professor (Chair sponsored by the Swedish Natural Science Research Council) at the Department of Physiological Botany, University of Lund, from 1976.

Torsten Ingestad (1962, *Macro element nutrition of pine, spruce and birch seedlings in nutrient solution*). Professor of the Physiology of Forest Trees at the College of Forestry at Uppsala from 1964.

Lennart Eliasson (1963, *Studies on the effects of translocated herbicides on aspen and pea with particular regard to the responses of the roots*). 'Docent' at Stockholm 1964–1973, Professor of

Physiological Botany at the University of Umeå from 1973.

Ahmed Fadeel (1964, *Studies on the metabolism of chlorophyllous roots*), Professor at the University of Kuwait from 1972.

Sune Pettersson (1966, *Active and passive processes of the sulphate transport through roots*). 'Docent' and 'Lektor' at Lund 1966–1979, Professor of Plant Physiology at the University of Agriculture at Uppsala from 1979.

Lars Olof Björn (1967, *The effect of light on the development of root plastids*). 'Docent' at Lund, 1967–1971, Professor of Physiological Botany at the College of Agriculture in Copenhagen 1971–1972, at the University of Lund from 1972.

In 1972 Burström was succeeded by Lars Olof Björn. His researches include the formation of chloroplasts and the relation between photosynthesis and growth.

In 1946 a Branch of Microbiology was established within the Department of Plant Physiology. With an increasing understanding of the important part played by the microorganisms in nature additional funds were made available for research and teaching. In 1960 a Division of Microbiology was established with Börje Norén as its Head. He had received his doctor's degree at Uppsala and published a large number of papers, in particular on Myxobacteria. In 1975 he was appointed Professor of Microbiology at the University of Agriculture at Uppsala. In 1966, Claes Weibull became the first Professor of Microbiology at Lund. He had begun his undergraduate studies at Lund but later moved to Uppsala where he took his doctor's degree. He is known as the author of significant papers on the structure and chemistry of various groups of Bacteria. The Department of Microbiology was first housed in the same building as the Department of Plant Physiology, but in 1969 it moved to premises of its own. Since 1975 Birgit Hertz, one of Weibull's students, has been Head of the Division of Microbiological Ecology.

S. Murbeck and his school

As previously mentioned Svante Murbeck was appointed Professor of Botany (especially Systematics) and Head of the Botanical Garden in 1902. He had received his doctor's degree under Areschoug in 1891 (*Beiträge zur Kenntniss der Flora von Südbosnien und der Herzegovina*). During the following decade he published critical studies on a number of genera (e.g. *Agrostis, Asplenium, Cerastium, Gentiana, Rumex, Stellaria*), many of them being revisions for a forthcoming new edition (ed. 12) of Hartman, *Skandinaviens Flora*. However, this work was discontinued after the appearance of the first fascicle in 1889. Murbeck undertook four journeys to northern Africa (Tunisia, Algeria and Morocco) and published major works on the flora of these countries.

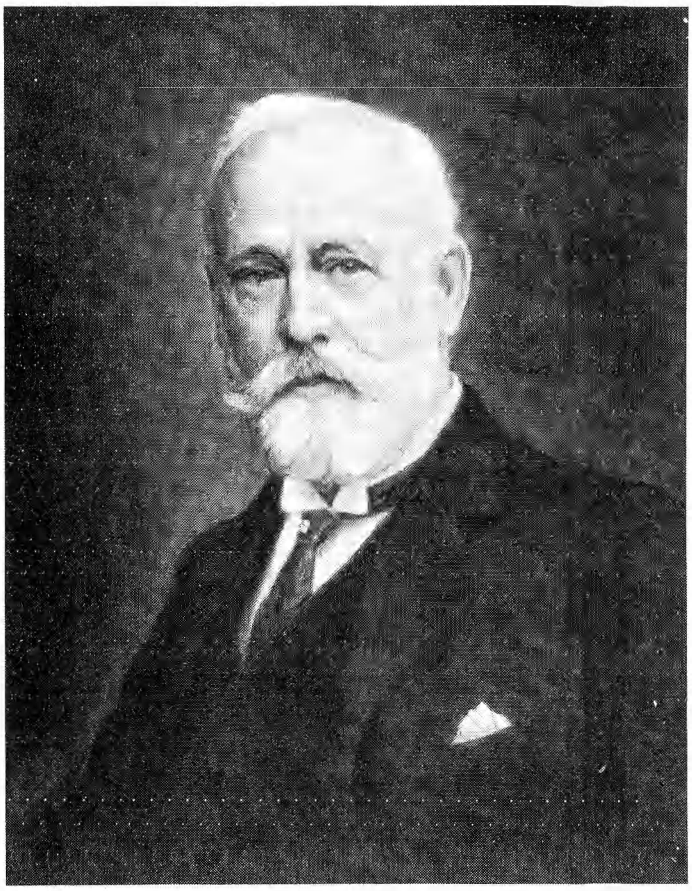

Fig. 11. S. Murbeck. Oil painting by C. Ljungberg 1934. Botanical Museum.

He was interested in the numerous taxa described in the aggregate species *Alchemilla vulgaris* (first as subspecies, later as species). In some classic papers (1897, major work 1901) he investigated their seed development and demonstrated that their constancy is the result of apomictic reproduction. After his appointment he published several major works, such as those on the flower morphology of *Papaveraceae* and *Rosaceae*. From his later years can be mentioned the comprehensive monographs on

Celsia (1925) and *Verbascum* (1933, several supplements). The latter is a masterpiece of its kind. It was completed after eight years of concentrated work after his retirement in 1924.

Murbeck has also gone down to posterity as the founder of the Botanical Museum. A new building was erected (1911–12) between the Agardhianum and the Botanical Laboratory and the herbarium collections were moved from these two buildings. Owing to depleted financial resources during World War I and at the beginning of the 1920's only the ground floor was made ready to house the collections. On the first floor a large room was taken over for the Department's library whose stock of books had been growing considerably through donations in particular from the Agardhs, Areschoug, Jönsson and Nordstedt, later also from Murbeck and Kylin. On the same floor were also rooms for the Professor (for some time he even lived there). During the twenties and thirties the second floor was gradually taken into use for the increasing number of collections and later also the third floor mainly for the collections of cryptogams. The Museum, once considered more than adequate, is now over-crowded and the need for new premises is urgent.

Murbeck could at times be severe and exacting but he attracted a considerable number of students. Some of those who took their doctor's degree during his time can be mentioned here, the diversity of their research illustrating the broadening horizons of systematic botany during the first quarter of this century.

Herman G. Simmons (1906, *The vascular plants in the Flora of Ellesmereland*). 'Docent' at Lund 1906–1914. Lecturer in Botany and Zoology at the College of Agriculture at Uppsala 1914–1932. Honorary Professor 1917. He took part in several expeditions, for instance to the Faeroes and to Greenland and adjacent areas, and published major papers on Arctic Botany.

Herman Nilsson-Ehle (1908, *Kreutzungsuntersuchungen an Hafer und Weizen*). 'Docent' at Lund 1909–1915. Professor of Botany 1915–1917, of Genetics 1917–1938, see above p. 460 and below p. 468.

Heribert Nilsson (1915, *Die Spaltungserscheinungen der Oenothera Lamarckiana*). Honorary Professor 1926. Professor of Botany, especially Systematics, 1934–1948, see below p. 464.

Einar Naumann (1917, *Undersökningar öfver fytoplankton ... inom vissa syd- och mellansvenska urbergsvatten*, i.e. Investigations on freshwater phytoplankton ... in southern and central Sweden). 'Docent' at Lund, of Botany 1917–1920, of Botany and Limnology 1920–1929. Professor of Limnology 1929–1934, see below.

Artur Håkansson (1923, *Studien über die Entwicklungsgeschichte der Umbelliferen*). 'Docent' for many years, for a time also Acting Professor, a research officer attached to the Department of Genetics 1945–1961 (personal appointment), Honorary Professor from 1948. He began as an embryologist, influenced by Murbeck, and in his later years he also published papers on apomixis in *Poa alpina* and *Potentilla*. However, his most important contributions fall within the field of Cytology. He often worked on material placed at his disposal by other botanists such as Murbeck (*Celsia* and *Verbascum*) and Heribert Nilsson (*Oenothera* and *Salix*). He was one of the first to demonstrate that the chromosome rings known from *Oenothera* are the result of structural changes (translocations) and that the behaviour of these rings explains the complex variation in this genus described by Hugo de Vries, Heribert Nilsson and others. Håkansson was the founder of a school of Cytology in southern Sweden and for many years its inspiring leader.

Among Murbeck's collaborators Otto R. Holmberg should also be mentioned. He never took an academic degree, but was known as an outstanding taxonomist specializing in the vascular plants of Scandinavia. From 1909 till 1930 he was Curator of the Botanical Museum (after Nordstedt). He published two parts of *Skandinaviens Flora* (1922, 1926). This was to take the place of *Skandinaviens Flora* by C. J. and C. Hartman, which had appeared in many editions during the 19th century, but the project was broken off by Holmberg's premature death.

Limnology

When Murbeck retired in 1924 Einar Naumann became Acting Professor for two and a half years. He was a brilliant scientist and a colourful personality but took no great interest in traditional taxonomy. Instead, he was a pioneer in the field of Limnology, i.e. freshwater biology. He published significant papers, in particular on the classification of lakes, on the production of nutriment, on bog ore and on the colouring of water caused by various organisms. In 1929 he was offered a Personal Chair of Limnology. His premises at Lund were modest (a few rooms in the old Department of Chemistry), but the Limnological Laboratory at Aneboda in the province of Småland offered better facilities, at least during the summer.

Naumann died in 1934, only 43 years old, and none of his many students were qualified to succeed him as Professor. In 1942, Sven Thunmark was appointed Acting Professor and in 1947, when the Riksdag had granted funds for a permanent Chair, he became Professor of Limnology. Thunmark had worked with Naumann at Aneboda, but he was a student of Uppsala and a member of the active school of Plant Sociology founded by Rutger Sernander and G. Einar Du Rietz. He received his doctor's degree there in 1942 (*Über rezente Eisenocker und ihre Mikroorganismengemeinschaften*). He published major papers on the vegetation of some lakes in Småland and in later years devoted much time to the increasing problems of polluted waters but met with little cooperation and many of his suggestions were not carried out until after his death.

In 1969 Thunmark was succeeded by Sven Björk, one of his students who two years previously had defended his thesis on *Ecologic investigations on Phragmites communis. Studies in theoretic and applied limnology*. His first step as Professor was to find new premises to replace those in the former Department of Chemistry where the limnologists had worked since Naumann's days. With increasing resources the Department of Limnology has attracted many students and is largely concerned with practical aspects such as the restoration of polluted or filled-up lakes.

Recent developments in Plant Taxonomy

In 1927 Thore C. E. Fries was appointed Murbeck's successor as Professor of Botany, especially Systematics. He belonged to the renowned family of botanists and was the grandson of Elias Fries. He had received his doctor's degree at Uppsala in 1913 (*Botanische Untersuchungen im nördlichsten Schweden*, an outstanding work on Plant Sociology and Vegetation History in Swedish Lapland). He spent some time in central Africa and published major papers dealing mainly with the flora and phytogeography of the high mountains of Kenya. In 1930 he made a further journey to South Africa and Rhodesia accompanied by two of his students, Henning Weimarck and Tycho Norlindh. The expedition ended tragically for Fries who died suddenly of pneumonia. His two companions continued their collections in Rhodesia and managed to bring the extensive material to Lund. Fries can be considered as the initiator of the interest in the study of the vegetation and flora of southern Africa which flourished at Lund during the decades after his death. (See below.)

Fig. 12. E. Naumann. Photograph c. 1930. Department of Limnology.

When Fries died the Chair remained vacant for more than three years. After much discussion and the publication of a large number of pamphlets by the applicants Heribert Nilsson was appointed Professor in 1934. He had been Professor of Systematic Botany and Genetics at the College of Agriculture at Uppsala since 1932, and before that had been attached to the Departments of Botany and Genetics at Lund as 'docent'. For a number of years he had also been engaged in plant breeding at Weibullsholm, and had been Acting Professor at the College of Agriculture at Alnarp.

As a scientist he differed in most respects from Fries. At the beginning of his studies he had been greatly influenced by Lidforss. He tackled taxonomic problems with the help of experimental methods such as crossings and analyses of hybrids. He was no friend of classical taxonomy founded on the study of herbarium sheets. In his thesis (1915) he set out to show that the complex variation in *Oenothera lamarckiana* was a result of the recombination of genes in accordance with the Mendelian laws. He believed neither in mutations nor in cytogenetics. For many years he denied the importance of chromosomes in heredity and never accepted the cytological facts which in the 1920's provided quite a different explanation of the *Oenothera* problem.

From his youth till his death in 1955 he worked to clarify the variation within the difficult genus *Salix*. He did not accept the traditional taxonomical treatment of this genus in Floras and monographs. Instead he crossed a great number of species and analysed the hybrids and their descendants in great detail. He also crossed the hybrids with their parents or with other hybrids and even produced an 'octonary' fertile hybrid (i.e. deriving from eight different ancestors). He published several major papers on his results, but it is doubtful if these have had any lasting influence on the taxonomy of *Salix*.

It has been said of Heribert Nilsson that he was an orthodox Mendelist and was sceptical of all other theories including the theory of evolution as presented by Darwin and many subsequent biologists. He denied the existence of a slow continuous development in the plant and animal kingdoms as described by Lyell and most paleontologists. Like Cuvier at the beginning of the 19th century he believed in a series of gigantic catastrophes that were caused by 'extratelluric' forces and that exterminated the flora and fauna of the whole world. However, the gametes of the former organisms survived and within half an hour had recombined to synthesize a new flora and a new fauna.

Heribert Nilsson summarized all arguments he could find against Darwinian evolution in his magnum opus *Synthetische Artbildung. Grund-Linien einer exakten Biologie.* It was published in 1953, two years before his death, as a result of eleven years of work. It is a comprehensive work (more than 1,300 pages including an extensive summary in English and a long list of literature), but in spite of its many challenging ideas it has attracted little attention among biologists and geologists.

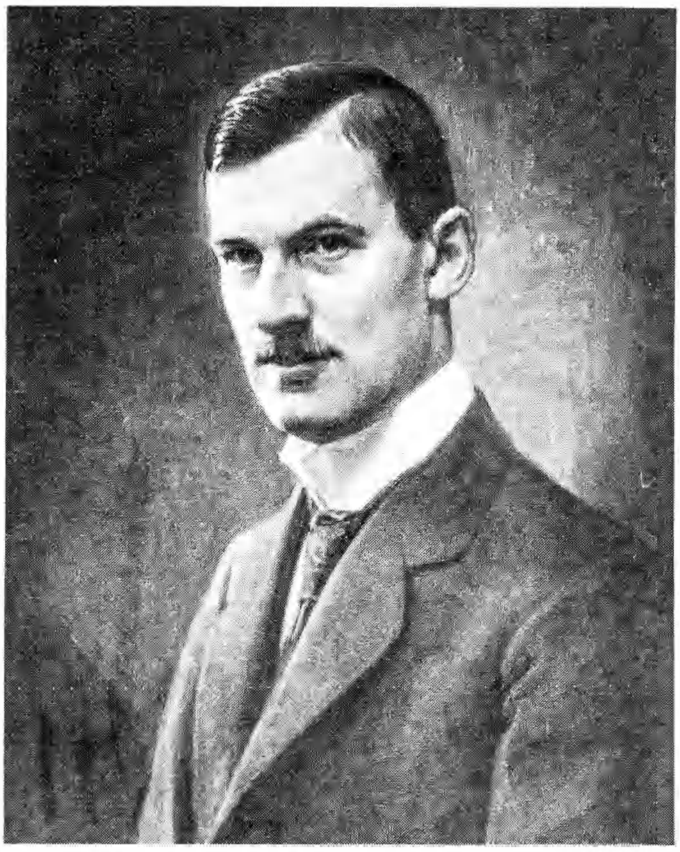

Fig. 13. Th. Fries. Oil painting (after a photograph) by C. Ljungberg 1950. Botanical Museum.

One might think that a professor who was known for so many peculiar ideas would be isolated from collegues and students. However, his criticism was often constructive and discussions with him could be very stimulating even in topics far removed from his own fields of research. In fact his time as Professor was a period of great activity in Systematic Botany, and a large number of theses were published even though not all of them could be considered as having been directly inspired by him. A selection of these follows:

Henning Weimarck (1934, *Monograph of the Genus Cliffortia*). 'Docent' at Lund 1935–45. Curator of the Botanical Museum at Lund 1945–1949, Head of the Botanical Garden at

Göteborg 1949, Professor of Botany, especially Systematics, at Lund 1950–1969. See below.

Eric Hultén (1937, *Outline of the history of arctic and boreal biota during the quaternary period*). Curator of the Botanical Museum at Lund 1932–1944, Professor and Head of the Botany Department of the Natural History Museum, Stockholm, 1945–1961. As a student from Stockholm he had taken part in a Swedish expedition in the Bering Sea area and published a large *Flora of Kamtchatka and the adjacent islands*. At Lund he continued to work on Arctic Floras and published *Flora of the Aleutian Islands* in 1937. The first parts of his comprehensive *Flora of Alaska and Yukon* (issued between 1941 and 1949) were completed while he was at Lund. Here he also began to collect material for his *Atlas över växternas utbredning i Norden* (i.e. Atlas of the distribution of vascular plants in northwestern Europe), which maps the areas of some 1,850 species in Scandinavia and adjacent districts round the Baltic (1950, 2nd ed. 1971). Phytogeographical groups and possible immigration routes are discussed.

Hakon Hjelmqvist (1940, *Studien über die Abhängigkeit der Baumgrenzen von den Temperaturverhältnissen unter besonderer Berücksichtigung der Buche und ihrer Klimarassen*. 'Docent' at Lund for many years, Honorary Professor in 1977. See below p. 472.

Tycho Norlindh (1943, *Studies in the Calenduleae. 1. Monograph of the genera Dimorphotheca, Castalis, Osteospermum, Gibbaria and Chrysanthemoides*). Curator of the Botanical Museum at Lund 1950–1965, Professor and Head of the Botany Department of the Natural History Museum, Stockholm, 1965–1972. He has published a number of works on the floras of South Africa and Rhodesia and also the first part of *Flora of the Mongolian Steppe*.

Stig Waldheim (1947, *Kleinmoosgesellschaften und Bodenverhältnisse in Schonen*), 'Laborator' of Plant Biology at Lund 1948–1962. He was a graduate of the University of Lund but was greatly influenced by the school of Plant Sociology led by G. E. Du Rietz at Uppsala. He published papers on the taxonomy and ecology of Mosses, and on the vegetation of calcareous fens.

Ove Almborn (1948, *Distribution and ecology of some South Scandinavian lichens*). Curator of the Botanical Museum at Lund 1966–1980. Like Waldheim he was influenced by the Du Rietz school. He has later specialized in the lichen flora of southern Africa.


Fig. 14. H. Nilsson. Oil painting by M. Emond 1948. Botanical Museum.

Heribert Nilsson retired in 1948 and was succeeded by Henning Weimarck in 1950. During the fifteen years he held the post of 'docent' at Lund he published a great number of papers mainly on the flora and phytogeography of southern Africa. Together with Tycho Norlindh and others he published many results from the Rhodesia expedition. Several students became interested in African botany and made further journeys often in cooperation with botanical institutes in southern Africa.

Weimarck was also interested in the flora of Scandinavia. From the 40's can be mentioned papers on *Quercus*, *Prunus* and *Aethusa*. He used experimental and cytological methods, including crossings. During the 50's and 60's a large number of students took up research of this kind. The facilities at the Agardhianum were improved and a Division of Cytotaxonomy came into being.

For many years Weimarck devoted the major

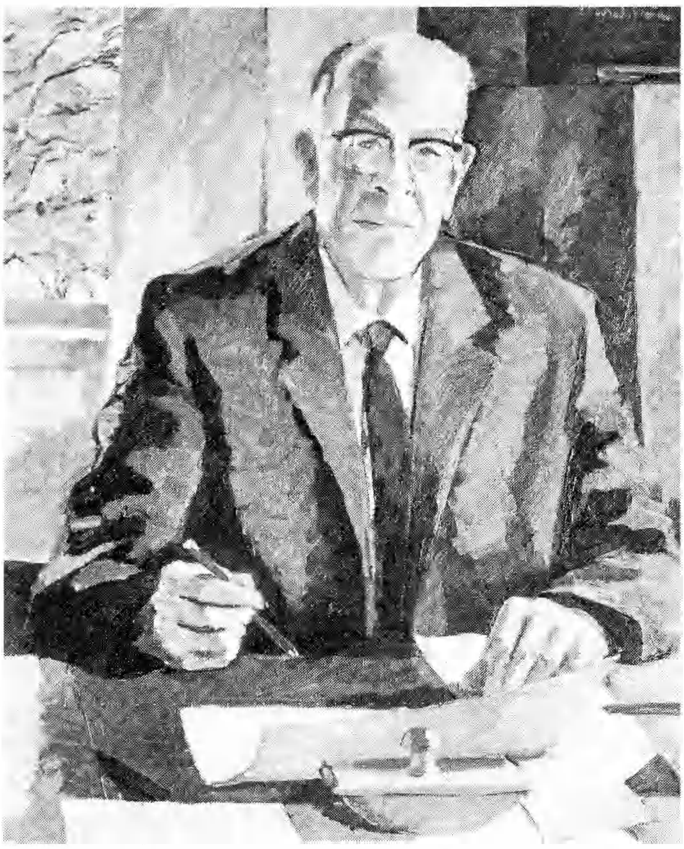

Fig. 15. H. Weimarck. Oil painting by G. Nordström 1969. Botanical Museum.

part of his time to the flora of the province of Skåne. In 1938 he began an extensive survey of the vascular plants of Skåne, special interest being paid to the many districts from where little was known of the flora. He engaged many students and amateur botanists in this project. All data gathered from field-studies, herbaria and literature were examined critically and collected in a comprehensive card index. *Skånes Flora* was published in 1963. It is a major work (more than 700 pages) containing fairly detailed descriptions of some 1,800 species known (as wild or introduced) from Skåne. A large number of species not reported from Skåne but occurring in the adjacent provinces and in Denmark are also listed. Information on ecology and distribution is brief. Weimarck worked for many years (especially after his retirement in 1969 till his death) on a supplement which was to contain dot maps showing the distribution of most species in Skåne. This work is to be published in the near future.

Some theses published during Weimarck's time as Professor are mentioned here.

Hans Runemark (1956, *Studies in Rhizocarpon*). Professor of Systematic Botany at Lund from 1970. See below.

Nils Malmer (1962, *Studies on mire vegetation in the archaean area of southwestern Götaland, South Sweden.*) 'Laborator', later Professor, in the Division of Plant Biology, Lund, from 1963. See below p. 468.

Rolf Dahlgren (1963, *Studies in Aspalathus and some related genera in South Africa*). During his eight years as 'docent' at Lund he published a large number of works mainly on South African vascular plants, including extensive monographs of the large genus *Aspalathus* (Leguminosae) and the endemic family Penaeaceae. Since 1972 he has been Professor at the Botanical Museum, University of Copenhagen.

Bertil Nordenstam (1968, *The genus Euryops, Compositae*). He is the author of several major works on South African vascular plants, mainly Compositae and Liliaceae. In 1970 he was appointed Curator at the Botany Department of the Natural History Museum, Stockholm, and in 1980 he became Professor and Head of the recently established Department of Vascular Plants there.

Börje Lövkvist should also be mentioned among Weimarck's collaborators, especially as he was responsible for most of the chromosome numbers recorded in *Skånes Flora*. He was a student of Lund but later moved to Uppsala where he published his thesis, *The Cardamine pratensis complex. Outlines to its cytogenetics and taxonomy,* in 1956. From 1957 to 1963 he held the post of 'docent' at Lund. In 1963 he was appointed 'Laborator', later Professor, at the College of Agriculture, Alnarp Division, specializing in the cultivation of ornamental plants.

In 1970 Hans Runemark was appointed Professor of Systematic Botany at Lund. He was originally a lichenologist, but after having completed his thesis in 1956 he initiated an extensive project, viz. an investigation of the flora of the Aegean islands in Greece. Together with a large number of students he is working on a detailed survey of the flora of this archipelago.

Some of his other students have begun research on various Scandinavian taxa, as a rule using cytotaxonomic methods. Among the many theses published during the 1970's only one will be mentioned:

Arne Strid (1970, *Biosystematics of the Nigella arvensis complex. With special reference* *to the problem of non-adaptive radiation*). This work is part of the series *Studies in the Aegean flora*. Together with Rolf Dahlgren he made trips to South Africa during 1965 and 1966. He has published several papers on South African topics including monographs of the genera *Adenandra* (Rutaceae) and *Bobartia* (Iridaceae). In 1972 he was appointed Professor of Systematic Botany at the University of Copenhagen. A recent result of his studies on the flora of Greece is *Wild flowers of Mount Olympus* (1980).

In the 1970's a Branch of Botanical Cytotaxonomy (BCT) was organised at the Wallenberg Laboratory which was erected adjacent to the Department of Plant Physiology in the northern part of Lund. Some of the research workers previously housed in the Agardhianum could move in there. Provisional experimental greenhouses in the Tuna area in the eastern part of the town were also taken over.

In the 1960's a Division of Marine Botany was established in the Department of Systematic Botany. From the beginning it has been led by Torgny von Wachenfeldt. At first it was housed in a room in the Agardhianum, later it moved to a laboratory near the Tuna greenhouses and at the end of the 1970's, when its activities had increased considerably, it was given new premises in the 'Kemicentrum' (Department of Chemistry). The research programme includes taxonomic and ecological studies on the marine vegetation of the Sound and the Baltic, mainly Macroalgae and Phytoplankton. Much attention is being paid to factors controlling production and to the effects of pollution.

Plant Ecology

A Division of Plant Biology was established towards the end of the 1940's by Stig Waldheim. In 1948 he was appointed 'Laborator', a new post which he kept till 1962. Nils Malmer succeeded him in 1963, from 1969 with the title of Professor. For nearly twenty years the plant biologists had only access to two small rooms in the basement of the Museum, but in the middle of the 1960's they took over the Botanical Laboratory from the plant physiologists. See above p. 461.

In 1979 the former Division of Plant Biology was separated from the Department of Systematic Botany and became the Department of Ecological Botany. The past decade has seen much activity in this field, and the Department is now overcrowded. Among the diversity of projects can be mentioned analyses of ecosystems, effects of pollution, vegetation of wetlands and vegetation of woodlands, especially beech, oak and conifer forests. Close collaboration has been established with the National Swedish Environment Protection Board and with the local nature conservancy units which are attached to the county administration.

The following are two of the numerous theses published in Plant Ecology during the 1970's.

Mats Sonesson (1970, *Studies on mire vegetation in the Torneträsk area, northern Sweden*). Since 1974 he has been Professor and Head of the Nature Research Station at Abisko under the Swedish Academy of Sciences. He is the leader of several ecological projects in northern Lapland.

Folke Andersson (1970, *Ecological studies in a Scanian woodland and meadow area, southern Sweden*). Since 1979 he has been Professor of Terrestrial Ecology at the Department of Ecology and Environment Protection, University of Agriculture, Uppsala (Chair sponsored by the Natural Science Research Council).

Genetics

As stated above (p. 460) Herman Nilsson-Ehle was granted a Personal Chair in Genetics in 1917. The new Department had no premises of its own but occupied a single room in the Botanical Laboratory. The problem was partially solved when the geneticists were given a laboratory and a few acres of land for experimental purposes at the College of Agriculture at Alnarp outside Lund. In 1925 when Nilsson-Ehle also became Director of the Plant Breeding Institute at Svalöv (western Skåne) the Department of Genetics moved to better facilities there.

Nilsson-Ehle's research yielded many results of great practical importance, for instance his study of mutations in oats, wheat and barley. The many new cultivars that came from Svalöv contributed largely to the reasonably adequate agricultural output during the Second World War compared with the meagre harvests during the First World War.

He also paid much attention to the improvement of forest trees and fruit trees. He discovered a triploid (2n=57) 'giant aspen' (*Populus tremula* var. *gigas*) in Skåne, the leaves of which were notably larger than those of the normal type. This find initiated the establishment of a Forest Tree Breeding Institute at Ekebo near Svalöv led by Professor Nils Sylvén. Later on a Fruit Tree Breeding Institute was established at Balsgård in northeastern Skåne with Dr Ingvar Granhall as its first Director. Valuable results were yielded by studying tetraploids (for instance of apples) or by crossing related species such as apples and pears.

Nilsson-Ehle was certainly one of the most renowned representatives of Swedish natural science during the first half of this century, also internationally. He was an enthusiastic teacher, full of constructive ideas. His period as Professor coincided with one of diverse development in Genetics, and his inspiring personality attracted many students.

The following are some representative theses published during his time:

Göte Turesson (1922, *The genotypical response of the plant species to the habitat*). 'Docent' at the Department of Botany at Lund 1921–1935. Professor of Systematic Botany and Genetics at the College of Agriculture at Uppsala 1935–1958. He is internationally known as the founder of Gene Ecology, and for introducing the concepts of ecotype and ecospecies which he applied to the study of differentiation in various genera and species, especially seashore plants such as *Armeria* and *Atriplex,* and inland and coast forms of *Hieracium umbellatum*.

Olof Tedin (1925, *Vererbung, Variation und Systematik in der Gattung Camelina*). Research in plant breeding in Stockholm, at Weibullsholm and from 1931 at Svalöv as Division Leader, specializing in potatoes. Honorary Professor 1958.

Gunnar Nilsson-Leissner (1925, *Beiträge zur Genetik von Triticum spelta und Triticum vulgare*). Research in plant breeding at Svalöv 1923–1944. Professor and Head of the Central Seed Control Institute, Stockholm, 1944–1961.

Johan Rasmuson (1927, *Genetically changed linkage values in Pisum*). Research in plant breeding at Alnarp and Svalöv. Head of the Institute for the breeding of sugar-beets at Hilleshög, western Skåne, 1935–1960. Honorary Professor 1948.

Fig. 16. H. Nilsson-Ehle. Oil painting by A. Waldur 1937. Department of Genetics.

Arne Müntzing (1930, *Outlines to a genetic monograph of the genus Galeopsis. With special reference to the nature and inheritance of partial sterility*). Research in plant breeding at Hilleshög and Svalöv 1929–1938. Professor of Genetics at Lund 1938–1968. See below p. 470.

Fredrik Nilsson (1933, *Studies in fertility and inbreeding in some herbage grasses*). Plant breeding research at Weibullsholm, Undrom, Svalöv and Åkarp 1925–1946, Professor of Fruit and Berry Breeding at the College of Agriculture, Alnarp unit, 1946–1969.

Albert Levan (1935, *Zytologische Studien an Allium schoenoprasum*). Research in plant breeding at Hilleshög 1933–1938, at Svalöv 1938–1947. 'Laborator' (Cytology) at Lund 1947, Professor 1969–1971.

Åke Gustafsson (1935, *Studies on the mechanism of parthenogenesis*). 'Docent' 1935–1947 at Lund, Professor at the Institute of Forest Research, Stockholm, 1947–1968, Professor of Genetics at Lund 1968–1974. See below p. 470.

In 1938 Herman Nilsson-Ehle was succeeded by Arne Müntzing as Professor of Genetics. Two years earlier the Riksdag had granted funds to make the Chair a permanent one. As Director at Svalöv he was succeeded by Åke Åkerman.

Müntzing's thesis (1930) was a milestone in the history of Genetics. When crossing *Galeopsis pubescens* and *G. speciosa* he obtained one almost sterile triploid F_2 plant which was morphologically identical with *G. tetrahit*. By back-crossing this plant with *G. pubescens* he obtained a fertile tetraploid plant which could not be distinguished from a genuine *G. tetrahit*. These crossings resulted in the first synthesis of a previously known species and convincingly demonstrated the importance of chromosomes (especially with reference to polyploidy) in the formation of new taxa.

Müntzing's research covers a wide field of Genetics and Cytogenetics including apomixis in *Potentilla* and *Poa*, accessory chromosomes in various genera and experimental breeding of cultivated plants such as rye-wheat (*Triticale*) and tetraploid rye.

From 1938 the Department of Genetics was housed in provisional premises in the former Department of Chemistry. Eventually (in 1951) the geneticists were able to move to a new building in the northeastern part of Lund, but this proved to be too small from the beginning owing to the rapid development of Genetics especially after 1945. Several annexes have been added during the last two decades and some branches of the Department have moved to the Wallenberg Laboratories near by.

Müntzing's thirty years as Professor saw a notable expansion of the Department in all respects. It is internationally known for its research. The following is a selection of the many theses published in botanical Genetics during this period.

Erik Åkerberg (1941, *Cytogenetic studies in Poa pratensis and its hybrid with Poa alpina*). Research in plant breeding among other places at Weibullsholm and Ultuna, Professor and Head of the State Institute of Research in Agriculture at Ultuna 1954–1956, Head of the Plant Breeding Institute at Svalöv 1956–1971.

Ingvar Granhall (1943, *Genetical and physiological studies in interspecific wheat crosses*). Research in plant breeding at Svalöv 1939–1948 as Division Leader, Head of the Fruit Tree Breeding Institute at Balsgård 1948–1954, Professor and Head of the State Institute of Plant Pathology 1955–1971.

Áskell Löve (1943, *Cytogenetic studies on Rumex subgenus Acetosella*). Professor of Botany at Winnipeg, Manitoba, and at Montreal, Canada, later (1963–1974) at Boulder, Colorado, USA.

Robert Lamm (1944, *Cytogenetic studies in Solanum, sect. Tuberarium*). Research in plant breeding at Svalöv and Alnarp, Professor at the College of Agriculture, Alnarp unit, 1963–1971.

Axel Nygren (1946, *The genesis of some Scandinavian species of Calamagrostis*). 'Laborator' (Systematics and Genetics) at the College of Agriculture at Ultuna 1949–1962, Professor of Genetics there 1962–1978.

Kåre Fröier (1946, *Genetical studies on the chlorophyll apparatus in oats and wheat*). Plant breeding research at Svalöv 1945–1959 as Division Leader, mainly for textile plants, Professor and Secretary of the Swedish Academy of Agriculture 1960–1978.

Gunnar Östergren (1951, *The mechanism of co-orientation in bivalents and multivalents*). 'Docent' at Lund 1951–1963, Professor of Genetics at the College of Agriculture (now Swedish University of Agricultural Sciences) at Ultuna from 1963.

Arne Hagberg (1953, *Studies on heterosis*). Plant breeding research at Hilleshög and Svalöv (from 1953 as Division Leader), Head of the Plant Breeding Institute at Svalöv (the Swedish Seed Association) 1972–1979. Honorary Professor 1965. Professor and Head of the Department of Genetics and Plant Breeding at the Swedish University of Agricultural Sciences (Svalöv unit) from 1979.

Antonio Lima-de-Faria (1956, *Fine structure of the kinetochore and of the arms and its bearing on chromosome organisation*). 'Lic. biol.' in Lisbon 1945, matriculated at Lund 1947, 'docent' 1956–1969. Professor and Head of the Institute of Molecular Cytogenetics at Lund from 1969 (Personal Chair sponsored by the Swedish Natural Science Research Council).

Nils Nybom (1956, *Studies on radiation-induced mutations in barley*). Plant breeding research at Svalöv. Head of the Fruit and Berry breeding Institute at Balsgård 1960–1970. Honorary Professor 1965.

Arne Lundqvist (1958, *Studies on self-incompatibility in rye, Secale cereale L.*). 'Docent' at

Lund 1958–1963, 'Lector' there 1963–1968, Professor of Genetics at the College of Agriculture in Copenhagen 1968–1974, Professor of Genetics at the University of Lund from 1974. See below.

In 1968 Müntzing was succeeded by Åke Gustafsson. In the 1940's he published major works on *The genesis of the European blackberry flora* and on *Apomixis in higher plants,* the latter being a comprehensive survey of all known information on cytology, embryology, propagation, distribution and species formation in apomictic genera. He later returned to these subjects which he first dealt with in his thesis in 1935. His extensive production also includes studies on mutations induced by X-rays and other external agencies, a field of research that involves many aspects of importance for practical plant breeding.

In 1974 Arne Lundqvist was appointed Åke Gustafsson's successor. He and his students have continued the research initiated by Müntzing and Gustafsson and increased its already great diversity. Lundqvist's own investigations include self-incompatibility in Poaceae, chiefly rye, and in several other plant families.

Palaeobotany, Quaternary Botany and Palaeoethnobotany

Palaeobotany has never been greatly to the forefront at Lund, which is a remarkable fact as there are probably more plant fossils in the deposits of Skåne than in any other province in Sweden. The first finds of fossil plants were recorded in 1819 and 1820 by Sven Nilsson, later Professor of Zoology at Lund and also well known as a geologist and archaeologist. In the sandstone at Höör (central Skåne) he found impressions of large leaves (resembling *Musa,* according to C. A. Agardh). Nilsson stated that "it is a remarkable truth that this ancient forest has grown in a climate similar to that now prevailing in the tropics." (Translated from the Swedish.) Later he described a number of plant fossils from the Rhaetic-Liassic coal deposits in Skåne. A well-known genus of Mesozoic Cycadophyta, predominant in this formation and first found by Nilsson, has been named *Nilssonia* by the French palaeontologist Adolphe Brogniart.

Half a century later (1871) Alfred Nathorst, a young student at Lund, published finds of leaves of subfossil arctic plants, e.g., *Betula nana, Dryas octopetala* and *Salix reticulata,* in glacial layers of fresh-water clay in southern Skåne. The previous conceptions of a 'Great Ice Age' had been vague, but Nathorst's finds definitely confirmed that the melting of the ice was succeeded by an arctic climate and an arctic vegetation in much of northern Europe. His thesis *Om några förmodade växtfossilier* (On some presumed plant fossils), Lund 1874, proved that some so-called fossil algae are in reality impressions of various plants or animals. For a number of years he was 'docent' at Lund (Geology) and also worked as a geologist in Stockholm. In 1884 he became Head of a new Department of Palaeobotany (including Recent Archaegoniates) with the title of Professor at the Natural History Museum in Stockholm, a post which he held till 1917. He was also participant or leader of several expeditions to Spitsbergen and Greenland. The Department soon became known as a centre of palaeobotanical research. Nathorst and his successors published many works, especially on Arctic fossil plants, but also on the fossil flora of Skåne, which has since become fairly well known.

In the 1930's a Division of Historical Geology and Palaeontology was organized within the Department of Geology at Lund. Later Gustaf Troedsson became the first Professor and Head of this Division (1950–1954). He and his successor from 1956 to 1980, Gerhard Regnéll, and their students have mainly devoted themselves to Palaeozoology, but researches on plant fossils from Skåne have also been carried out. A major work by Troedsson, *On the Höganäs series of Sweden,* (1951) also records the significance of plant fossils (mainly Pteridophytes and Cycadophytes) in the coal layers (Rhaeto-Liassic) in northwestern Skåne.

In 1949 a new Division of Quaternary Geology was established within the Department of Geology with Tage Nilsson as its first Head, from 1969 as Professor. He defended his thesis, *Die pollenanalytische Zonengliederung der spät-und post-glazialen Bildungen Schonens,* at Lund in 1935. This work was largely influenced by the founder of pollen analysis, Lennart von Post, Professor in Stockholm, who worked out refined methods for determining a chronology of the latest postglacial. During the past three decades this Division has done much research along these lines with special reference to the relation between climate and vegetation history.

In 1971 Tage Nilsson was succeeded by one of his students, Björn Berglund. His thesis, *Late-quaternary vegetation in eastern Blekinge, southeastern Sweden,* was published in 1966. The Division moved from the Department of Geology to new premises in the northeastern part of Lund in 1973, and there is now in addition a Laboratory of Quaternary Biology and a Laboratory for Age Dating of subfossil material by the radiocarbon method.

In this connection should also be mentioned research in Palaeoethnobotany. During the last three decades Hakon Hjelmqvist (see above p. 466) has devoted much time to the study of the ancient history of cultivated plants, especially the cereals. He has worked out methods of analysing carbonized seeds and fruits and of interpreting impressions of seeds in ceramics from ancient settlements. He has established cooperation with archaeologists in Sweden and Denmark and published a number of papers on their finds, e.g., on the neolithic period of Sweden and on the Iron Age of Cyprus.

Phytochemistry

Phytochemistry has been established during the last three decades within the Department of Chemistry.

A Division of Biochemistry was organized in the 1950's with Gösta Ehrensvärd as its first Professor (from 1956 to 1975). He had received his doctor's degree at Stockholm, and he had held several posts as 'Docent' or Professor there. His own research covered a great many subjects within this expanding field, for instance studies on the metabolism or various organisms such as Bacteria and Fungi, including *Neurospora, Penicillium* and *Torulopsis*.

Among the many theses published from this Division only a few with relevance to Botany will be mentioned:

Sten Gatenbeck (1960, *Studies on the biosynthesis of anthraquinones in lower fungi*). 'Docent' at Lund, Professor of Biochemistry at the College of Technology, Stockholm, from 1969.

Klaus Mosbach (1965, *Studies on the biosynthesis of aromatic compounds in fungi and lichens*). 'Docent' at Lund, Professor of Biochemistry there from 1977.

In the 1960's a College of Technology was organized at Lund. It now constitutes the Technical Faculty of the University. In 1966 Börje Wickberg was appointed the first Professor of a new Division of Organic Chemistry within this Faculty. He was a graduate of Stockholm, a student of the renowned specialist in the chemistry of plant products, Holger Erdtman, and in 1959 he defended his thesis, *Studies in algal chemistry*. Wickberg and his students have investigated the chemistry of a great many plant substances, chiefly in the Fungi, much attention being paid to toxic compounds.

The rapid progress made in Phytochemistry, for instance in the study of the structures of the compounds or of metabolism, has been of value in several fields of Botany, in the first hand in Physiology, Ecology and Genetics (in particular cell biology), and, on an increasing scale, in Systematics. Chemical investigation has sometimes provided important criteria for the delimitation of species and other taxonomic units especially within the Fungi and Lichens but also in vascular plants.

The Botanical Garden

As mentioned earlier (p. 456) the present Botanical Garden was founded by J. G. Agardh in the 1860's. Until the past decade it has remained part of the Department with the Professor of Systematic Botany as Director. In 1972 the Garden was separated from the Department and organized as a special division directly under the University with Lennart Engstrand as Director. The close cooperation with the research and teaching activities of the Department has been retained, but the change has given rise to a more open attitude towards the general public. Guided tours of the Garden and the greenhouses are arranged, in particular for schoolclasses, and the number of visitors has increased considerably. The Garden has always been estimated by the public but during the last few years its value as a cultural centre has become more widely appreciated.

Concluding remarks

If we search for a common denominator to characterize teaching and research in Botany at the University of Lund during the past three hundred years, we can point to the University's almost chronic lack of funds. There has been no parallel to the rich estates bequeathed to the University of Uppsala in the seventeenth century by King Gustavus Adolphus. The 'golden age' in the 1950's and 60's, when the Swedish Natural Science Research Council and the Wallenberg Foundation gave generous support to the natural sciences, has been followed by a period with a harsher financial climate. Nevertheless we, the present generation of botanists at Lund, can be proud of our predecessors. Many of them attained results of the utmost importance and are of international repute though they have often worked under adverse conditions.

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Appendix. Index of Persons

Studies in the Aegean Flora XXIII
The Dianthus fruticosus complex (Caryophyllaceae)

HANS RUNEMARK

Runemark, H. 1980 12 15. Studies in the Aegean Flora XXIII. The Dianthus fruticosus complex (Caryophyllaceae). *Bot. Notiser 133:* 475–490. Stockholm. ISSN 0006-8195.

The *Dianthus fruticosus* complex consisting of obligate, fruticose chasmophytes endemic to S Greece is revised. The complex was previously divided into three species, *D. fruticosus* L., *D. creticus* Tausch (= *D. arboreus* auct. non L.) and *D. rhodius* Rech. fil. It is now referred to a single species *D. fruticosus* L., subdivided into 8 allopatric subspecies: ssp. *fruticosus,* ssp. *amorginus* Run. ssp. nov., ssp. *rhodius* (Rech. fil.) Run. stat. et comb. nov., ssp. *karavius* Run. ssp. nov., ssp. *occidentalis* Run. ssp. nov., ssp. *creticus* (Tausch) Run. stat. et comb. nov., ssp. *sitiacus* Run. ssp. nov., and ssp. *carpathus* Run. ssp. nov. The chromosome number 2 n = 30 is reported from two samples representing ssp. *amorginus* and ssp. *creticus* respectively. The ecology and distribution pattern as well as phytogeographical boundaries in the East Aegean are briefly discussed.

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Dianthus fruticosus s. lat. belongs to the Aegean chasmophytic relic element. Like most members of this element it is a long-lived, ± evergreen shrub. Taxonomically the complex seems rather isolated. The closest relative may be *D. rupicola* Biv. from S Italy, Algeria and the Balearic Islands. No close affinity exists with fruticose, chasmophytic *Dianthus* species in the Aegean such as *D. juniperinus* S. & S., *D. aciphyllus* Ser., *D. pulviniformis* W. Gr. (all endemic to Crete) and *D. elegans* Urv. (the East Aegean, W and S Turkey).

Three species have been described within the complex, viz. *D. fruticosus* L. (1753), *D. creticus* Tausch (1830) = *D. arboreus* auct. non L., and *D. rhodius* Rech. fil. (1943) but no infraspecific taxa. The three species, mainly distinguished on leaf characteristics, have been recognized without much comment in recent standard Floras. The single critical study so far was made by Davis (1953 pp. 106–111).

The extensive area of distribution of the complex in S Greece (Fig. 1) includes islands like Crete and Karpathos that have been isolated since the Messinian (i.e. for 5–6 millions of years). It indicates a high age for the complex as long distance migration is highly improbable (see Runemark 1969, Greuter 1971). The distribution of two of the taxa recognized (ssp. *occidentalis* and ssp. *amorginus*) includes areas which have probably been widely separated by sea since the Messinian. At least part of the present differentiation pattern seems therefore to have been established before the connections in the Aegean were broken.

The complex has apparently remained remarkably stable over millions of years, as with many other Aegean chasmophytes (cf. Greuter 1979). An important factor in this pronounced conservatism may be that chasmophytes, especially those confined to smooth rock walls, are ‘trapped’ in an extreme and very stable habitat (Snogerup 1971) resulting in a very specialized gene pool that prevents adaptive radiation into new habitats.

In contrast to the general stability in the complex a pronounced local differentiation is found. The majority of the populations known can be recognized on combinations of minor morphological features. They may represent random segregates of a previously much richer gene pool as well as results of non-adaptive radiation by genetic drift.

The populations are usually fairly small, most

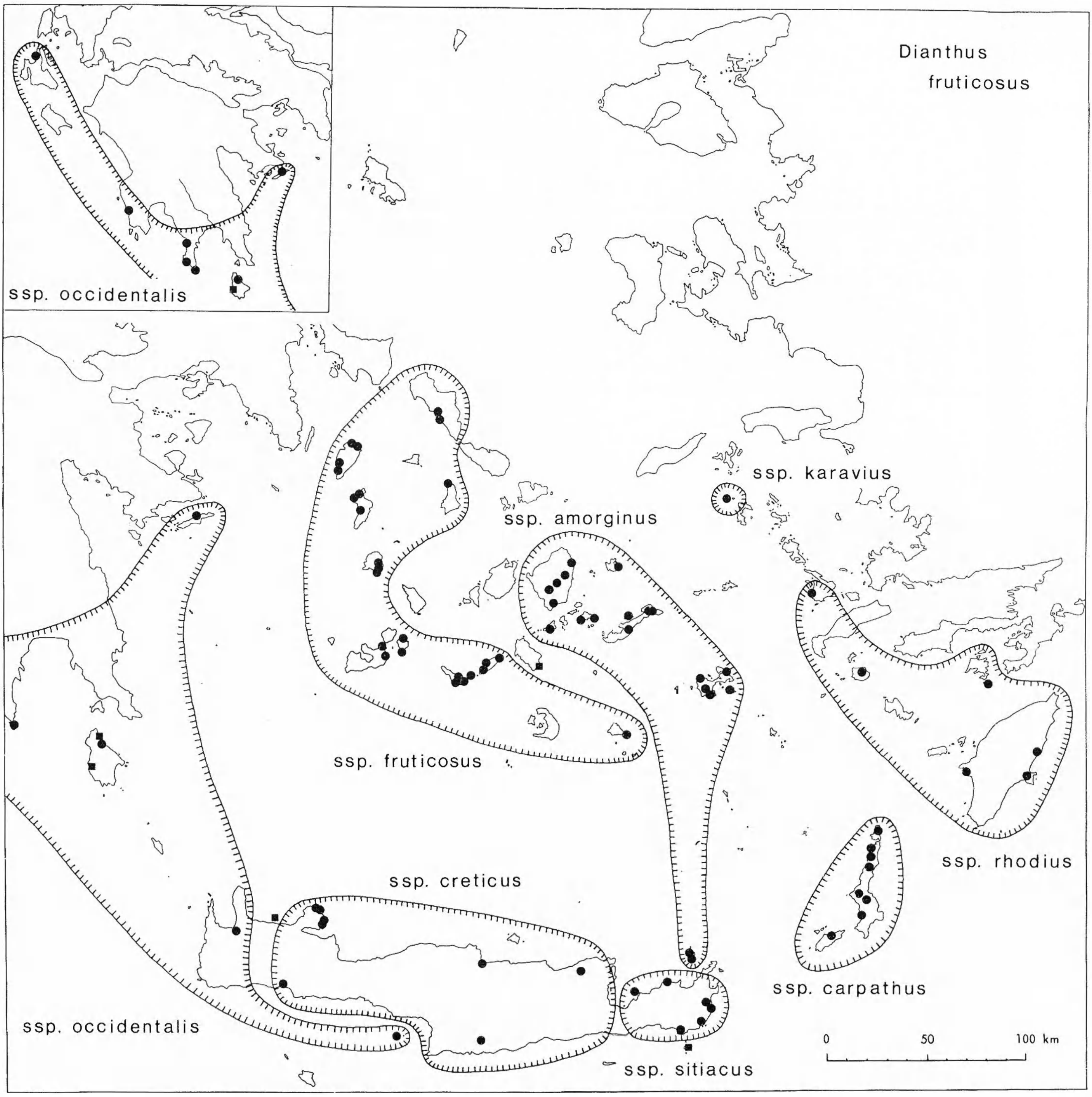

Fig. 1. The distribution of *Dianthus fruticosus*. Dots indicate localities from which material has been investigated by the author, squares show localities from which no material has been seen (cf. Material).

of them not exceeding 200 individuals, sometimes much fewer. Information on population structure is limited, usually most (occasionally all) individuals on a cliff are virtually inaccessible. The rather extensive material from a few localities (e.g. Assos on Kefallinia, Katholiko and Gazi in Crete, Finiki on Karpathos, the town cliff on Serifos) points to a considerable variation within populations. This agrees with observations on other relic chasmophytes in S Greece such as *Erysimum* sect. *Cheiranthus* (Snogerup 1967 a, b), *Allium bourgeaui* (Bothmer 1974) and the *Stachys swainsonii* complex (D. Persson in prep.).

Within the complex it is possible to recognize a number of regional form series which may be of interest for the future study of the history of the Aegean Flora. The paucity of clear-cut morphological discontinuities (apparently a common feature in *Dianthus* taxonomy) as well as the pronounced local differentiation excludes the use of specific status for these form series. The complex has therefore been treated as a single species, subdivided into eight allopatric, reasonably distinct subspecies.

The relationships between the subspecies can scarcely be evaluated on the evidence available. Some admittedly tentative remarks based on overall similarity and variation range follow:

(1) In Crete and on adjacent small islands four subspecies occur. Two of these, ssp. *creticus* and ssp. *sitiacus,* are apparently closely related and represent a common evolutionary line. The two others, ssp. *amorginus* and ssp. *occidentalis,* certainly have evolved along other lines.

(2) Ssp. *sitiacus* and ssp. *carpathus* are similar in habit, leaf texture and size. I am inclined to interpret this similarity mainly as a result of parallel (? adaptive) evolution.

(3) Ssp. *fruticosus* and ssp. *occidentalis* show certain similarities in variation pattern and may be derived from the same evolutionary line.

(4) From normal phytogeographical patterns in the Aegean ssp. *rhodius* could be expected to show affinities with South Aegean form series. However, no close affinity with ssp. *carpathus,* ssp. *sitiacus* or ssp. *creticus* can be traced. On the contrary some populations in this rather variable subspecies show marked similarities to ssp. *amorginus.*

(5) Ssp. *karavius,* represented by a single, spatially isolated population, is interpreted as an odd, local variant, now impossible to refer to any of the regional subspecies.

Material

The investigation is based on:

(1) Collections from the following Herbaria: ATH, B, C, E, K, LD, UPA, W, WU and W. Greuter's private herbarium (Gr). I am most obliged to the Curators and staffs of these Herbaria for placing their collections at my disposal. I wish especially to thank Professor D. Phitos, Patras, for kindly offering to collect flowering and fruiting material from Nisiros in the autumn of 1980.

(2) My own collections and field observations and collections by other botanists from Lund. Being myself a mediocre climber I am indebted to the efforts of my companions during field work in the Aegean. Some of the riskiest climbs have been made in connection with collecting *Dianthus.* Most memorable are Professor Nordenstam's climb of the 500 m high, almost vertical S wall of Kalamos on Anafi and Dr Bentzer's climb of the c. 300 m high, vertical wall of loose, weathered volcanic rock on eastern Milos.

The material investigated (from more than 90 localities) certainly represents the majority of existing populations. From 5 localities (indicated by squares on Fig. 1) no material has been studied:

Cyclades. Ios. Akr. Pirgari; plants inaccessible; observed by Runemark and Bentzer in 1967. *Crete.* Distr. of Kidonia, the island of Ag. Theodoro; plants inaccessible; observed by Rechinger in 1942; Distr. of Sitia, the island of Koufonisi, 1916(?) Gandoger, according to Rechinger (1943 p. 156). *Kithira.* Mylopotamo 1890 Major, according to Rechinger (1943 p. 156); Aj. Pelajia, observed by Greuter in 1974.

In the locality lists the following abbreviations of collectors' names have been used: Be (B. Bentzer), Bo (R. von Bothmer), D (P. H. Davis), E (L. Engstrand), G (M. Gustafsson), Gr (W. Greuter), Rech (K. H. Rechinger), R (H. Runemark), S (S. Snogerup), Str (A. Strid).

Ecology

Dianthus fruticosus is an obligate chasmophyte mainly occurring in the most exposed parts of the cliffs, predominantly in small cracks in smooth, vertical cliff walls (cf. the discussion on gradients in cliffs by Snogerup 1971 pp. 158, 159). It occurs in cliffs of all expositions and is one of the relatively few chasmophytes also common on very sunny, S-exposed cliff walls.

D. fruticosus is mainly confined to maritime cliffs (cf. Runemark 1969) close to or within a few kilometers from the sea at altitudes ranging from a few meters above sea level to 300 m. In only a few cases has it been found further inland and at higher altitudes (in the Asterousi Mts in S Crete, on Karpathos and Naxos). Most extreme in this respect is the locality on the extensive limestone cliff on the W side of the mountain Oros Zeus on central Naxos, 8 km from the sea, where it reaches an altitude of 900 m.

The vegetation period of *D. fruticosus* extends over most of the year, though with a marked decrease in activity in mid-winter. Vigorous growth occurs all through the summer from June to August. Flowering normally starts in June and proceeds until September or October (cf. p. 480). *D. fruticosus* is exceptional among Aegean chasmophytes in its unusually long flowering period, but many other chasmophytes have their main vegetative development during the summer and flower late. As examples can be mentioned *Staehelina fruticosa,* and the *Campanula heterophylla* and *Lactuca acanthifolia* complexes.

Phenologically these species are not at all adapted to the present climatic conditions in the Aegean where practically no rain falls from May to September. The vigorous growth throughout the summer as well as the late flowering before the autumn rains point to a continuous water supply even during the dry summer period.

Many Aegean cliffs constitute the edges of elevated land. Water percolating from the rock at higher altitudes reappears in places as permanent or temporary seepage on cliffs. However, maritime chasmophytes are in no way confined to this type of cliffs and moreover they generally avoid seepage sites. Many cliffs rich in chasmophytes are situated on narrow ridges that have no external water supply. One example is the only known locality for *D. fruticosus* ssp. *karavius* on the rocky islet of Petrokaravi (10 km W of Patmos) situated on the upper part of a c. 70 m high, very narrow sea cliff only c. 200 m long. Also large parts of the cliff wall that have broken off but which are still upright and even large boulders at the foot of a cliff may occasionally be inhabited by vigorous chasmophytes.

The very heavy summer dew is certainly an important factor for the survival of many perennial plants in maritime habitats in the Aegean. However, the dew can hardly on its own account for the water needed for vigorous growth and flowering. The obvious conclusion would be that *D. fruticosus* as well as several other chasmophytes can utilize water stored in the rock over long periods.

Phytogeography

Cliffs have always attracted botanists working in the Mediterranean because of the abundance of rare endemics. The cliff habitat has certainly been floristically better explored than any other biotope in the Aegean. The cliff flora in the Aegean has been extensively discussed by Rechinger (1951), Davis (1951), Runemark (1969), Greuter (1971) and Snogerup (1971). Detailed biosystematic studies of Aegean chasmophytes have been published by Snogerup (1967 a, b) and Bothmer (1974).

Dianthus fruticosus is one of the most widely and evenly distributed Aegean chasmophytes (cf. map of maritime cliffs in Runemark 1969 p. 112). It is only absent from a few islands rich in chasmophytes in the Central Aegean: Levitha and Kinaros (E of Amorgos), Sirina, Safora and Karavi (between Astipalea and Karpathos) and Sifnos (W Cyclades).

The beauty of *D. fruticosus* has attracted the attention of man, apparently already in antiquity. Paintings of flowers in the palaces of Knossos and Zakros in Crete have been interpreted as depicting *D. fruticosus* (cf. Goulandris et al. 1968 p. 6). It therefore does not seem improbable that *D. fruticosus* was brought into cultivation and later has become naturalized in new sites, especially as several localities are situated in the vicinity of old castles and monasteries. However, the variation pattern with mainly discrete, local populations as well as the regional differentiation do not support this hypothesis. It is certainly a mere coincidence that Aegean chasmophytes often occur in the vicinity of old castles and monasteries as such buildings were usually placed close to or on large maritime cliffs for strategic reasons.

The most distant and spatially isolated population of *D. fruticosus* grows on walls and cliffs at the old castle of Assos on Kefallinia. The population is morphologically distinct but shows clear affinities with populations in Peloponnisos. Other outposts occur far from human dwellings, e.g. on Mani in Peloponnisos, on Idhra and on two extremely steep islets in the East Aegean (Petrokaravi and Trambeto).

D. fruticosus has its centre of variation in the Cardaegean (cf. map in Greuter 1971 p. 50). It has an unusual extension westwards along the south and west coast of Peloponnisos to the island of Kefallinia and another along the east coast to Idhra. The only other Aegean chasmophyte with such a wide range is *Brassica cretica* (Snogerup unpubl.) though the *Symphytum* (*Procopiana*) *creticum* complex reaches Zakinthos and *Lactuca acanthifolia* Idhra.

It also extends considerably into the East Aegean, reaching the islet of Petrokaravi (10 km NW of Patmos) in the north. Other Aegean chasmophytes with similar extensions are *Cephalaria squamiflora* ssp. *squamiflora* (reaching Ikaria), *Lactuca acanthifolia* (reaching Petrokaravi), and *Salsola carpatha* (reaching Telendos W of Kalimnos).

The phytogeography of the East Aegean seems to be very complicated. An Anatolian element can be discerned on the islands of Mitilini, Chios and Samos and to a lesser extent also on Ikaria, Kos and Rodhos. Other islands such as Psara (Greuter 1976), Nisiros (Papatsou 1975), the islands between Kalimnos and Samos (investigated by Runemark and Bothmer in 1974), Tilos, and Simi seem to lack an Anatolian element. They all are characterized by an impoverished typical Aegean flora.

Several of these islands are surrounded by deep water (Psara, Nisiros, Tilos, and Simi) and may have been isolated for a long period of time. However, the islands between Kalimnos and Samos are all situated in rather shallow water (70–80 m deep) and have probably been part of the Turkish mainland during marine regressions (estimated to 100–200 m) in connection with Pleistocene glaciations. According to sea charts the topography of the bottom is unusually even in this area, suggesting the presence of an alluvial plain, probably an extension of the present plain at the mouth of the Menderes river on the Turkish mainland. During the regressions the islands may therefore have been isolated rocky outcrops in a more or less swampy plain, effectively preventing the migration of plants adapted to the dry and rocky habitats of the present islands.

Similarly the extensive area of serpentine on the eastern part of the Datça peninsula has certainly been an effective barrier to the migration of many plants. The central and western parts of the peninsula may phytogeographically represent an Aegean island, as indicated by the occurrence of the chasmophytes *Erysimum rhodius* (on limestone cliffs) and *Linum arboreum* (on limestone cliffs and serpentine slopes). The peninsula which botanically has been only superficially investigated, certainly warrants a more thorough survey.

The distribution of the Aegean chasmophyte *D. fruticosus* and the ecologically vicarious W and S Anatolian *D. elegans* (Fig. 2) illustrates in a suggestive way the phytogeographical complexity of the East Aegean.

The subspecies recognized within *D. fruticosus* are mainly centred on one of the major refugia for tertiary chasmophytes in the Aegean (see the map in Runemark 1971 p. 23). In only two cases does the distribution of subspecies include areas which have been widely separated by the sea for a long period of time.

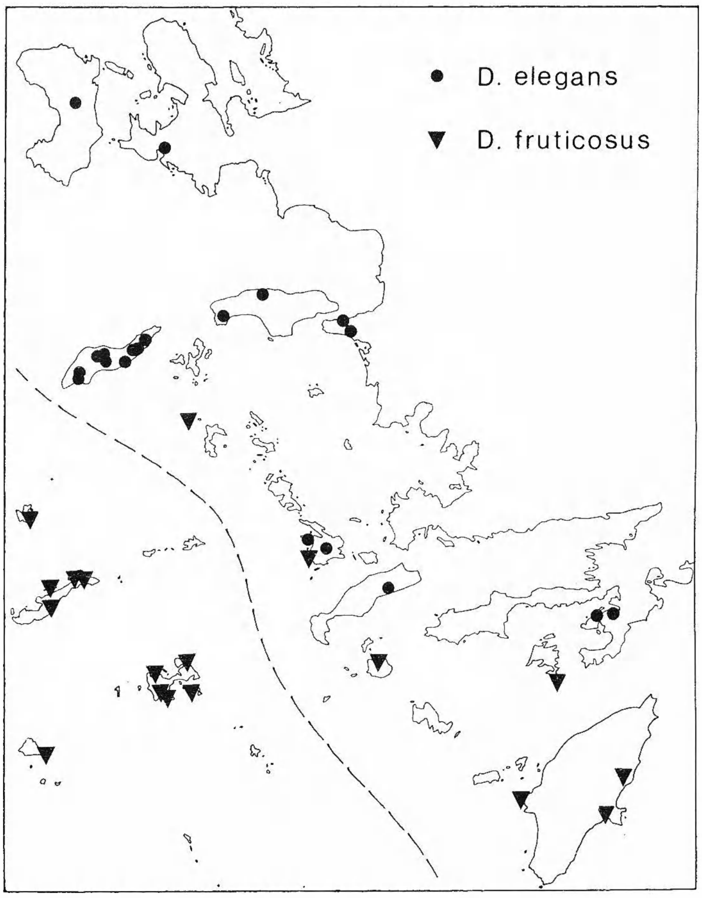

Fig. 2. The distribution of *Dianthus fruticosus* and *D. elegans* in the East Aegean. The broken line indicates the phytogeographical border between the Greek and Anatolian flora according to Rechinger (1950).

D. fruticosus ssp. *amorginus* has thus its main centre of distribution in the central and southeastern part of the Central Aegean with isolated populations on the Yanisades Islands off the coast of easternmost Crete. This distribution pattern is not unique among maritime chasmophytes. Thus *Origanum* (*Amaracus*) *tournefortii, Anthyllis aegaea,* and *Eryngium amorginum* are all confined to the Central Aegean with the exception of a single locality in easternmost Crete. In the same way the distribution of *D. fruticosus* ssp. *occidentalis* in western Crete as well as in Peloponnisos correspond e.g. to that of *Asperula taygetea,* a chasmophyte growing from sea level up to the subalpine zone.

Morphological notes

D. fruticosus is an intricately branched shrub, usually forming dense cushions from 20 to 100 cm or more in diameter. It is certainly the woodiest member of the genus. The basal stems are often 5–10 cm in diameter, occasionally up to 15–20 cm. A stem from Naxos, 6 cm in diameter had c. 75 annual rings. Apparently many individuals attain a great age contributing to genetic stability in the populations.

The leaves are densely crowded in vegetative shoots (internodes only a few mm long). The annual growth of a shoot begins in early spring (February to March) and generally continues until August or September. Usually the leaves of the previous year's growth have withered by spring but often remain on the twig one more year. New lateral shoots develop from May to September, mainly on the current year's growth.

Flowering stems with elongated internodes, about equalling the leaves, terminate vigorous shoots from 1 to 4 years old.

Leaves. D. fruticosus is very variable in the shape, texture and size of the leaves. Extremes are flat, coriaceous leaves up to 35–40×8 mm (in ssp. *fruticosus*) and terete ones, 8–10×1 mm (in ssp. *sitiacus*).

The leaves are always flat (coriaceous to fleshy) in ssp. *fruticosus,* ssp. *occidentalis* and ssp. *karavius*. They are semiterete to terete in ssp. *sitiacus*. In ssp. *amorginus* and ssp. *rhodius* they are normally flat and in ssp. *carpathus* and ssp. *creticus* normally semiterete to terete. Even in subspecies with varying leaf texture the individual populations are usually homogeneous.

There is not uncommonly a considerable variation within an individual (even within the same shoot) in general leaf shape (linear to narrowly obovate, obovate to ovate, lanceolate to obovate), and in the shape of the apex (acute to obtuse, apiculate to acute). This variation is partly correlated with the position of the leaf along the annual shoot. The lowermost leaves are generally shorter (often much shorter) than the leaves in the middle part of the shoot but are of the same breadth. The uppermost leaves also usually differ in being shorter but are also considerably narrower. However, there is also a considerable plasticity in minor leaf characteristics, probably regulated by external factors during leaf development. No apparent difference has been observed between leaves of vegetative and flowering shoots.

In flat-leaved forms there is a variation from rather thin (coriaceous) to very fleshy leaves. As could be expected populations or individuals growing on the lower part of sea cliffs, exposed to salt spray, usually have fleshy leaves. Ssp. *fruticosus* from the SW Cyclades (Milos, Poliegos and Serifos) is an exception. In this area even populations growing on islets exposed to heavy salt spray have leaves with hardly any tendency towards fleshiness (in similar habitats in the Folegandros area, ssp. *fruticosus* has moderately fleshy leaves). Moreover populations with fleshy leaves also occur far from the sea.

Davis (1953, voucher in K) cultivated offspring of ssp. *carpathus* (from Finiki) at Kew. The original material had fleshy to almost subterete leaves while the cultivated material had thin leaves. On the other hand offspring from a population of ssp. *amorginus* from a sea cliff on Astipalea cultivated in greenhouses in Lund for almost 20 years has maintained the very fleshy leaves of its parents.

Apparently the background of fleshiness is complex in *D. fruticosus*. At least five variants can be recognized: (1) modificative fleshiness on sea cliffs, (2) genetically fixed fleshiness on sea cliffs, (3) lack of fleshiness on sea cliffs, (4) fleshiness on inland cliffs (modificative or genetically fixed ?), and (5) lack of fleshiness on inland cliffs.

Flowers. D. fruticosus has a very long flowering period beginning in June (occasionally even in late April or May) and often extending into October. New flowers develop continuously for several months in the same inflorescence.

The flowers of *D. fruticosus* s. str. (= ssp. *fruticosus*) have sometimes been recorded as scentless by contrast to those of the rest of the complex. The admittedly sparse information available does not support such a difference. Scented and scentless flowers occur even within the same population, e.g. on locus classicus for *D. fruticosus* on Serifos.

The petals have a long, exserted claw and a broadly obovate-obtriangular lamina with a slightly rounded, coarsely and sparsely dentate apex. No obvious differences in shape have been observed within the complex. The size of the petals varies between populations and even between flowers in the same inflorescence. Some general trends have been observed: ssp. *fruticosus* and ssp. *occidentalis* have the largest petals, 11–14 mm wide, the Kefallinia population seems to be the largest-flowered population within the whole complex, the smallest petals, only 7–8 mm wide occur in ssp. *carpathus* and ssp. *karavius*.

The lamina is pale (yellowish) pink to purplish-red with a variously marked, more intensely coloured, barbulate basal spot on the upper surface. No obvious variation in colour has been observed within populations. The information on variation between populations is limited as the exact colours cannot be seen in herbarium material. Also, notes on colour on labels have to be treated with caution. Most of the populations have pure pink to purplish-pink petals. Purplish-red petals have only been observed in ssp. *fruticosus* from the SW Cyclades (Serifos, Milos and Poliegos). Pale pink petals slightly tinged with yellow occur in ssp. *occidentalis*, ssp. *fruticosus* from N Cyclades and ssp. *amorginus* from C Cyclades.

The calyx is cylindrical to slightly fusiform with erect teeth. No difference in shape has been observed within the complex. Strictly cylindrical and fusiform calyces often occur in the same inflorescence. The calyx is fully developed in length at anthesis but increases in breadth in fruit. There is a great variation in breadth in the same inflorescence. The calyces of the first flowers are often much broader than in later ones and the last flowers may have unusually narrow calyces. The length usually ranges from 18 to 22 mm, only in ssp. *occidentalis* and ssp. *fruticosus* it is slightly longer, 20–25 mm, and in part of the material of ssp. *rhodius* and ssp. *creticus* slightly shorter, 16–18 mm. Ssp. *karavius* falls outside the normal variation range with calyces only 12–13 mm long.

The calyx teeth are 5–11 mm long, very narrowly triangular and normally acute to almost aristate. However, collections from Kithnos and Kea (ssp. *fruticosus*) and some collections from Akrotiri (ssp. *creticus*) have obtuse calyx teeth.

Bracts. The number of bracts and their shape and breadth have been used as critical characters for the present subdivision of the *D. fruticosus* complex.

Both the basal part of the calyx and the usually short pedicel are covered by tightly adpressed, imbricate, decussately arranged, straw-coloured to pale green, rather hard and tough bracts. The uppermost 2–3(–4) pairs of bracts are usually similar in shape and size while the lower (outer) ones, if present, gradually or more rarely abruptly decrease in size downwards and usually also in relative breadth. The lowermost ones are often very small, narrowly triangular to almost subulate. A clear separation between involucral bracts (epicalyx scales) enclosing the base of the calyx as opposed to bracts situated along the pedicel is in most cases impossible.

The number of bracts varies from (2–)6 to 30, i.e. (1–)3 to 15 pairs. There is generally a remarkable difference in the number of bracts of the first flower in an inflorescence (sometimes also including the first flower in vigorous inflorescence branches) and later ones. The first flower has 6–12 bracts while later ones have a greater number. The number of bracts may increase successively (especially in ssp. *fruticosus* and ssp. *amorginus*). However, it is often abrupt, the number of bracts in the second and third flower may be more than the double. Ssp. *sitiacus* is an exception as all flowers have approximately the same number of bracts (20–30). As far as can be judged from the rather poor material available the populations of ssp. *rhodius* from Rodhos also have approximately the same number of bracts in all flowers, ranging from 10 to 12(–14).

There is a considerable variation in the shape of the uppermost pairs of bracts in *D. fruticosus*. As in leaf shape there may be some variation in detail between flowers and also between adjacent pairs of bracts in the same flower. Therefore a number of flowers in a collection must be studied.

Not uncommonly some bracts, especially the lower ones (in exceptional cases all) are foliaceous, i.e. with a linear or terete, green lamina up to 5 mm long. The shape of these bracts may be abnormal and has been neglected in the descriptions of taxa.

Seeds. No obvious differences between the subspecies have been found.

Cytology

Chromosomes from material cultivated in greenhouses in the Botanical Garden, Lund have been counted in sectioned root tips fixed in Navashin-Karpechenko and stained in crystal violet.

The chromosome number found was $2n=30$, agreeing with previous records for *D. 'arboreus'* on material of unknown origin (cf. Fedorov 1969 p. 204). No differences in pollen size, indicating polyploidy, have been observed between the subspecies.

Collections studied: ssp. *creticus*: Crete. Ag. Selinaris; from cuttings collected in 1980; ssp. *amorginus*: Astipalea. Between Baia di Zofiri and Punta Tripiti; from seeds collected in 1960.

Taxonomy

The shape and size of the leaves in the text refer to normally developed leaves in the middle part of vegetative and flowering shoots. The shape and size of bracts refer to the two to three uppermost pairs of bracts of a flower.

Dianthus fruticosus L. (1753)

D. creticus Tausch (1830) = *D. arboreus* auct. non L. (cf. Greuter 1965 p. 186).
D. rhodius Rech. fil. (1942).

Typus. The illustration in Tournefort, Voyage du Levant 1719 p. 183.

Fruticose, glabrous perennial, usually with numerous, densely leafy vegetative shoots, usually forming compact cushions, 20–100 cm in diameter. Flowering stems often numerous, 1–30 cm long, carrying corymbose inflorescences with (3–)5–20(–30) densely crowded flowers. Leaves 8–40×1–8 mm, flat, sometimes slightly cymbiform, coriaceous to very fleshy, lanceolate, linear or obovate, or subterete to terete, cylindrical, narrowly obovoid or fusiform; apex rounded, obtuse, acute or apiculate. Petals pale (yellowish) pink, purplish-pink to purplish-red, limb 7–14 mm wide, obovate-obtriangular, basally with a variously marked, more intensely coloured, barbulate region; apex slightly rounded, coarsely and sparsely dentate; claw exserted. Calyx 12–25 mm, tubular or narrowly fusiform; teeth 5–11 mm, acute, sometimes almost aristate, rarely obtuse, often with barbulate margins. Bracts (2–)6–30 with narrow hyaline, sometimes barbulate margins. Uppermost bracts broadly obovate, elliptical to almost round (exceptionally almost linear), attenuate or abruptly contracted at apex to retuse; apex mucronate to cuspidate, rarely foliaceous with a short green lamina. Lower bracts resembling the upper ones or continuously or abruptly decreasing in size, the lowermost ones then often narrowly triangular to almost subulate. Seeds black to brownish-black, striate, c. 2 mm long, flat (often slightly and irregularly bent), broadly elliptic in outline; embryo straight, protruding; testa cells narrow, on the central part of the back sometimes isodiametric, strongly convex, a few somewhat spinulose. 2n=30.

Habitat. Obligately chasmophytic, mainly confined to cracks in exposed, smooth, vertical cliffs. Mainly on hard limestone but also on young volcanic rock and hard, crystalline schists.

Distribution. Southern and central parts of the Aegean, S and W Peloponnisos, Kefallinia.

Key to the subspecies

1\. Bracts 20–30 in all flowers; leaves 10–20 mm long, terete to subterete, distinctly apiculate .... ssp. *sitiacus*
– Bracts 6–12(–14) in the first flower(s) of an inflorescence; leaves rarely apiculate 2
2\. Bracts (4–) 6–8 in the first flower(s), 2–3 times as long as broad, apex distinctly attenuate; leaves flat to subterete, obtuse to subacute .... ssp. *amorginus*
– Bracts (6–)8–12(–14) in the first flower(s), 1–2 times as long as broad, apex truncate to rounded-triangular, rarely slightly attenuate ... 3
3\. Leaves terete to subterete 4
– Leaves flat 6
4\. Leaves 10–20 mm long, obtuse to subacute; flowering stems 1–5 cm .... ssp. *carpathus*
– Leaves (15–)25–35 mm long, usually acute; flowering stems (4–)10–25 cm 5
5\. Leaves 1–2 mm broad; pedicel less than 5 mm long .... ssp. *creticus*
– Leaves 2–3 mm broad; pedicel 10–15 mm long .... ssp. *rhodius*
6\. Calyx 12–13 mm, lowermost pairs of bracts broadly triangular; leaves obovate, obtuse .... ssp. *karavius*
– Calyx 16–25 mm, lowermost pairs of bracts not broadly triangular 7
7\. Bracts 3–4(–4.5) mm broad; leaves 1–3(–4) mm broad 8
– Bracts (4–)5–6 mm broad; leaves 2–8 mm broad 10
8\. Leaves 10–20 mm long, obovate, apex obtuse; flowering stems up to 7 cm ...... ssp. *carpathus*
– Leaves 25–35 mm long 9
9\. Leaves 1–2(–3) mm broad, fleshy; bracts only slightly longer than broad .... ssp. *creticus*
– Leaves 2.5–4 mm broad, lanceolate to linear-lanceolate, rarely slightly obovate, coriaceous to thick; bracts c. 2 times as long as broad .... ssp. *rhodius*
10\. Leaves 4–8 mm broad, obovate-spathulate, obovate, oblong or elliptic, apex rounded to obtuse, occasionally subacute ...... ssp. *fruticosus*

- Leaves 2–4 mm broad, linear to linear-lanceolate, apex usually acute .... ssp. *occidentalis*

Ssp. **fruticosus**, Fig. 3 A

Flowering stems 8–20 cm. Leaves flat, (20–)25–35(–40)×4–8 mm, coriaceous to thick, sometimes moderately fleshy, narrowly obovate, rarely obovate-spathulate, oblong or elliptic; apex rounded (rarely mucronulate), obtuse or occasionally subacute. Flowers purplish-red to pale (yellowish) pink, petals 10–13 mm broad. Calyx (18–)20–25 mm, teeth 7–10 mm, acute or obtuse. Bracts (6–)8–12 of first flower(s) in an inflorescence, broadly obovate to broadly elliptic, (4–)5–6 mm broad, 1.2–2 times as long as broad; apex triangular, rounded-triangular, rounded, rarely abruptly contracted to almost truncate, shortly cuspidate or mucronate. Bracts in later flowers (14–)16–26.

Habitat. The populations in the SW Cyclades grow on siliceous rock (young volcanic rock in Milos and Poliegos, crystalline schists in Serifos). All other populations are confined to limestone cliffs. Some populations occur on islets off the coast of Serifos, Poliegos and Folegandros. From a few metres above sea level up to 300 m.

Distribution. N, W, and S Cyclades: Andros, Siros, Kea, Kithnos, Serifos, Milos, Poliegos, Folegandros, Sikinos, Anafi.

Comments. Ssp. *fruticosus* is normally fairly distinct, characterized by a combination of flat, broad, obovate leaves with a rounded to obtuse apex and broad upper bracts. Notes on variation:

(1) The populations in SW Cyclades (Serifos, Milos, Poliegos) all growing on siliceous rock have purplish-red flowers. Populations from other islands growing on limestone all seem to have ± pink flowers.

(2) Moderately fleshy leaves occur in the Folegandros-Sikinos area only.

(3) All populations on Kithnos and some on Kea have obtuse calyx teeth. Elsewhere in the complex this feature has only been observed in some collections of ssp. *creticus* (from Akrotiri in Crete).

(4) The collections from Sikinos and Kea have rather narrow leaves, (3.5–)4–5 mm wide, but with the typical shape of ssp. *fruticosus* (obovate with rounded apex).

(5) One of the collections from Andros (S 21119) agrees with material from Kea. The two other collections (Stamatiado 6615, S & Be 32617) approach ssp. *amorginus* in the few (6–8), relatively long bracts.

Collections. *Andros*. 2 km SW of Zanagiar, 50–100 m, 1964 S 21119 (LD); 1.5 km ESE of Akra Apothikes, 80–200 m, 1968 S & Bo 32617 (LD); SE of Paleopolis, above the road to Stavropeda, Kaki Melissa, 150–200 m, 1969 Stamatiado 6615 (ATH). *Kea*. 0.5 km SSW of Kastriani, c. 150 m, 1968 S & Bo 34347 (LD); 2.5 km E of Pisa, 1968 S & Bo 34208 (LD); Ormos Poles, E of old Karthea, 1968 S & Bo 34437 (LD); 1 km SW of the islet of Spanopoula, 150 m, 1968 S & Bo 34280 (LD); N–NE of the monastery of Kastriani, 50–150 m, 1968 S & Bo 34324 (LD). *Siros*. Akra Grammaton, 1968 S & Bo 33621 (LD); Trionaki, 1969 R, Str & G 40022 (LD). *Kithnos*. 2 km NE of Mirsini, 0–200 m, 1968 R & E 37866 (LD); Iavalido Bay (Palea Kastro), 0–250 m, 1968 R & E 37862 (LD); Ormos Mirsini, 0–250 m, 1968 R & E 37878 (LD); between Flambourion and Panagia Stratiotissa, 1969 R, Str & G 40543 (LD); cliffs facing N to NW, above sea, 1974 Young 321/H (K). *Serifos*. Cliffs around the small town of Serifos (not explicitly stated on all labels), 1700 Tournefort (P, not seen), Sibthorp (K), 1856 Orphanides 919 (K, LD, W, WU), 1883 Heldreich (W), 1939 Davis 870 (E, K, W), 1961 Gathorne-Hardy (E, W), 1966 Str 23353 (LD), 1967 R & Be 30116 (LD); 1–2 km S–SW of Livadion, 1967 R & Be 27500 (LD); 2–2.5 km SW of Livadion, 1967 R & Be 27512 (LD); the islet of Mikronisi, 1967 R & Be 27947, 29998 (LD). *Milos*. S of the island of Kounidhi, 1967 R & Be 29919 (LD); Akr. Romma, 200 m, 1967 R & Be 29631 (LD). *Poliegos*. The N shore, 1967 R & Be 29601 (LD); small island along the N shore, 1967 R & Be 29605 (LD); small island along the S shore, 1967 R & Be 29613 (LD). *Folegandros*. 1938 Davis 214 (E, K); 200–300 m high sea cliffs on the SE part, 1960 R & N 14688 (LD); Pelagi (the SE point), 50 m, 1960 R & N 14669 (LD); Adelfia Petra, the W islet, 1960 R & N 14596 (LD); 1 km NW of Limin Karastostasi, 1964 S 21175 (LD), 1967 R & Be 25544 (LD); the NE point, R & Be 25056 (LD); Paleokastro, 300 m, 1972 Young 140/H (K). *Kardiotissa*. 1960 R & N 14550 (LD). *Sikinos*. Near the temple, 1939 D 899 (E, K); Agia Marina, 450 m, 1972 Young 151/H (K); the N coast, 3 km W of Kastro, 1967 R & Be 25000 (LD); the E promontory, 1967 R & Be 24747 (LD). *Anafi*. E of the monastery of Kalamos, near the sea, 1958 R & S 8015 (LD); the Kalamos promontory, S side, 200 m, R & N 14862 (LD).

Ssp. **occidentalis** Run. ssp. nov., Fig. 3 B

Bracteae floris primi inflorescentiae 8–10(–12). Bracteae 5–6 mm lata, apex bractearum superiorum rotundatus vel rotundato-triangularis, cuspidatus vel rarius mucronatis. Folia 25–35×2–4 mm, plana, linearia vel lineari-lanceolata, acuta vel subacuta, rarius obtusa, crassa vel carnosa.

Typus. Peloponnisos. Distr. Lakonia. 2 km N of

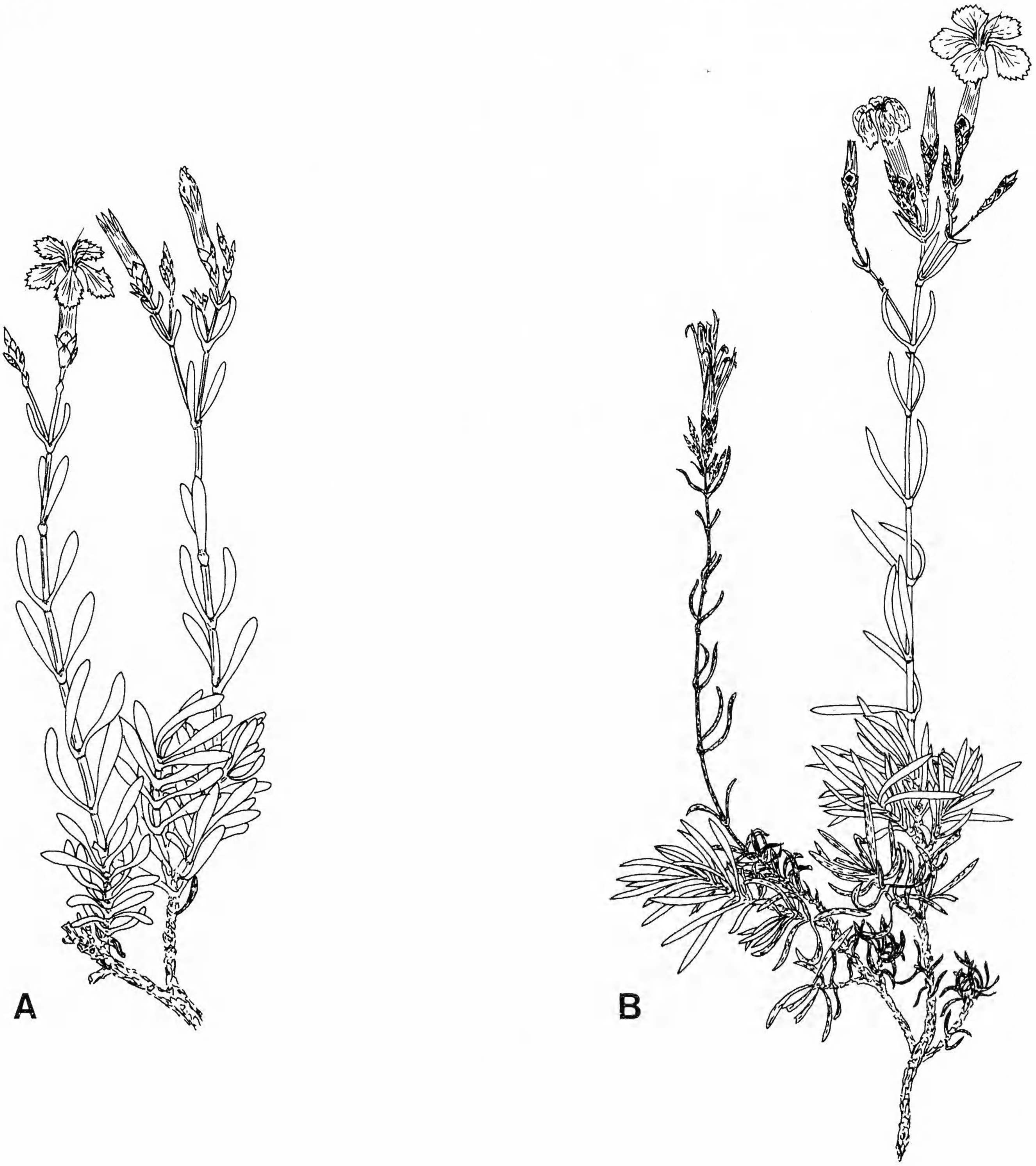

Fig. 3. *Dianthus fruticosus*. — A: ssp. *fruticosus* (narrow-leaved form from Andros, S 21119). — B: ssp. *occidentalis* (holotype). — × 0.5.

Areopolis. Coastal rocks facing N, 30 m s m, 1966 A. Strid 23408 (LD, holotype).

Flowering stems 10–30 cm. Leaves flat, 25–35×2–4 mm, thick to fleshy, linear to linear-lanceolate, apex acute to subacute, or in some leaves obtuse. Flowers pink to pale (yellowish) pink, petals 11–14 mm broad. Calyx 20–25 mm, teeth 7–11 mm, acute. Bracts 8–12 in the first flower(s) in an inflorescence, elliptical to almost round, (4–)5–6 mm broad; apex rounded to rounded-triangular, cuspidate or rarely mucronate. Bracts in later flowers up to 20.

Habitat. Limestone cliffs up to 200 m above sea level.

Distribution. Westernmost Crete, Paximadhia islands off the coast of S C Crete, S and SW Peloponnisos, the islands of Kithira, Idhra, and Kefallinia.

Comments. Ssp. *occidentalis* is characterized by flat, linear to linear-lanceolate, mainly acute leaves, (4–)5–6 mm broad, elliptical to almost round bracts, and large flowers and calyces.

The material seen is fairly homogeneous. In most of the material the leaf apex is distinctly acute but in the collections from Kefallinia, Pylos and Paximadhia the leaf apex varies from acute to obtuse.

Collections. *Crete*. Distr. of Ag. Vasilis, Paximadhia, the W island (Paximadhia major), 1904 Dörfler 996 (WU), 1964 S, Str & Bo 20896 (LD); Distr. of Kissamos, SE of Rocca (9 km ESE of Kastelli), 150 m, 1964 S, Str & Bo 21027 (LD). *Kithira*. N of Paleochora, E of Potamos, 150–200 m, 1964 Gr 6625 (Gr). *Idhra*. 2 km E of Ormos Mandraki, 0–200 m, 1974 R & Bo 47290 (LD). *Peloponnisos*. Lakonia, peninsula of Mani: Akrotirion Taenaron (Cap Matapan), above Porto Kalion, 1958 Rech 20132 (K, LD, W), SW of Gerolimin, 0–50 m, 1964 R & S 20700 (LD), 2 km N of Areopolis, 30 m, 1966 Str 23408 (LD); Messenia: small island off Pylos, 1959 Dede (K), Pylos, small bay N of the island of Sfaktiria, 1979 Gr 17278 (Gr). *Kefallinia*. Assos, 1940 D 1128K (K), 1966 S 23684 (LD), 1971 Phitos 11440, 11951 (UPA).

Ssp. **amorginus** Run. ssp. nov., Fig. 4 A

Bracteae floris primi inflorescentiae (4–)6–8. Bracteae 3–3,5 mm lata, apex bractearum superiorum valde attenuatus, cuspidatus. Folia 15–30×1,5–3(–4) mm, plana, linearia, anguste elliptica vel anguste obovata, obtusa vel subacuta, plerumque carnosa vel fere subteretia.

Typus. Amorgos. Panagia Chotzoviotissa, 200–400 m, 1958 Runemark & Snogerup 12334 (LD, holotype).

Flowering stems 2–15 cm. Leaves 15–30× 1.5–3(–4) mm, flat, usually fleshy, or sometimes almost subterete, linear, narrowly elliptic or slightly obovate, apex obtuse to subacute, rarely rounded or acute. Flowers pink, purplish-pink or pale (yellowish) pink, petals 8–11 mm broad. Calyx 18–22 mm, calyx teeth 7–9 mm, acute. Bracts (4–)6–8 in the first flower(s) of an inflorescence, 3–3.5 mm broad, (2–)3 times as long as broad, apex distinctly attenuate, cuspidate. Bracts of later flowers 10–16, rarely up to 20.

Habitat. Limestone cliffs from 10 m above sea level to 900 m (on Naxos). Also found on very small islands close to Keros and Astipalea.

Distribution. Central and southeastern parts of C Aegean, islands off the N coast of easternmost Crete, Naxos, (?)Iraklia, Keros, Amorgos, Denousa, Astipalea, Dragonara, Yanisada.

Comments. Ssp. *amorginus* is characterized by long, narrow upper bracts with a distinctly attenuate apex. There is a considerable variation in habit and leaf shape. No regional differentiation is evident but a number of easily recognized local variants occur. Notes on variation:

(1) The material from the type locality (Amorgos, Panagia Chotzoviotissa) has flowering stems 5–7 cm high, unusually small, narrow, and mainly almost subterete leaves, and small flowers. In habit it somewhat resembles populations of ssp. *carpathus*.

(2) The odd collection from the peak (c. 500 m) of Kalamos on Anafi (S 21192) shows some similarity to the Panagia Chotzoviotissa population but is morphologically extreme (only 2 linear bracts in the first flower and terete leaves). Further investigation of the extensive sea cliff of Kalamos is needed as typical ssp. *fruticosus* occurs on the lower parts of the cliff.

(3) Populations with very short flowering stems dominate on Astipalea but also occur on Naxos, Amorgos and Dragonara.

(4) The populations from the Yanisades off the N coast of easternmost Crete have flat, 2–4 mm broad leaves and bracts with an attenuate apex. They are extremely unlike all collections from the eastern mainland Crete (ssp. *sitiacus*) and must be referred to ssp. *amorginus*. One of the collections from Dragonara (R & N 16568) is virtually indistinguishable from some populations on Astipalea. The other collection from the same island (Gr 7832) is similar but some specimens have broader leaves (c. 4 mm) with a rounded apex. In this respect (but not in shape of bracts) it approaches ssp. *fruticosus*. The third collection, from the island of Yanisada (R & S 18634), has linear leaves mainly with acute to subacute apex.

(5) The specimens from Iraklia (R & S 5501) have no reproductive parts. The leaves are intermediate between ssp. *fruticosus* and ssp. *amorginus*. For phytogeographical reasons it has provisionally been included in ssp. *amorginus* but flowering or fruiting material is needed.

Collections. *Amorgos*. Panagia Chotzoviotissa, 200–300 m, Orphanides (K, LD, WU), 1881 Heldreich

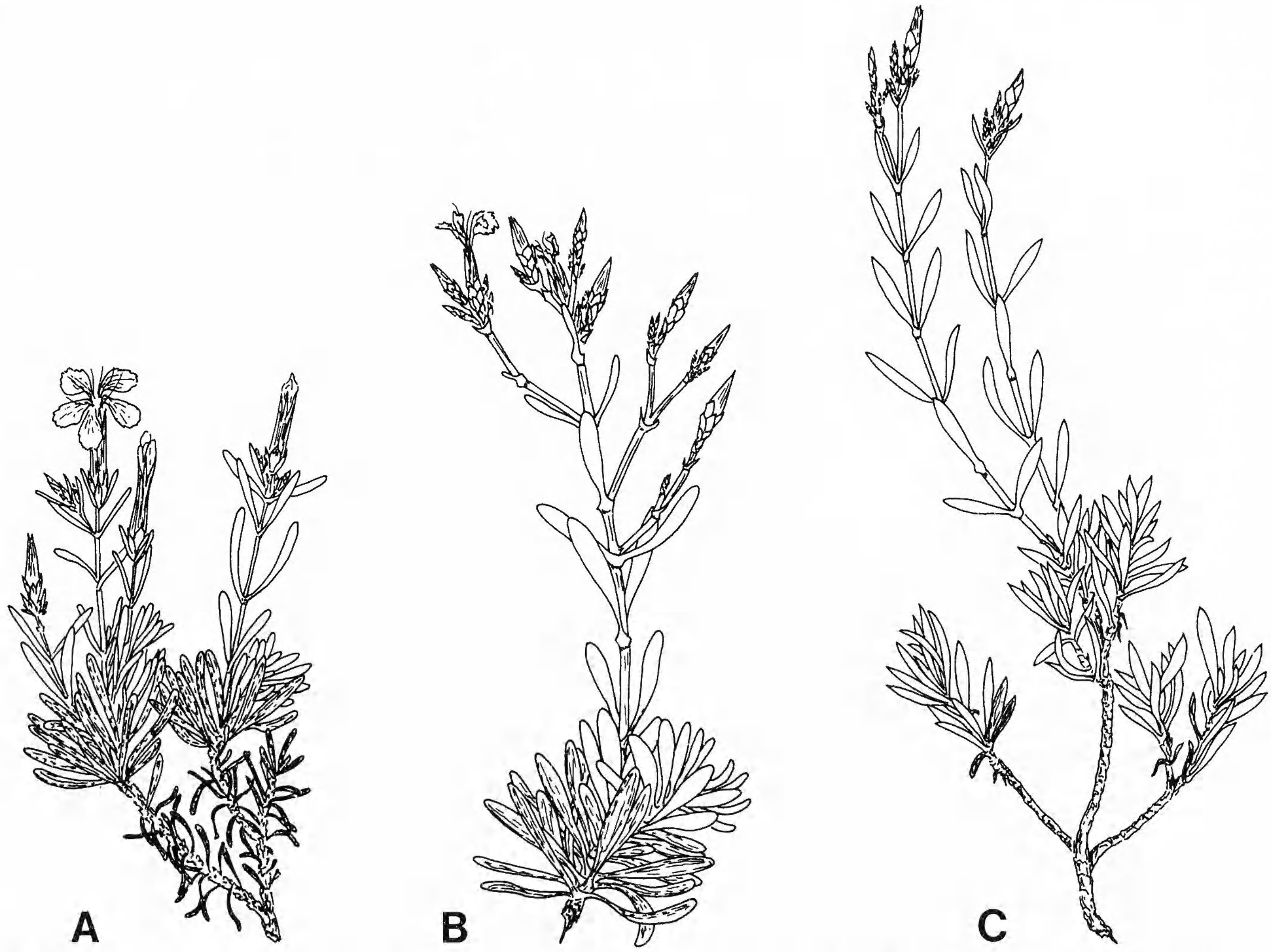

Fig. 4. *Dianthus fruticosus*. — A: ssp. *amorginus* (form with short flowering stem, Astipalea, R & N 15319). — B: ssp. *karavius* (holotype). — C: ssp. *rhodius* (syntype, K). — × 0.5.

(K, LD), 1897 Leonis (WU), 1932 Rech 2315 (WU), 1958 R & S 12334 (LD); Langada, 200 m, 1939 D 954K (E, K), 1963 S 20240 (LD); Krikelas, 1932 Rech 2357 (K, LD); the island of Nikouria, 1967 R & Be 30585 (LD). *Keros*. The islet of Gourgari, 1960 R & N 15905 (LD); islet W of the small island of Andreas, 1958 R & S 10955 (LD). *Iraklia*. S of the highest peak, 300 m, 1958 R & S 5501 (LD). *Denousa*. SW of Akr. Moskonar, 100–200 m, 1958 R & S 9531 (LD). *Naxos*. NW part of Oros Zeus, 580 m, 1958 R & S 5784 (LD); W side of Oros Zeus, 1977 Young 418/H (K); S of Ormos Liona, 1958 R & S 9181 (LD); 3 km NW of Ormos Kalantou, 200–250 m, 1958 R & S 10256 (LD); 2 km W of the bay N of Moutsouna, 100 m, 1958 R & S 10577 (LD); 2 km NNE of Ag. Stefano, 500 m, 1958 R & S 10166 (LD). *Astipalea*. Between Baia di Zofiri and Punta Tripiti, 1960 R & N 15217 (LD); S of Baia della Sabbia, 1960 R & N 15103 (LD); Attimadari, 100–350 m, 1960 R & N 15344 (LD); Mt Fourni, 400 m, 1960 R & N 15319 (LD); the islet of Kondropoula, 20 m, 1960 R & N 15224 (LD). *Crete. Distr. of Sitia. Yanisades Islands*. Dragonara, NW exposed cliffs facing the sea, 1960 R & N 16568 (LD), Kolones, 1966 Gr 7832 (W, Gr); Yanisada, 1963 R & S 18634 (LD).

Ssp. **rhodius** (Rech. fil.) Run. stat. et comb. nov., Fig. 4 C

Dianthus rhodius Rech. fil. in Rechinger, K. H., Flora Aegaea 1943 p. 156 (Akad. Wiss. Wien, Mat. Nat. Kl., Denkschr. 105:1).

Typus. In fissuris rupium calc. montis Hag. Elias prope Archangelos, ca. 400 m, 1935 Rechinger 8403 (K, LD, syntypes).

Flowering stems 10–20 cm. Leaves (20–)25–35×(2–)3–4 mm, greyish green, flat, sometimes slightly cymbiform, lanceolate to linear-lanceolate, a few occasionally obovate, apex narrowly acute, acute or occasionally obtuse, coriaceous to thick, rarely very fleshy to almost subterete. Flowers pink to purplish-pink, petals 8–10 mm broad. Calyx 16–20 mm, calyx teeth 5–7 mm, acute. Bracts (6–)8–12(–14) in the first flower(s) of an inflorescence, 3–4 mm broad, c. 2 times as long as broad, apex roundish-triangular to rounded, mucronate or cuspidate. Bracts 12–24 in later flowers.

Habitat. Limestone cliffs from 20 m above sea level to 400 m (on Rodhos). On Nisiros on volcanic rocks.

Distribution. The East Aegean: Rodhos, the islet of Trambeto (near Simi), Nisiros, Kalimnos.

Comments. Ssp. *rhodius* is characterized by lanceolate to linear-lanceolate, greyish-green leaves and bracts 3–4 mm broad with a roundish-triangular to roundish apex. It is only known from 6 localities distributed over 4 islands. Only 2 collections are in flower (Nisiros and Trambeto) and from one locality (Monolithos on Rodhos) reproductive parts are wholly lacking. There is a considerable variation in the complex. The Rodhos populations seem very distinct, while populations from other islands to some extent approach ssp. *amorginus*. Notes on variation:

(1) The material from Rodhos is fairly homogeneous mainly characterized by lanceolate, sharply acute leaves, and 10–12 bracts, apparently in all flowers. The collections from Monolithos deviate slightly in leaf shape having linear-lanceolate, rather thick leaves, often with an obtuse apex.

(2) The collection from the small island of Trambeto S of Simi has only 8 bracts (with a rounded apex) in the first flowers and leaves varying from slightly obovate and obtuse to lanceolate and acute. In habit the collection approaches some collections of ssp. *amorginus*.

(3) The population on Nisiros has 6–10 bracts in the first flowers and up to 20 bracts in later developed ones. The pedicel of most flowers is unusually long, 5–10 mm. The leaves are mainly lanceolate with an acute to subacute apex. The two collections from Kalimnos (apparently from the same locality) were both collected in early April. They are poor with dry infructescences, leaves of the previous year, and new shoots just beginning to develop. The Kalimnos material agrees with the Nisiros collection in number and shape of bracts and in the long pedicels (up to 15 mm) of most flowers, but deviates in the very fleshy to almost subterete leaves. In habit the material from Nisiros and Kalimnos resembles a collection of ssp. *amorginus* from Denousa (E of Naxos, R & S 9531) which is also characterized by flowers with unusually long pedicels.

Collections. Rodhos. Mt Ag. Elias at Archangelo, 400 m, 1935 Rech 8403 (E, K); S of Archangelo, 200–400 m, 1964 S & Kjellqvist 22075 (LD); Monolithos, 1935 Rech 7390 (LD), 1967 R & Be 29321 (LD); 1.5 km S of Kalatos, Mt Marmara, 300 m, S 22129 (LD). *Simi.* The islet of Trambeto, 50 m, Bo 22873 (LD). *Nisiros.* Emporion in direction of Lakki, 1974 Papatsou 1356 (UPA), 200 m, 1980 Phitos 16707 (UPA). *Kalimnos.* Near Photis, 1887 Major 668 (E, K); Ag. Fozia, N and NE exposed limestone cliffs, 100 m, 1974 R & Bo 46096 (LD).

Ssp. **karavius** Run. ssp. nov., Fig. 4 B

Bracteae floris primi inflorescentiae 8–10, c. 4 mm lata. Apex bractearum superiorum ± rotundatus. Calyx minor, 12–13 mm longus. Folia plana, carnosa, anguste obovata, obtusa, 20–30(–35)×3–4 mm.

Typus. Dodecannisos. Patmos. The island of Petrokaravi, 1974, Runemark & Bothmer 46740 (LD, holotype).

Flowering stems 8–9 cm. Leaves flat, fleshy, 20–30(–35)×3–4 mm, narrowly obovate, apex obtuse to almost rounded. Calyx 12–13 mm, teeth 5–6 mm, ± acute. Flowers pink, petals 7–8 mm wide. Bracts 8–10 in the first flower(s) in an inflorescence, broadly elliptical to almost round, c. 4 mm broad; apex ± rounded, shortly cuspidate. Bracts in later flowers 12–16, lowermost pair(s) broadly triangular, connate for 1/3 to 1/2 of their length.

Habitat. Limestone cliff, 40–50 m above sea level.

Distribution. Known from a single locality, the islet of Petrokaravi, 10 km NW of Patmos. Petrokaravi is a narrow, c. 200 m long and 50 m high almost inaccessible sea cliff.

Comments. Ssp. *karavius* is characterized by small flowers, very short calyces, almost rounded upper bracts and lowermost pair(s) of bracts broadly triangular and connate for 1/3 to 1/2 of their length. No affinity to other subspecies can be discerned even if in habit it approaches some collections of ssp. *amorginus* from Astipalea and the Yanisades islands.

Ssp. **carpathus** Run. ssp. nov., Fig. 5 B

Bracteae floris primi inflorescentiae 8–12, 3–4(–4,5) mm lata. Apex bractearum superiorum rotundatus vel rotundato triangularis, breve mucronatus vel muticus. Folia 10–20×1–3(–3,5) mm, teretia, subteretia vel subplana et carnosa, apex obtusus, rarius subacutus vel apiculatus. Pedunculus 1–7 cm longus.

Typus. Saria. 300 m W of the 'harbour' of Palatia, S-exposed limestone cliffs, c. 60 m, 1966 Bothmer 23187 (LD, holotype).

Flowering stem 1–4 cm, more rarely up to 7 cm. Leaves 10–20×1–3(–3.5) mm, terete, subterete, cylindrical to slightly clavate, more rarely almost flat, fleshy and narrowly obovate to almost linear; apex obtuse, rarely subacute, or apiculate in a few leaves. Flower pink, petals 8–10 mm broad. Calyx 18–22 mm, teeth 6–8 mm, acute. Bracts 8–12 in the first flowers of an inflorescence, 3–4(–4.5) mm broad, broadly elliptical to almost round, apex rounded to roundish-triangular, shortly mucronate or rarely pointless. Bracts 10–16, rarely up to 20 in later flowers.

Habitat. Limestone cliffs from 20 m above sea level to 800 m.

Distribution. Karpathos, Saria, Kasos.

Comments. Ssp. *carpathus* is characterized by the combination of short leaves, short flowering stems, and relatively few bracts in the first flowers. The local variation is pronounced, all known populations can be recognized on combinations of minor characteristics. Notes on variation:

(1) Most populations on Karpathos form low, extremely dense cushions with numerous, short flowering stems and short, subterete to terete leaves. In habit the plants often resemble ssp. *sitiacus*.

(2) The coastal population at Finiki on Karpathos is morphologically outstanding. The population is rather variable, the leaves are often unusually broad (up to 3.5 mm wide), almost flat (but very fleshy) and the flowering stems 5–7 cm long. The populations from Vurgunda on Karpathos and that from Kasos are morphologically transitional between the Finiki population and 'normal' ssp. *carpathus*.

Collections. Karpathos. Finiki, 1950 D 18089 (K), 1963 Gathorne-Hardy 434 (ATH, E), 1963 Gr 5174 (Gr), 1964 Stamatiado 6145 (ATH); Vurgunda, Akrotirias, 20 m, 1950 D 18041 (E, K); 3 km S of Elimbo, 250–300 m, 1966 Bo 23772 (LD); between Vurgunda end Elimbo, 400–450 m, 1967 R & Be 28370 (LD); Mt Lastos, Messi, 700 m, 1935 Rech 8166 (LD); between Marmakou and Holethria, W side of Mt Kalilimni, 700 m, 1950 D 18083 (E, K, W). *Saria.* 300 m W of Palatia, 1960 R & N 16707 (LD), 1966 Bo 23187 (LD); Endi, between Palatia and Argos, 30–80 m, 1963 Gr 5776 (Gr). *Kasos.* N of Poli, 130 m, 1962 Gr 4288 (Gr).

Ssp. **sitiacus** Run. ssp. nov., Fig. 5 C

Bracteae floris primi inflorescentiae 20–30. Bracteae superiora 3–4,5 mm lata, apex rotundatus vel rotundato-triangularis. Folia (8–)10–20(–25)×1–1,5 mm, teretia vel rarius subteretia, cylindrica vel anguste fusiformia, apiculata.

Typus. Crete. Ep. Sitia: in insulae Psira parte austro-occidentale, 150 m, 1966 Greuter 7601 (E holotype, K, W, Gr).

Flowering stems 2–10 cm. Leaves (8–)10–20(–25) ×1–1.5 mm, terete, rarely subterete, cylindrical to narrowly fusiform, all or almost all distinctly apiculate. Calyx 18–22 mm, calyx teeth 6–8 mm, acute. Bracts 20–30 in all flowers in an inflorescence; uppermost pairs broadly elliptical to almost round, 3–4.5 mm broad; apex rounded to roundish triangular.

Habitat. Maritime limestone cliffs from 20 to 300 m above sea level.

Distribution. Easternmost Crete (District of Sitia).

Comments. Ssp. *sitiacus* is easily recognized by the numerous bracts in all flowers as well as on the short, terete, apiculate leaves. The collections are homogeneous, except differences in internode length (also affecting the height of flowering stems) and in the shape of the bract apex.

Collections. Crete. Distr. of Sitia. The island of Psira, SW part, 150 m, 1966 Gr 7601 (E, K, W, Gr); Liopetra, 200 m, 1962 R & S 18490 (LD), 1966 Gr 7657 (Gr); 2 km SSE of Ag. Trias, 1976 Landström 3329 (herb. Landström, Lund); SSE of Chametulo, 1962 R & S 17682 (LD); W of Ano Zakros, 1962 R & S 17895 (LD); between Ano and Kato Zakros, 50 m, 1962 Gr 4481 (Gr); Kato Zakros, 20 m, 1975 Merxmüller & Podlech 30925 (UPA), 1976 Tzanodakis 2526 (UPA).

Ssp. **creticus** (Tausch) Run. comb. et stat. nov., Fig. 5 A

Dianthus creticus Tausch 1830, in Flora (Regensburg) 13(1): 246, 247.

Typus. [Crete] Cap Maleca, 1817 Sieber (K, LD, syntypes).

Flowering stems (4–)8–25. Leaves (15–)25–35×1–2(–3) mm, terete or subterete, cylindrical, rarely flat and fleshy, apex acute to subacute, occasionally obtuse, sometimes apiculate. Flowers pink to purplish-pink, petals 9–11 mm broad. Calyx (15–)16–22 mm, teeth 6–9 mm, acute or

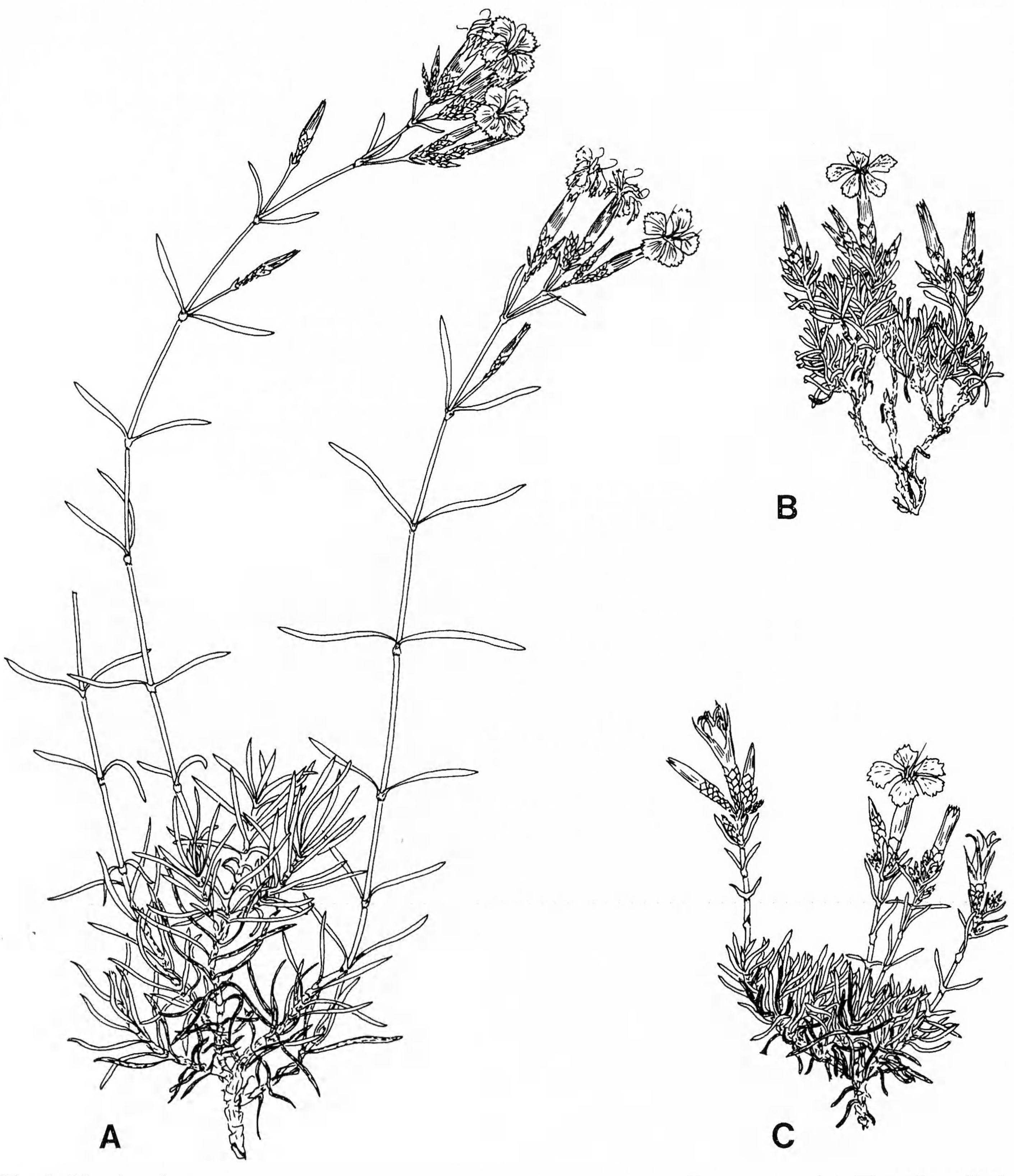

Fig. 5. *Dianthus fruticosus*. — A: ssp. *creticus* (Gazi, Rech 14040, LD). — B: ssp. *carpathus* (Karpathos, Rech 8166). — C: ssp. *sitiacus* (holotype). — × 0.5.

more rarely obtuse. Bracts 8–12 in the first flower(s) in an inflorescence, (2–)3–4 mm broad, elliptical to almost round, apex rounded to truncate or broadly roundish-triangular. Bracts up to 24 in later flowers.

Habitat. Limestone cliffs up to 400 m above sea level.

Distribution. Crete, except westernmost and easternmost parts.

Comments. Ssp. *creticus* is characterized by long, narrow, mostly terete to subterete leaves with an acute to subacute apex and 8–12 bracts in the first developed flowers. The local differentiation is moderate. Some notes of variation are given below:

(1) Most of the material is fairly similar in habit and leaf size. Only part of the collection from Fournofarangon (Rech 14136) is clearly deviating. Among the three sheets seen, one (in W) represents typical ssp. *creticus*, another (also in W) has short leaves (15–20 mm), short calyces (15–16 mm) and short flowering stems (4–6 cm), while the third sheet (in K) is intermediate.

(2) The leaves are all distinctly apiculate in the population at Ag. Selinaris, in this respect agreeing with ssp. *sitiacus*. In other populations apiculate leaves occur occasionally.

(3) Some collections from the Akrotiri peninsula have obtuse calyx teeth.

(4) In the material from Gazi (Almiros) unusually narrow bracts, only c. 2 mm broad, occasionally occur.

Collections. Crete. Distr. of Mirabello. Near Ag. Selinaris (Vrakasi), 100–300 m, 1938 D & Barneby (K), 1942 Rech 14340 (W), 1956 Goulimi 2308 (ATH), 1962 Gathorne-Hardy 287 (K), 1962 Gr 4739 (Gr), 1966 Gr 7589 (K, W, Gr), 1979 Hansen 1344 (C). *Distr. of Monophatsi.* Asterousi Mts, near Fournufarangon, 400 m, 1942 Rech 14136 (K, W). *Distr. of Malevyzi.* Gazi (Almiros), 10–40 m, 1870 Heldreich (K, W), 1899 Baldacci 218 (W, WU), 1938 D & Barneby (K), 1942 Rech 14040 (K, LD, W), 1948 Goulimi (ATH, K), 1952 Goulimi (ATH), 1966 Gr 7581 (K, W, Gr), 1969 Wängsjö 3178 (LD), 1971 Hansen 536 (C, Gr), 1972 Malicky (WU). *Distr. of Kidonia, Akrotiri.* Cap Maleka, 1817 Sieber (K, LD), Orphanides (B), 1893 Baldacci (K, WU), 1915 Gandoger (K); Katholiko, 1846 Heldreich (K), 1937 Lemperg 562 (K), 1942 Rech 13306 (K, W), 1961 Gr 3305, 3575 (Gr); Perivolitza, 50 m, 1966 Gr 7704 (Gr), Sklocha, 160 m, 1961 Gr 3284 (Gr). *Distr. of Sfakia.* Samaria gorge, Ag. Roumeli, 1882 Spreitzenhofer (WU).

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Cytological and morphological investigation of the genus Erodium L'Hér. in the Aegean

GERTRUD DAHLGREN

Dahlgren, G. 1980 12 15: Cytological and morphological investigation of the genus Erodium L'Hér. in the Aegean. *Bot. Notiser 133:* 491–514. Stockholm. ISSN 0006-8195.

Nine species of the genus *Erodium* from the Aegean islands have been studied: *E. laciniatum* (Cav.) Willd. (2n=20), *E. malacoides* (L.) L'Hér. (2n=40), *E. neuradifolium* Delile (2n=40), *E. chium* (L.) Willd. (2n=20), *E. botrys* (Cav.) Bertol. (2n=40), *E. gruinum* (L.) L'Hér. (2n=36), *E. vetteri* Barbey & Fors.-Maj. (2n=18), *E. cicutarium* (L.) L'Hér. (2n=40) and *E. moschatum* (L.) L'Hér. (2n=20). Special attention has been paid to the shape of the cotyledons, pubescence on different parts of the plant, shape, size and colour of petals and fruit characters. A key to the species in the area is given. Maps and locality lists are presented. One species, *E. vetteri,* is endemic to the island of Samos.

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Nine species of the genus have been distinguished in the Aegean. They belong to three subsections of sect. *Malacoidea* Willk. et Lange. Nomenclatural problems have not been treated. The taxonomy at species level mainly follows Flora Europaea (1968) and for higher ranks Guittonneau (1972):

Subsect. *Malacoidea* Brumh.: *Erodium laciniatum* (Cav.) Willd., *E. malacoides* (L.) L'Hér., *E. neuradifolium* Delile, *E. chium* (L.) Willd., *E. botrys* (Cav.) Bertol. and *E. gruinum* (L.) L'Hér.

Subsect. *Absinthioidea* Brumh.: *E. vetteri* Barbey & Fors.-Maj.

Subsect. *Cicutaria* Willk. & Lange: *E. cicutarium* (L.) L'Hér., *E. moschatum* (L.) L'Hér.

Material

Most of the material originates from the Cyclades but some populations are from Crete, the East Aegean islands, the West Aegean islands, Ikaria, N Sporades, Samos, Saria and Skiros (Figs. 1–9). It has been collected during the years 1957–67 chiefly by H. Runemark, S. Snogerup and B. Nordenstam.

The material is to be deposited at LD. The morphological analyses have been made on this material but also on herbarium sheets from C, E, G, K, LD, M, MA, S (abbreviations according to Holmgren & Keuken 1974). The chromosome number, germination and seedling stage and the morphology of the inflorescence have been studied on plants raised from seed of material collected in nature.

Cytology and morphology

Cytology

The cytological investigations were made on root tips at metaphase stage after fixation in the Müntzing modification of Navashin-Karpechenko (Müntzing 1933) and staining in crystal violet.

The chromosome numbers are shown in Table 1 (see also Fig. 10). For original localities of the cultivated material see under the respective taxon.

Two basic numbers occur, n=10 and, less often, n=9. Diploids and tetraploids dominate and only in *E. cicutarium* have hexaploids been reported. Warburg has interpreted the polyploidy as being a result of hybridization (Warburg 1938).

The chromosomes are only c. 2–3 μm long and uniform within a species. In *E. vetteri* (2n=18) one pair of chromosomes is somewhat longer than the others and satellites can usually be seen.

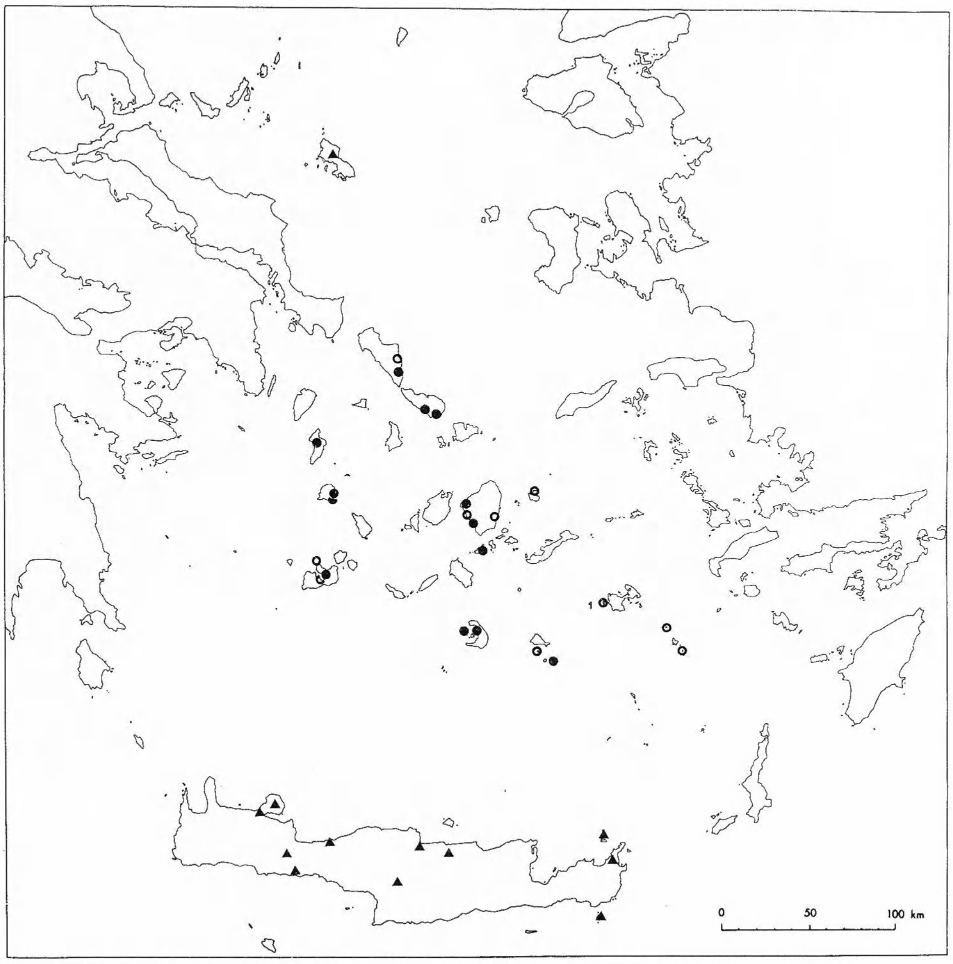


Fig. 1. *E. laciniatum.* — Symbols in Figs. 1–9: ● Localities for material with chromosome number determined. — O Localities for other material included in the investigation. — ▲ Localities from Rechinger (1943 a, b, 1961), Meikle (1954) and Rechinger & Greuter (1967).

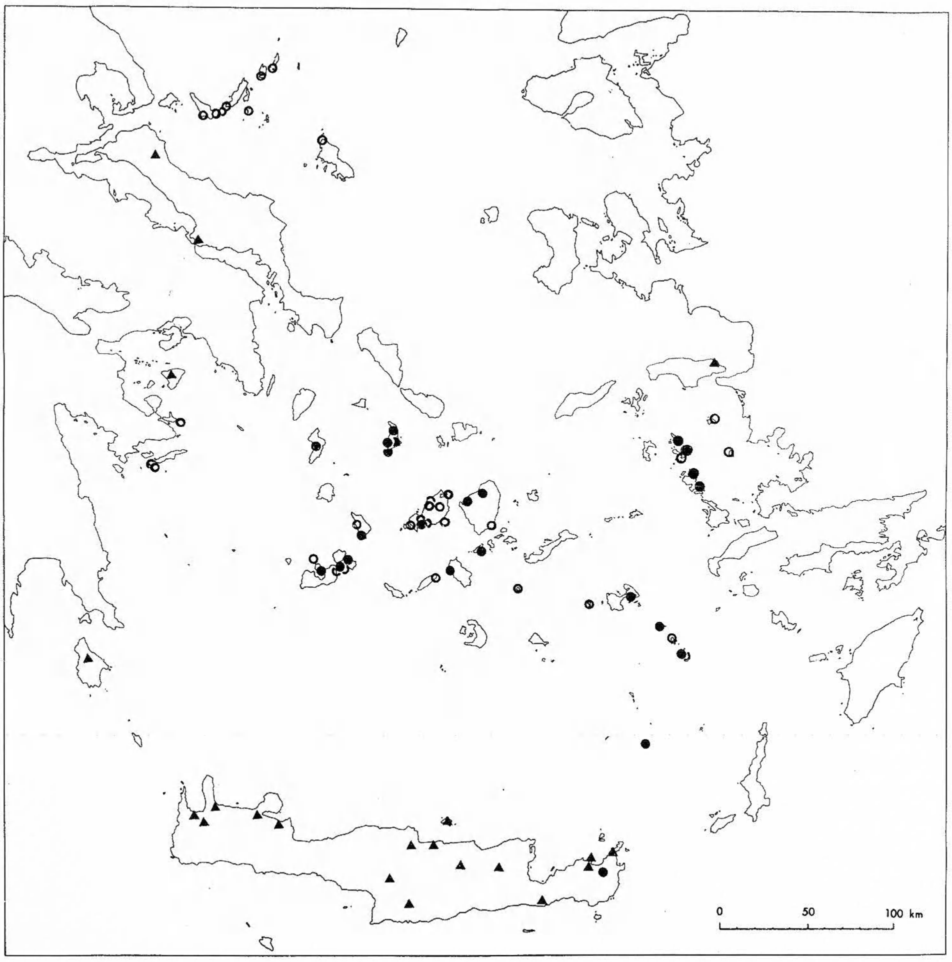


Fig. 2. *E. malacoides.*

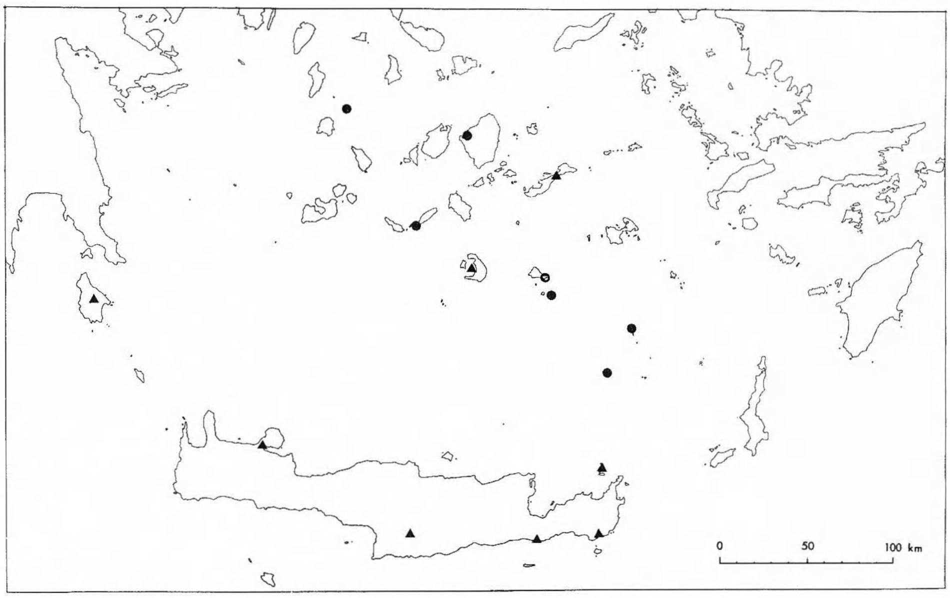


Fig. 3. *E. neuradifolium*.

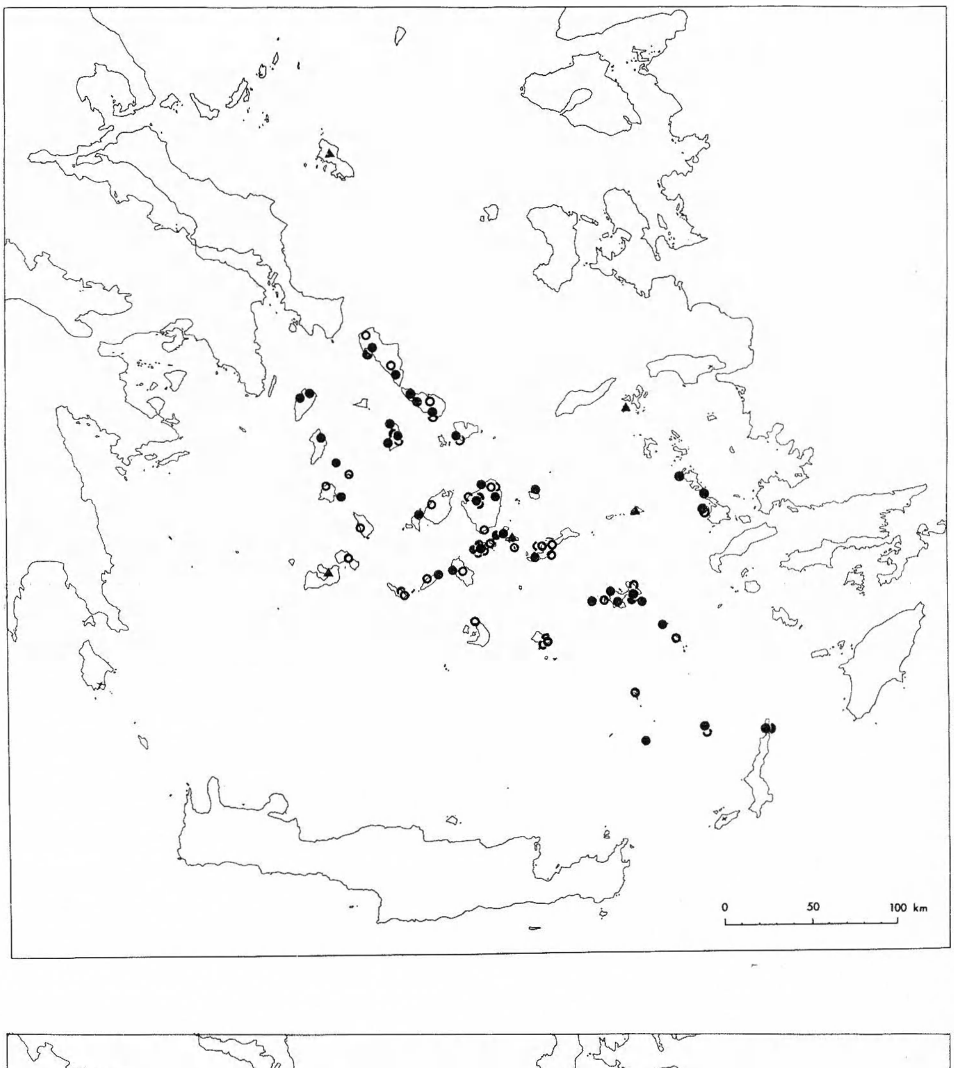


Fig. 4. *E. chium*.

Fig. 5. *E. vetteri*.

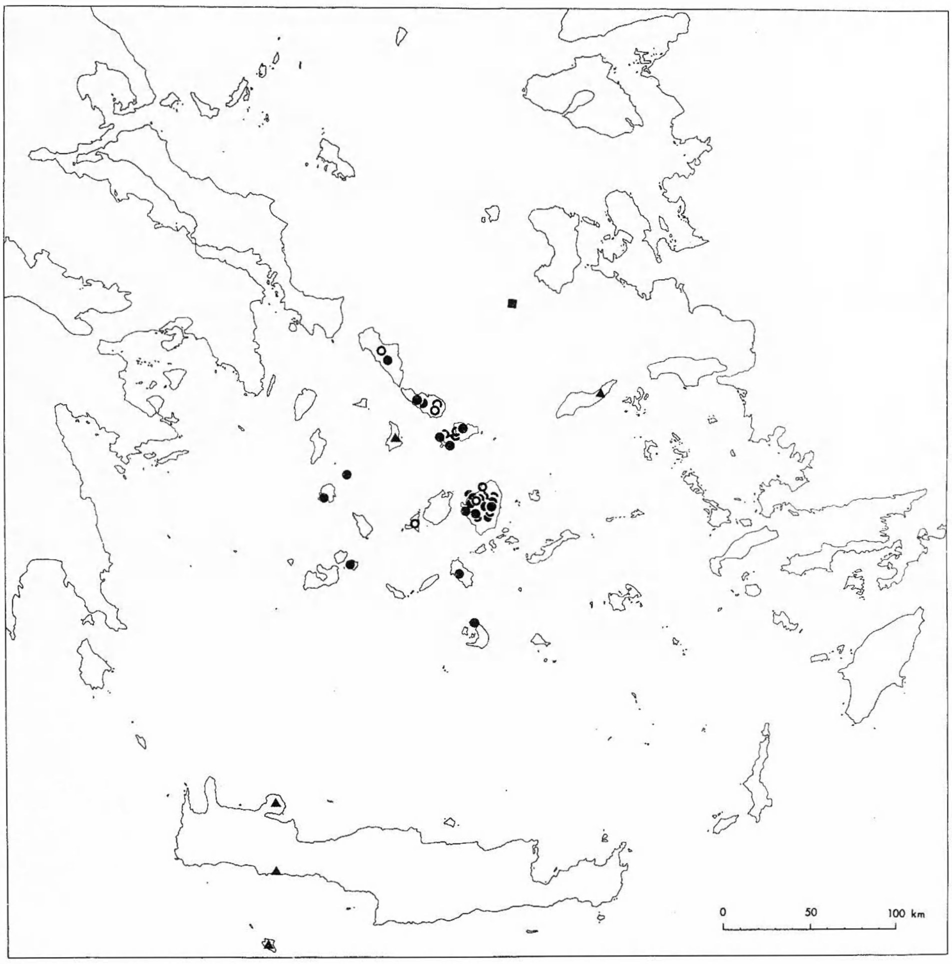


Fig. 6. *E. botrys*.

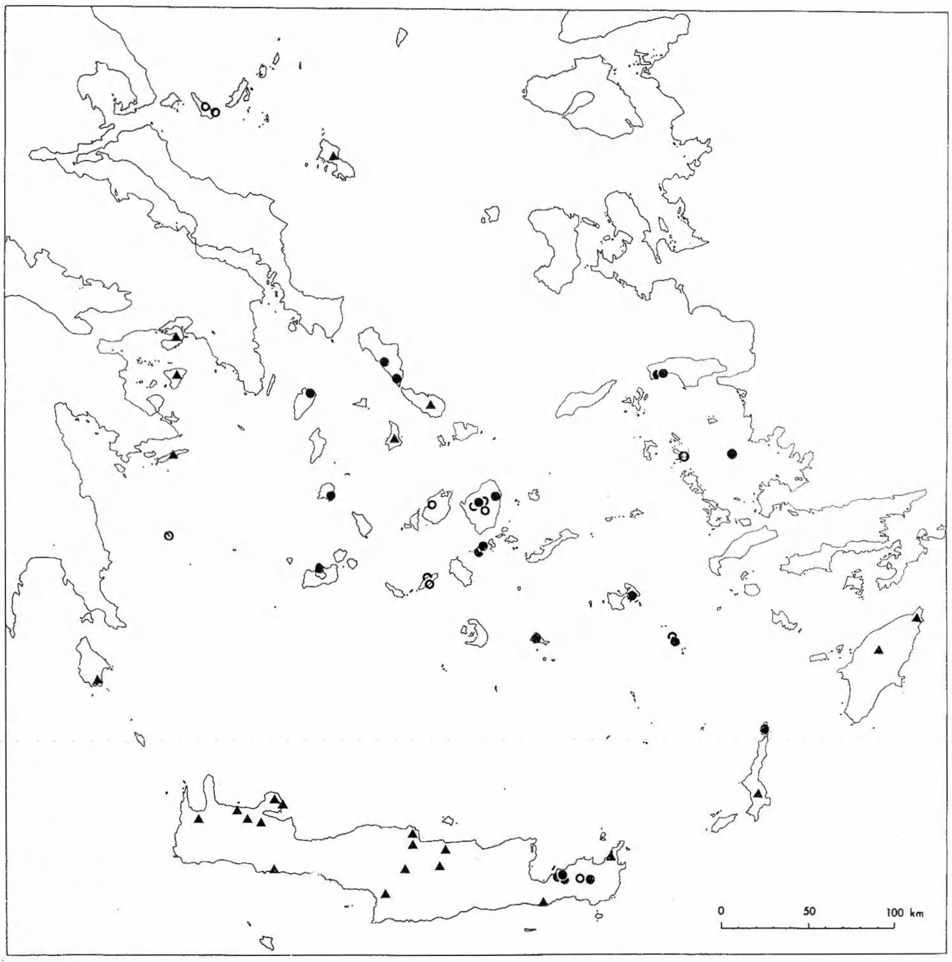


Fig. 7. *E. gruinum*.

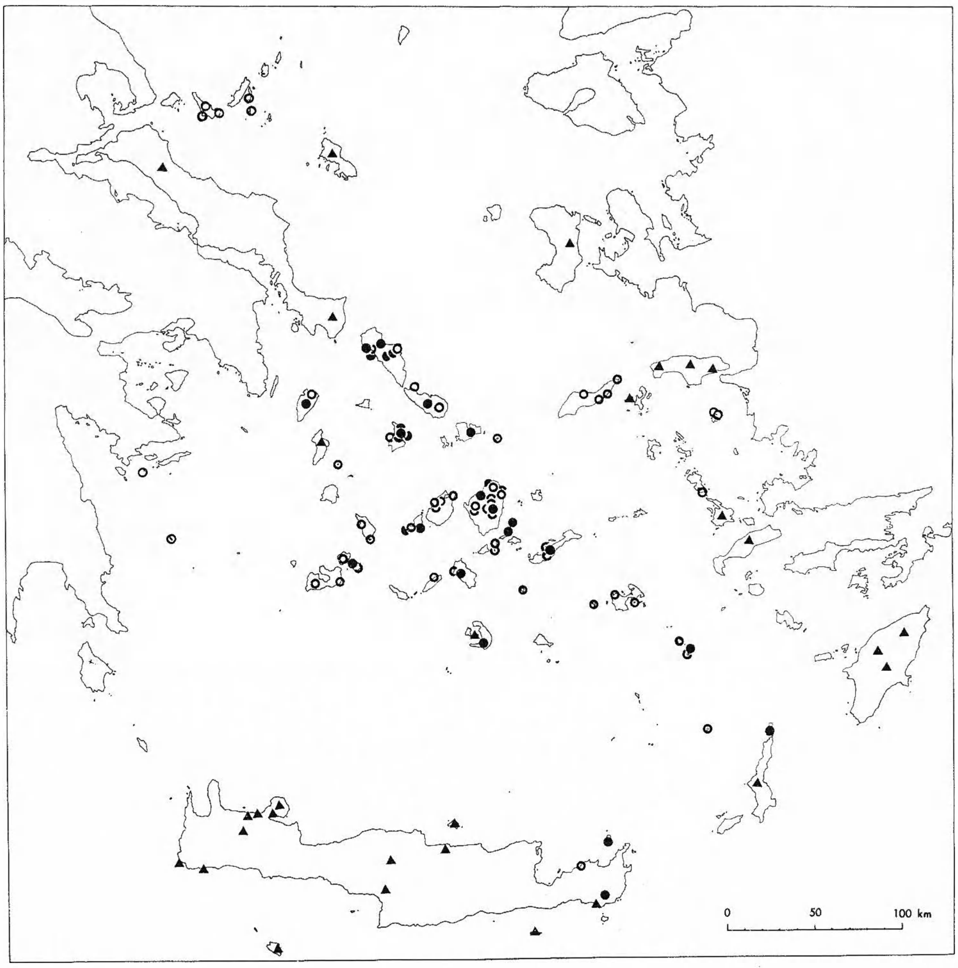


Fig. 8. *E. cicutarium*.

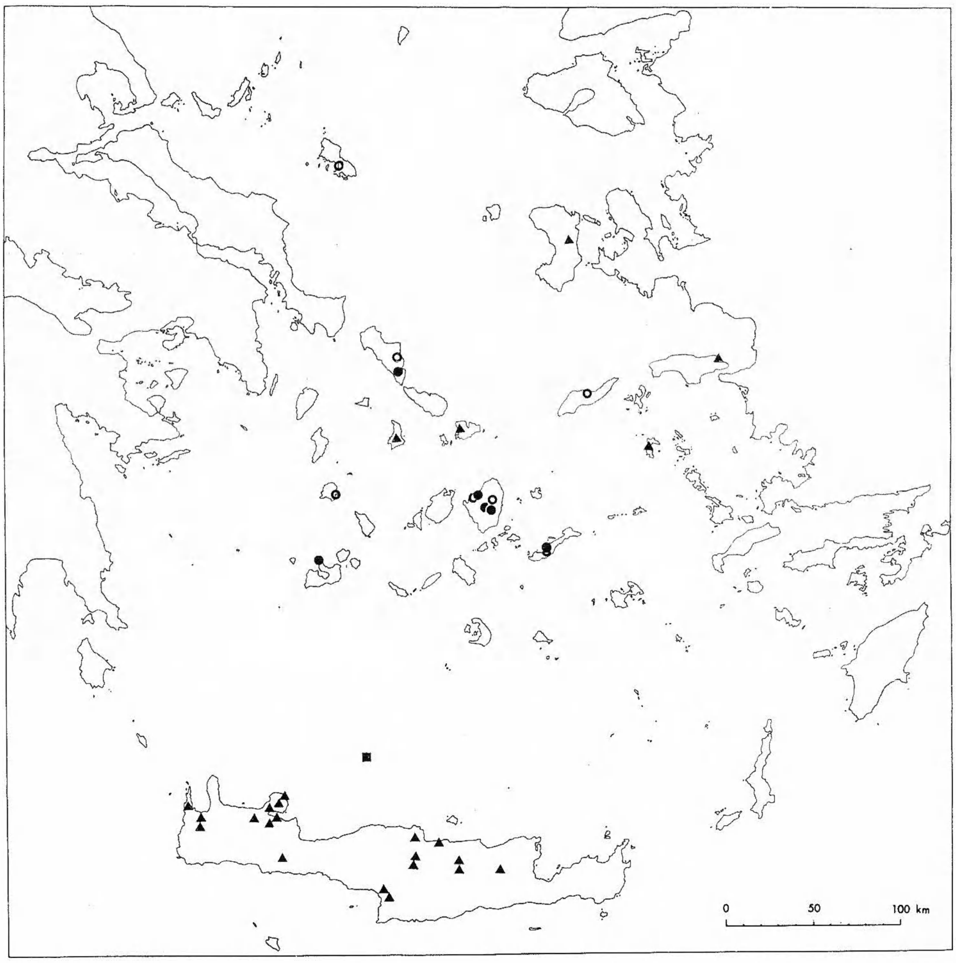


Fig. 9. *E. moschatum*.

Table 1. Chromosome numbers.

Taxon	Present investigation	Previous investigations	
E. laciniatum (Cav.) Willd.	20	20	Guittonneau 1964 (Algeria), 1965 (Spain), 1966 (Spain, Morocco), 1967 (Tunisia).
E. malacoides (L.) L'Hér.	40	40	Warburg 1938
ssp. *malacoides*		40	Guittonneau 1965 (France, Spain), 1967 (Tunisia)
E. neuradifolium Delile	40	40	Guitonneau 1965, 1966 (Spain), 1967 (Tunisia)
E. chium (L.) Willd.	20	20	Guittonneau 1964 (France, Algeria), 1965 (Spain)
	—	40	Warburg 1938
E. botrys (Cav.) Bert.	40	40	Heiser & Whitaker 1948 (California), Guittoneau 1965 (Spain, Portugal), 1967 (Tunisia)
E. gruinum (L.) L'Hér.	36	36	Guittonneau 1972 (Libya)
		40	Warburg 1938
E. vetteri Barbey & Fors.-Maj.	18	—	
E. cicutarium (L.) L'Hér.	—	36	Heitz 1926, Gauger 1937 (Germany), Negodi 1937 (Italy), Rottgardt (in Tischler) 1950, 1956 (Germany)
		48	Rottgardt 1956 (Germany)
		54(56?)	Rottgardt 1956 (Germany)
ssp. *cicutarium*	40	40	Heitz 1926, Gauger 1937 (Germany), Warburg 1938 (England), Löve & Löve 1942 (Sweden), 1956 (Iceland), Andreas 1947 (The Netherlands), Stebbins (in Heiser & Whitaker 1948), Mattick (in Tischler 1950), Rottgardt (in Tischler) 1950, 1956 (Germany), Baker (in Darlington & Wylie 1955), Larsen 1958 (European countries and South America), 1960 (Canary Islands), Guittonneau 1963 (France, Spain), 1967 (Tunisia)
E. moschatum L'Hér.	20	20	Gauger 1937 (Germany), Warburg 1938, Stebbins (in Heiser & Whitaker) 1948, Guittonneau 1965 (France, Spain), 1967 (Tunisia)

It is uncertain whether in this species the long chromosomes are to be regarded as a fusion product of two chromosomes or whether it is a case of aneuploidy. Differences in chromosome length in the karyotype of *E. gruinum* (2n=36) compared with *E. botrys* (2n=40) are difficult to establish.

Germination and seedling stage

The seeds normally germinate after a resting period. Germination has varied from 20 to 90 per cent, with the mean value c. 70 per cent. No differences between taxa have been observed.

The cotyledons appear 4–8 days after sowing. There is considerable variation between taxa of species rank and higher but almost constancy within a species. The diversity of the cotyledons in species of *Erodium* from the Netherlands has been described by Andreas (1947). The seedlings of the Aegean taxa investigated here fall into the following five cotyledon types (Fig. 11).

Type 1. Cotyledons petiolate, ovate, with truncate apex and cordate usually asymmetrical base; margin entire. Midvein and primary lateral veins distinctly depressed and ± shiny. Laminae, petioles and hypocotyl densely hairy. Mean length of laminae 18 mm, mean breadth 14 mm. Colour dark green above, reddish-brown below.

Type 2. Cotyledons petiolate, ovate or elliptical, with truncate or retuse apex and cordate often ± distinctly asymmetrical base; margin entire. Midvein distinct, lateral veins indistinct. Laminae, petioles and hypocotyl hairy, but less densely so and with shorter hairs than in Type 1. Mean length of laminae 10 mm, mean breadth 7 mm. Colour green above, light green below.

This type includes forms which are shortly pubescent and light green on both sides.

Type 3. Cotyledons petiolate, ovate with rounded-truncate apex and slightly cordate base; margin irregularly deeply crenate to shallowly lo-

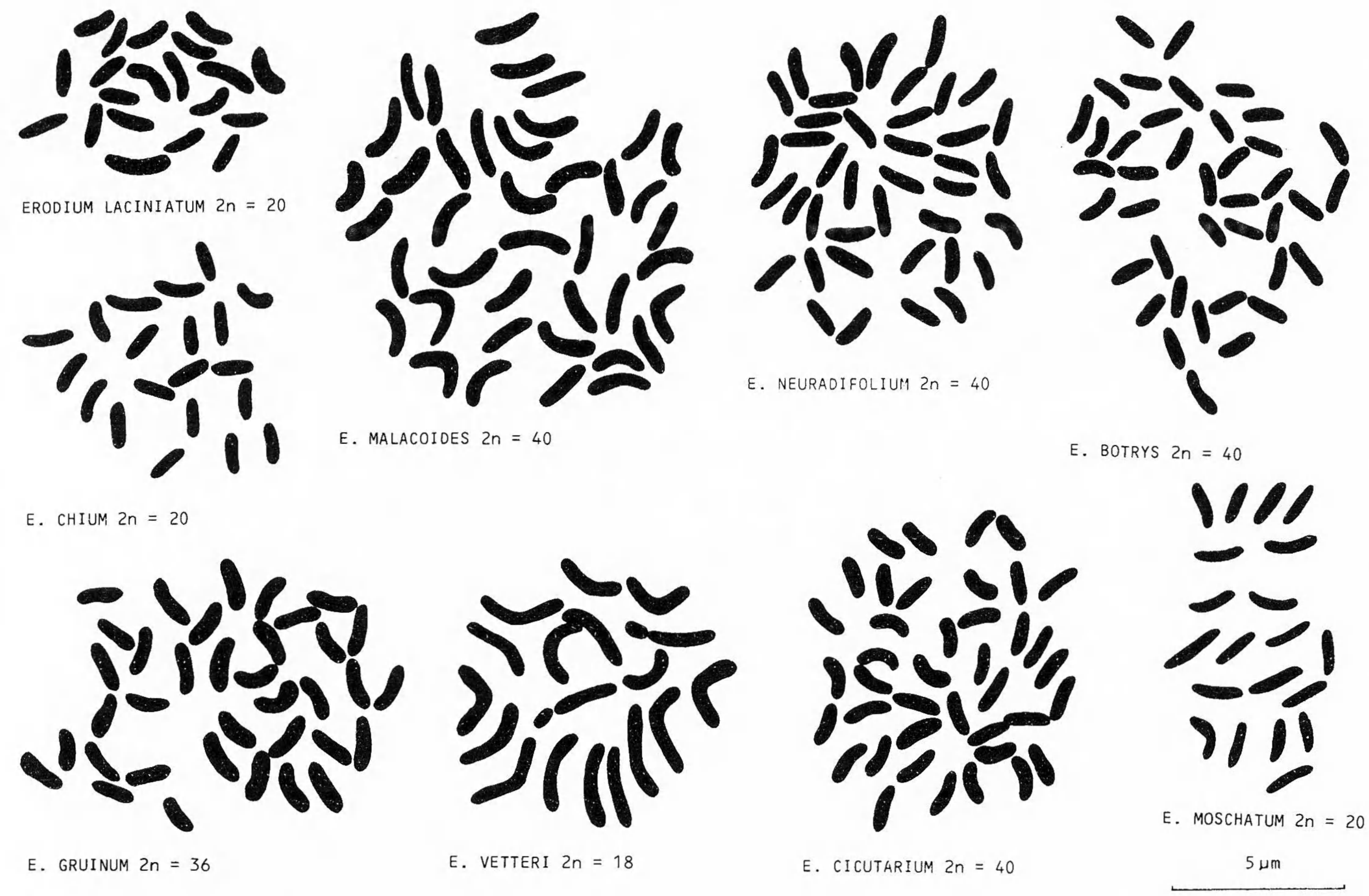


Fig. 10. Mitotic metaphase plates.

bate. Midvein distinct, lateral veins ± indistinct. Upper side of laminae, petiole and hypocotyl hairy. Mean length of laminae 13 mm, mean breadth 9 mm. Colour dark green, somewhat lighter below.

Type 4. Cotyledons petiolate, 3-lobate, end lobe larger than lateral ones. Sinuses deep but not reaching the midvein. One of the lateral lobes sometimes incized again resulting in a 4-lobate shape. Petioles and hypocotyl ± hairy, laminae sparsely hairy or glabrous. Mean length of laminae 10 mm, mean breadth 7 mm. Colour green on both sides.

Type 5. Cotyledons petiolate, lobate in upper part, divided in lower part; end lobe larger than lateral ones. Sinuses in upper part of lamina

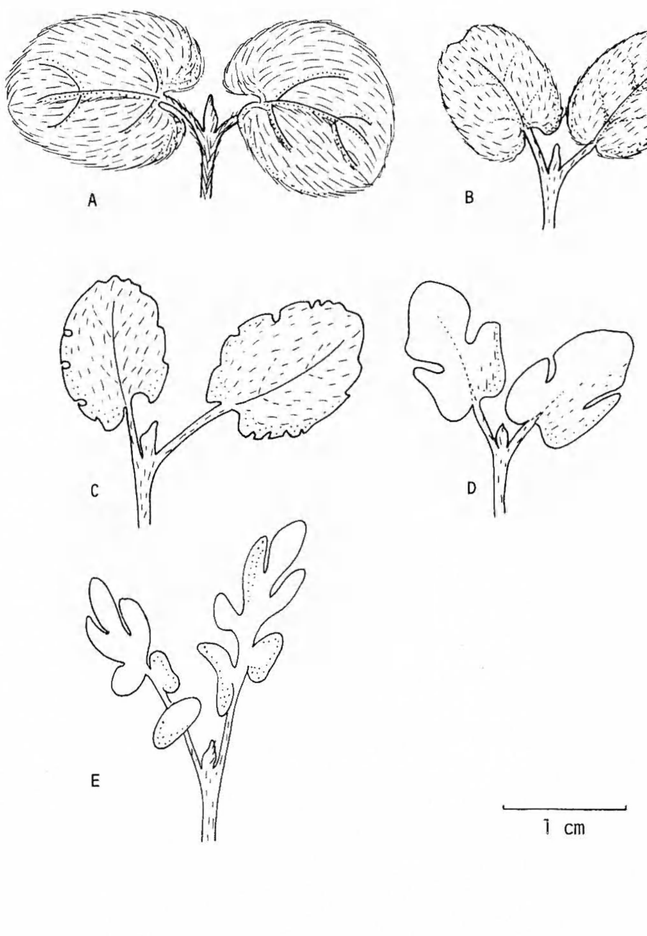


Fig. 11. Types of cotyledons. A: *E. gruinum*. — B: Species of the *E. malacoides* series included here and of *E. vetteri*. — C: *E. botrys*. — D: *E. moschatum*. — E: *E. cicutarium*.

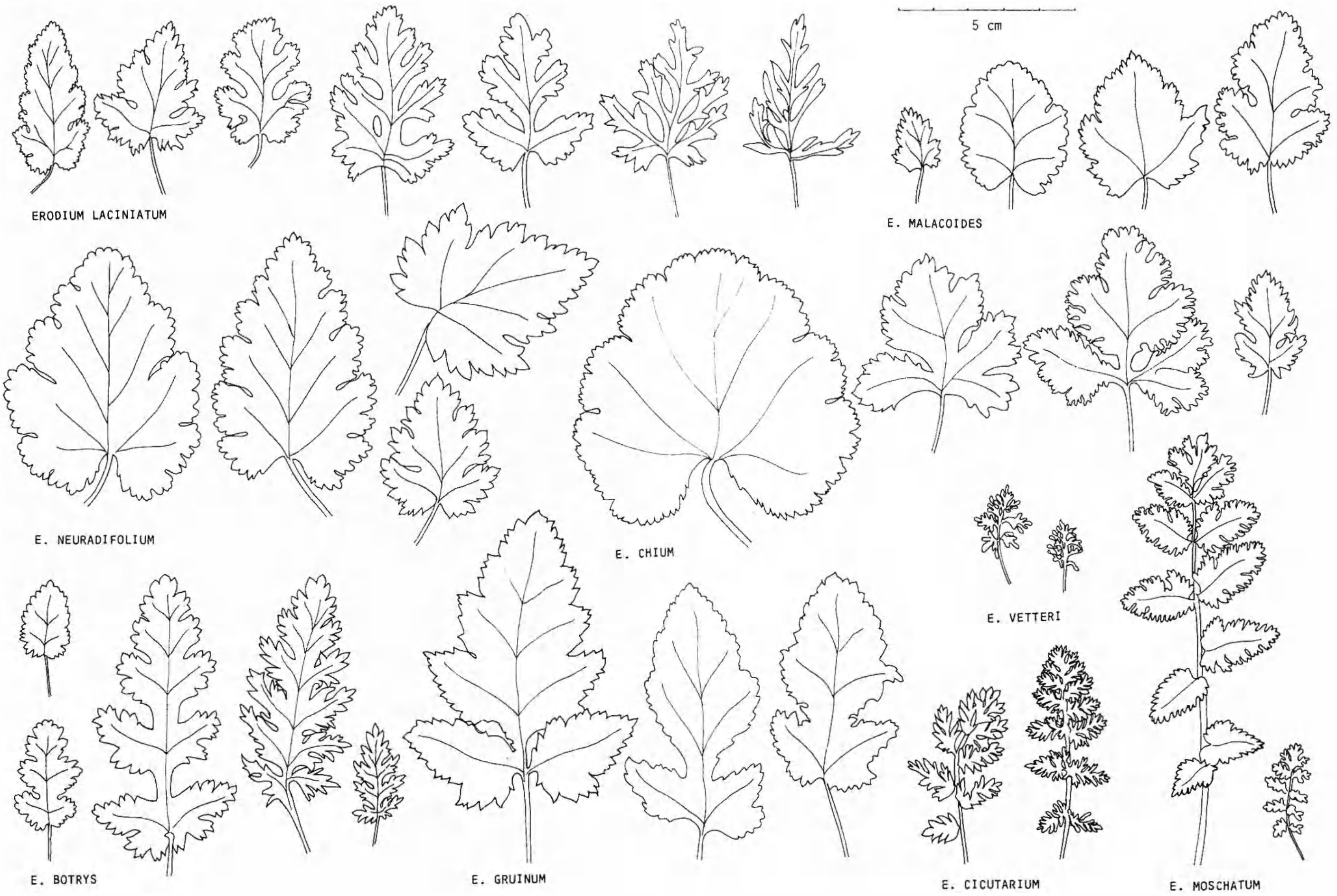


Fig. 12. Variation in leaf size and shape. The leaves are taken from the same level on plants of different samples.

almost reaching to the midvein. The two lowermost free segments obtriangular with ± cuneate base. Petioles and hypocotyl distinctly hairy, laminae sparsely hairy or glabrous. Mean length of laminae 16 mm, mean breadth 6 mm. Colour green on both sides.

The five types are distinct. They are described in a succession presuming development from entire to increasingly lobate forms, the latter even with free leaflet-like segments. The appearance of the cotyledons is of some taxonomic value. Thus all taxa of the *E. malacoides* series of subsect. *Malacoidea* studied have cotyledons of Type 2. This type also occurs in *E. vetteri* of sect. *Absinthioidea*. In the *E. botrys* series of subsect. *Malacoidea E. gruinum* has cotyledons of Type 1 and *E. botrys* of Type 3. Finally, in subsect. *Cicutaria E. cicutarium* has cotyledons of Type 5 and *E. moschatum* of Type 4.

Variation in leaf size and shape

The leaves of *E. cicutarium* and *E. moschatum* are pinnate, of the other taxa undivided to pinnatifid to pinnatisect. The size and shape of leaves can vary considerably between populations and variation is often also pronounced within populations. The flexibility ascribed to modification and/or inheritance is difficult to estimate. In cultivation under uniform conditions differences in size are less distinct, while the variation amplitude in shape remains unchanged. Least variation in shape and incision is found in the bipinnate species. Most variable are *E. laciniatum* and *E. chium*. In Fig. 12 the variation is represented by leaves taken at the same level from plants of different samples.

Pubescence

Five different hair types have been distinguished (Fig. 13) varying between taxa in combination, proportions and denseness (Table 2). The hairs are eglandular or glandular.

Eglandular hairs. Four types occur being unicellular or multicellular with either a verrucate or smooth surface. Verrucate-unicellular hairs are commonest and are normally present on stems,

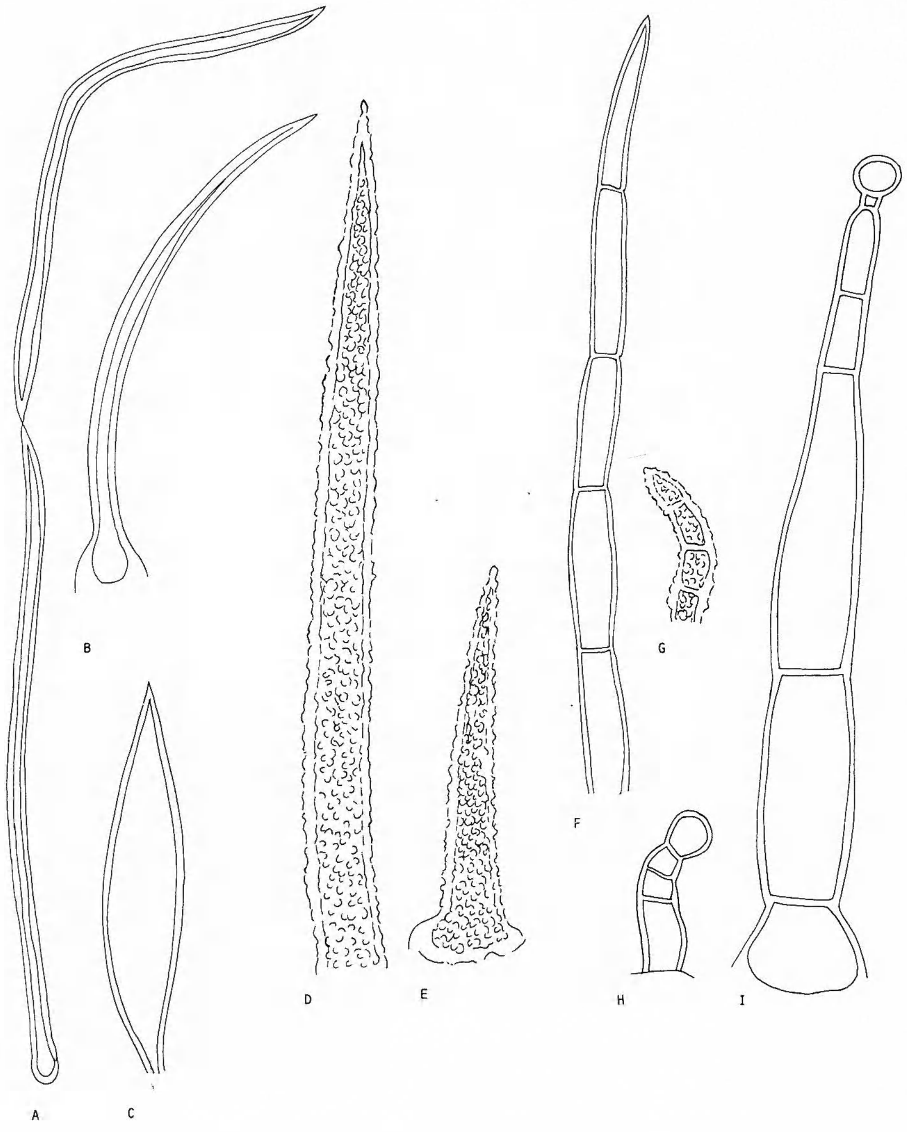


Fig. 13. Hair types. — A–G: Eglandular hairs. — A–C: Unicellular with a smooth surface, A–B from stem (*E. laciniatum* and *E. vetteri*), C from mericarp (*E. malacoides*). — D–E: Unicellular with a verrucate surface, from stem (*E. botrys* and *E. chium*). — F: Multicellular with a smooth surface, from stem (*E. gruinum*). — G: Multicellular with a verrucate surface, from stem (*E. malacoides*). — H–I: Glandular hairs, multicellular, from stem (*E. neuradifolium* and *E. moschatum*). — All c. ×120.

leaves, pedicels and sepals while smooth-unicellular hairs are mainly restricted to the mericarp.

Unicellular eglandular hairs occur mainly on the same parts of the plants in all taxa. Species differ in length and denseness of hairs and in having hairs appressed or spreading, etc. This variation, however, is also often great between populations within a species.

Multicellular eglandular hairs are rare. The smooth type is only found on stems and branches of *Erodium gruinum* and *E. moschatum* (Fig. 13 F). The verrucate type occurs on stems of *E. malacoides* only (Fig. 13 G).

Glandular hairs. These are mainly of a single type. They are always multicellular. The number of cells is usually 4–5, but the length of the two lower cells in particular varies greatly (Fig. 13 H, I). Glandular hairs are critical characters. They are common in *E. malacoides, E. neuradifolium* and *E. moschatum* and also occur in *E. botrys* but chiefly on the pedicels. *E. malacoides* and *E. moschatum* only have glandular mericarps. In *E. laciniatum* glandular hairs are usually lacking though in a few, low and morphologically deviating populations they may occur on pedicels and sometimes on sepals. In *E. gruinum* glandular hairs are lacking. The presence of glandular mericarps is thus one of the characters used for separating the species *E. malacoides* from *E. neuradifolium* and *E. moschatum* from *E. cicutarium*. Furthermore, *E. botrys* differs from *E. gruinum* in having glandular pedicels. The most variable species, *E. cicutarium,* includes populations with and without glandular hairs.

Inflorescence, flower and fruit

The inflorescence, often called an ‘umbel’, is in reality a composite cyme as for example in

Table 2. Distribution of hair types.
++ densely hairy, + hairy, (+) sparsely hairy.
* present in some populations only,**lacking in some populations.

	Eglandular hairs				Glandular hairs
Taxon	unicellular smooth	unicellular verrucate	multicellular smooth	multicellular verrucate	multicellular
E. laciniatum					
stem	(+)	+			
pedicels		+			(+)
leaves		+			
sepals		+			(+)
mericarp	+				
E. malacoides					
stem	(+)	+		(+)	+
pedicels		(+)			++
leaves		+			+
sepals		+			+
mericarp	+				+
E. neuradifolium					
stem		+			+
pedicels		+			+
leaves	+	+			+
sepals		+			+
mericarp	+				
E. chium					
stem		+			
pedicels		+			(+)
leaves		+			
sepals		+			(+)
mericarp	+				
E. botrys					
stem		++			+*
pedicels		+			++
leaves		+			
sepals		+			(+)
mericarp	+				
E. gruinum					
stem	(+)	+	+		
pedicels		+			
leaves		+			
sepals		+			
mericarp	+				
E. vetteri					
stem		+			
pedicels		+			+
leaves		+			
sepals		+			+
mericarp	++				
E. cicutarium					
stem		+			+**
pedicels		+			+
leaves		+			+
sepals		+			+
mericarp	+				
E. moschatum					
stem		+	+		+
pedicels		+			++
leaves		+			(+)
sepals		+			(+)
mericarp	+				+

Pelargonium. The number of bracts varies from 3 to 8 except in *E. laciniatum* which generally has only 2 bracts. The number of flowers in each inflorescence varies within the genus from 1 to c. 20, but in the taxa treated here it varies from 2 to 9.

The single flower has usually been described as actinomorphic or slightly zygomorphic. The symmetry varies between taxa. Thus the flowers of *E. cicutarium* in this region seem to be actinomorphic or nearly so. *E. laciniatum, E. botrys* and *E. gruinum* are often actinomorphic. In some populations, however, there is a tendency to zygomorphy, the two adjacent upper petals and the lower middle one being broader and sometimes shorter than the other two lateral petals. The flowers in *E. malacoides, E. neuradifolium, E. vetteri* and *E. moschatum* can exhibit another type of zygomorphy, the upper petals being broader and shorter than the other three which resemble one another. *E. chium* is the most variable species in this character with actinomorphic to distinctly zygomorphic flowers of the latter type with 2 broad and 3 relatively narrow petals.

Size, shape, colour and venation of the petals in combination are often reliable characters for distinguishing species in nature (Figs. 14, 15). They have rarely been used by previous authors probably because the petals are often shed a few hours after the flowers open. On the other hand each plant produces many flowers continuously. In herbarium material the petals are often missing or damaged or have at least changed colour.

In *E. chium, E. vetteri* and *E. gruinum* the petals overlap basally. In other taxa they taper at the base and the sepals can be seen between the petals, in some populations of *E. cicutarium* the petals tapering into an actual claw.

Only *E. vetteri* has white corollas. *E. gruinum* has big, violet corollas, twice the size of those of most other taxa, and it is the only species with bluish petals. *E. malacoides* differs in having petals of a strong magenta colour distinguishing it from *E. neuradifolium* which has pink petals.

In petal colour too *E. chium* shows most variation, the colour ranging from pale pink to yellowish-pink or dark pink. Unlike other taxa the petals often have a wrinkled surface. Most taxa are characterized by a red spot basally and red veins radiating from it. In *E. moschatum* and *E. cicutarium,* however, both the basal parts of the petals and the veins are white or whitish.

The fruit is a capsule-derived schizocarp which splits into five mericarps, starting at the base. The outer part of the style is retained on the mericarp forming the so-called beak which becomes spiralized as soon as the mericarp becomes free and is hygroscopically sensitive.

In the upper part of the mericarp there is a more or less wide and deep depression called the pit which in some species bears multicellular glands. The surface of the pit is covered with unicellular papillae. Below the pit the mericarp in some taxa is provided with one or two transverse furrows.

The size and pubescence of the beak and mericarp, the appearance and depth of the pit, the presence or absence of glands in the pit and the number of furrows, etc., are important characters for distinguishing taxa (Table 3 and Figs. 16–20).

Taxonomy

Key to the taxa

1\. Leaves pinnate 2
– Leaves undivided or pinnatifid–pinnatisect 3
2\. Leaflets divided more than half-way to midrib; pit of mericarp without glands; plant not smelling of musk .... 8. *E. citutarium*
– Leaflets divided less than half-way to midrib; pit of mericarp with glands; plant smelling of musk .... 9. *E. moschatum*
3\. Perennial, forming hard cushions of basal rosettes, leaves pinnatisect, greyish .... 7. *E. vetteri*
– Annual or biennial, ± ascending, leaves of variable appearance, green 4
4\. Beak of fruit c. 60–110 mm 5
– Beak of fruit c. 25–45 mm, rarely up to 60 mm .. 6
5\. Petals 8–12 mm, pink with distinct carmine veins; mericarp 8–10 mm with 2 furrows at the base .... 5. *E. botrys*
– Petals 10–14 mm, pale violet with distinct carmine veins, mericarp 12–15 mm with 1, rarely 2, furrows .... 6. *E. gruinum*
6\. Inflorescence bracts 2 (rarely 3); petals apically slightly retuse .... 1. *E. laciniatum*
– Inflorescence bracts 3 or more; petals not retuse 7
7\. Mericarp with a furrow at the base of the pit 8
– Mericarp without a furrow at the base of the pit .... 4. *E. chium*
8\. Pit of mericarp with multicellular glands; furrow wide .... 2. *E. malacoides*
– Pit without multicellular glands; furrow narrow .... 3. *E. neuradifolium*

Subsection Malacoidea Brumh.

The E. malacoides series

1. Erodium laciniatum (Cav.) Willd.

Willdenow 1800 p. 633. *Geranium laciniatum* Cavanilles 1787 p. 228.

Cotyledons of Type 2. *Plant* 8–70 cm, ± densely hairy, with eglandular hairs. *Leaves* undivided, pinnatifid or ± bipinnatisect. Lamina 15–70 mm long, ovate, usually with a truncate base, rarely slightly cordate and with acute or obtuse apex. Deeply incised with crenate-acuminate lobes. *Bracts* usually 2, rarely 3, broadly triangular, glabrous and colourless, transparent or brown with a colourless part near the margin or with brown veins. *Inflorescence* 3–9-flowered. Pedicels with eglandular hairs. *Sepals* 5–7 mm long, acuminate, light green with raised dark green veins. *Petals* 6–10 mm long, elliptical with retuse apex, purplish-pink to light lilac with the three main veins ± distinct and dark. *Beak* 38–46(–60) mm. *Mericarp* 4–6 mm, densely covered with fine, white appressed hairs; pit narrow and shallow, without multicellular glands and without a furrow beneath the pit. 2n=20.

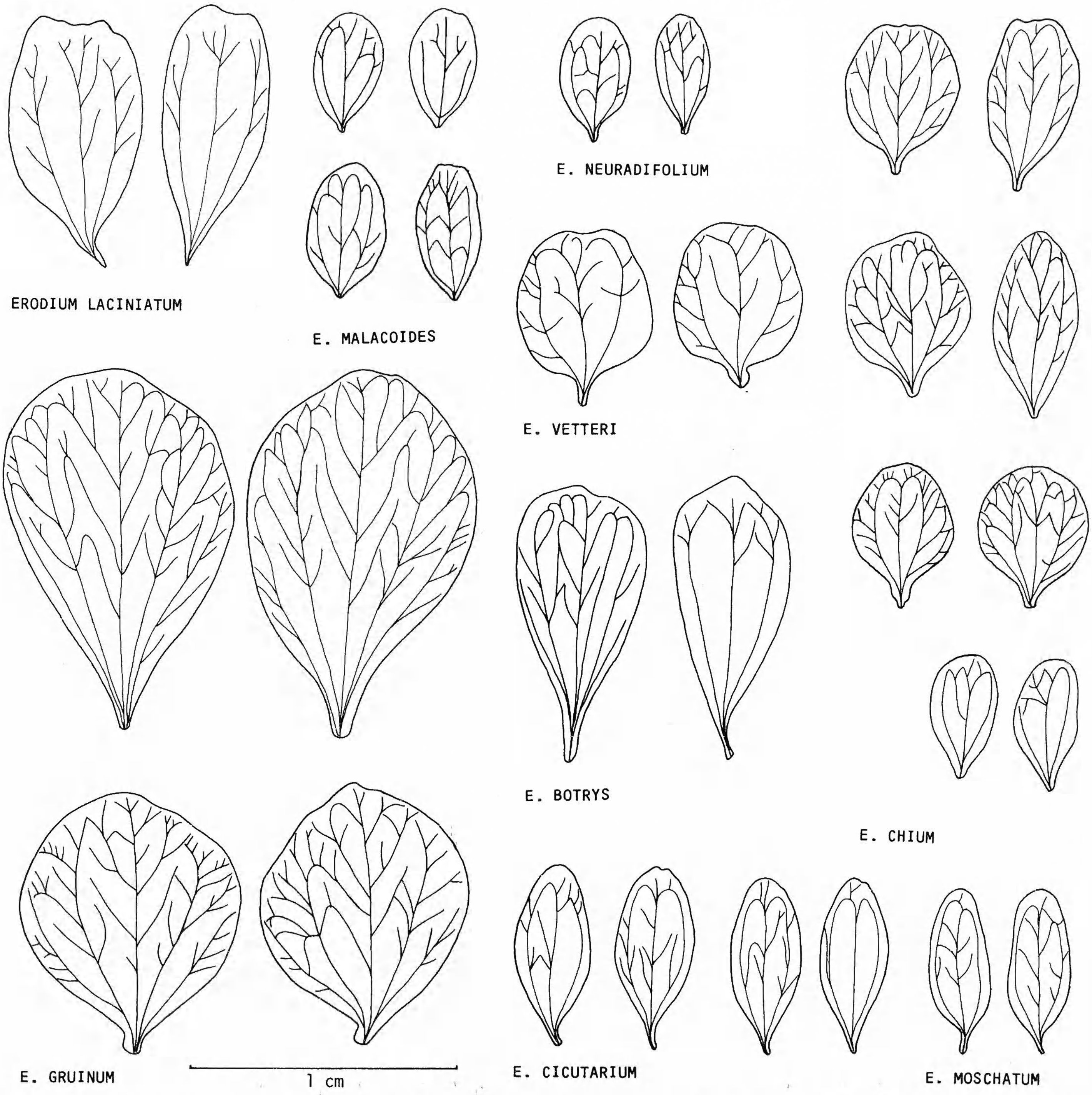


Fig. 14. Petals, one upper and one lateral, from each sample of the species, showing relative size, shape, venation and symmetry (actinomorphic flowers, petals ± similar; zygomorphic flowers, petals differing).

On seashores and sandy fields but also on littoral cliffs and in garigue.

Some populations of low small-leaved plants also differ in that the leaves are usually less incised, the lobes always rounded and crenate, and the inflorescences sometimes have 3 bracts. Pedicels and sepals in these populations may rarely be glandular (glandular hairs do not otherwise occur in *E. laciniatum*). In size, shape and colour of bracts and sepals they may or may not differ from the majority of the samples studied, while petal and fruit characters agree in all populations.

These deviating populations correspond most closely to what has been described as *E. pulverulentum* (Cav.) Willd. However, the deviating characters are often not correlated and thus there is no reason for distinguishing separate taxa.

Guittonneau (1972) has treated *E. laciniatum*

Fig. 15. Flowers of *Erodium*. — A: *E. laciniatum*. — B: *E. malacoides*. — C: *E. neuradifolium*. — D–F: *E. chium*. — G: *E. botrys*. — H: *E. gruinum*. — I: *E. vetteri*. — J, K: *E. cicutarium*. — L: *E. moschatum*. — All ×2.15.

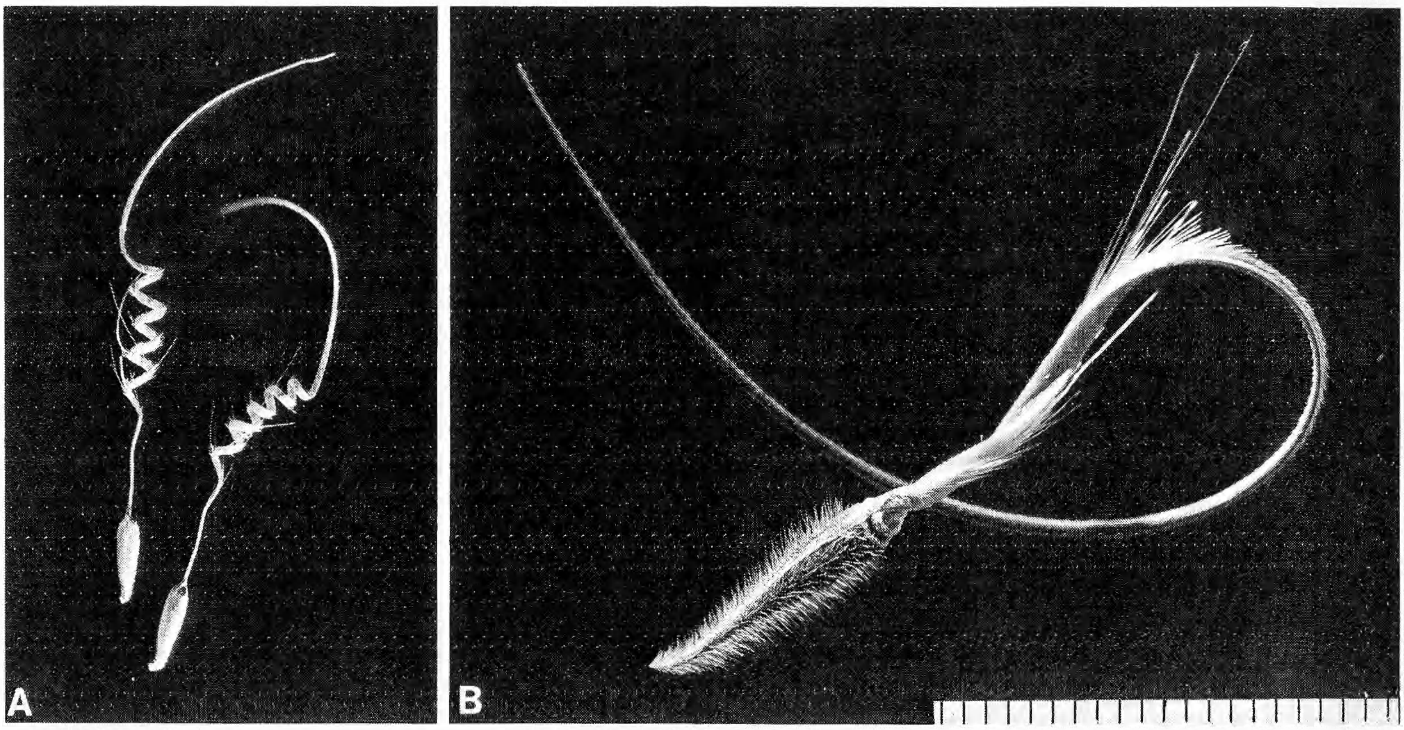


Fig. 16. Mericarps with beak. — A: *E. laciniatum*. — B: *E. gruinum*. — Scale in mm.

Table 3. Characteristics of beak and mericarp.

Taxon	Beak		Mericarp length in mm	Pit	Furrow
	length in mm	pubescence			
E. laciniatum	38–46	dense; fine, white appressed hairs	4–6	narrow, shallow eglandular	—
E. malacoides	25–36	dense; white, or brownish, semi-spreading hairs	4–6	wide, deep glandular	1, wide
E. neuradifolium	28–36	dense; white, appressed to semi-spreading hairs	4–6	narrow, deep eglandular	1, narrow
E. chium	30–44	variably dense; fine white, appressed hairs	4–5	narrow, deep eglandular	— or indistinct
E. botrys	60–110	basally dense, upwards often less dense; white coarse spreading hairs	8–10	wide, deep eglandular	2, the upper wider
E. gruinum	70–110	dense; white to creamy coarse spreading hairs	12–15	wide, deep eglandular	1 (2), wide
E. vetteri	35–45	exceedingly dense; long fine white mixed appressed and semi-spreading hairs	6–7	wide, shallow eglandular	—
E. cicutarium	35–45	dense; fine white to brownish, appressed hairs	5–6	narrow, shallow eglandular	1, narrow
E. moschatum	30–45	variably dense; long white to brownish, semi-spreading hairs	5–7	wide, deep glandular	1, wide

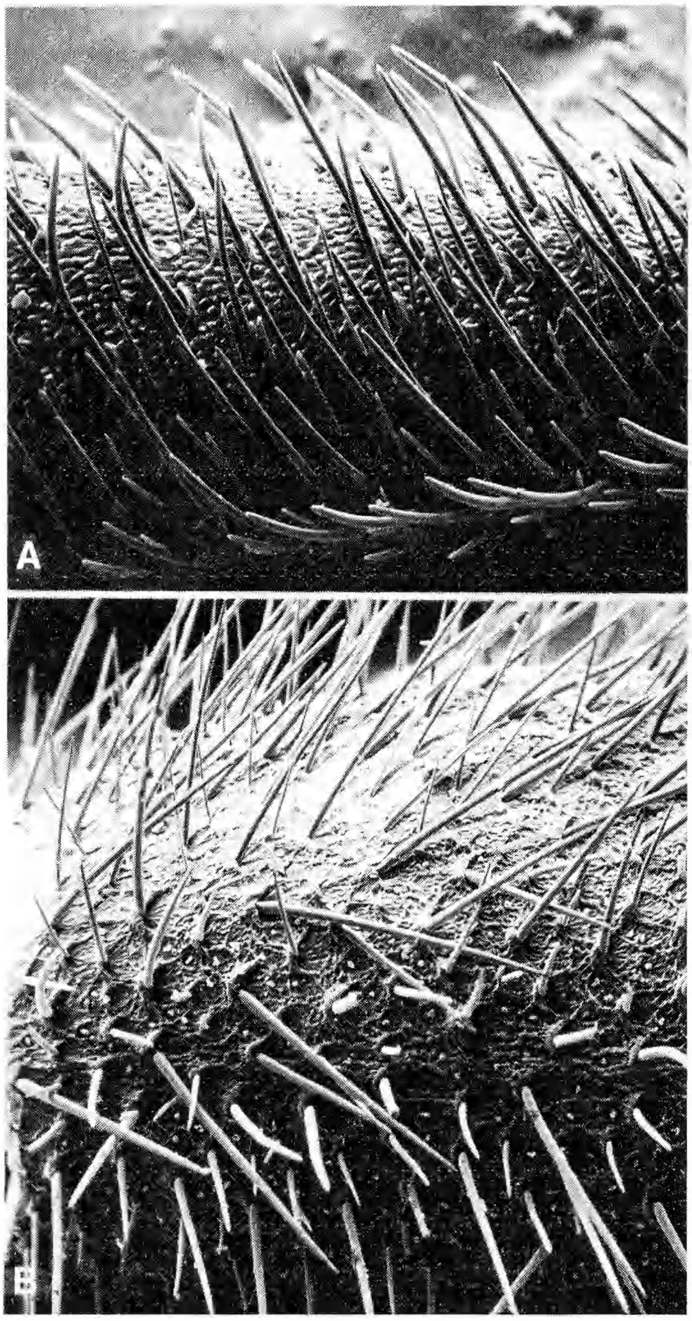


Fig. 17. A: mericarp with appressed hairs (*E. cicutarium*) ×90 and B: mericarp with spreading hairs (*E. gruinum*) ×36.

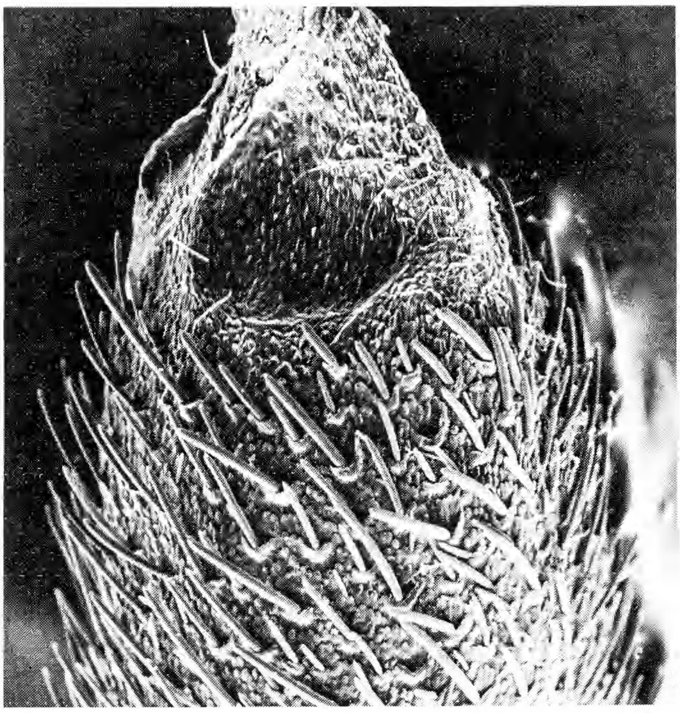
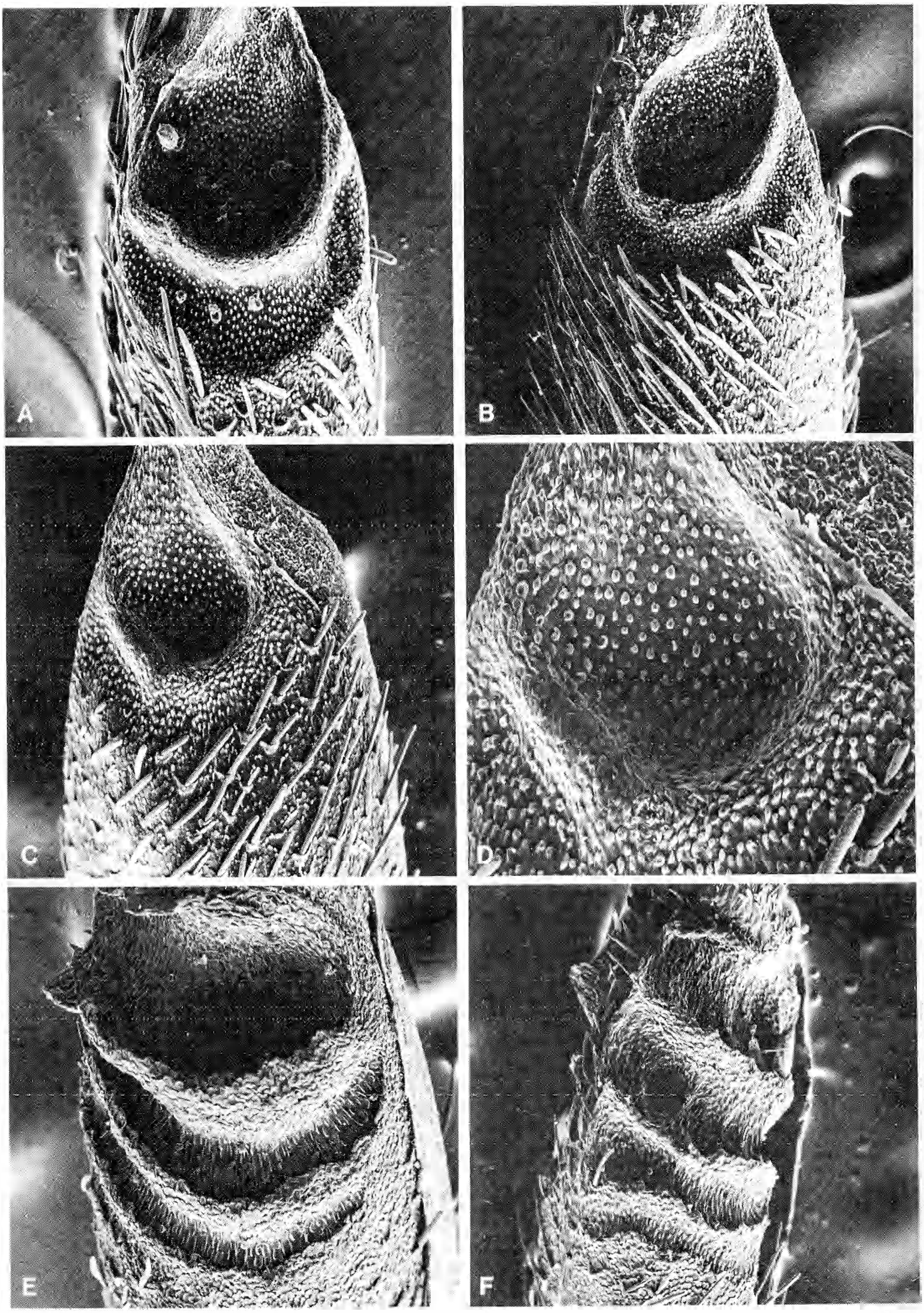


Fig. 18. Scanning electron photomicrograph of mericarp, upper part. *E. laciniatum* ×90.

and *E. pulverulentum* as two different species in the study of western Mediterranean material. They were found to grow under different ecological conditions, but it was pointed out that they would probably have to be united under one species after a more extensive analysis of the variation.

Herbarium material from Turkey and Iraq seems to show a somewhat more distinct correlation between characters than do the few scattered populations studied from the Aegean islands. Populations resembling *E. malacoides* in fruit appearance have been described from SW Spain and may be hybrids. No introgression from *E. malacoides* has been observed in the eastern Mediterranean material investigated.

Cyclades. Anafi. Fteni, the E island. Hard limestone; the island of Makra. S-exposed slopes and the highest peak (E 78). Andros. Korthion, sandy seashore and sandfields, 0–10 m; by the river S of the town of Andros, 0–10 m. Denousa. 1.5–2.5 km SSE of the innermost bay of Ormos Rousa, in a field, 50–200 m. Dio Adelfi. The E island, limestone, garigue. Iraklia. S of the harbour. On a sandy shore 1 km S of the harbour (E 109). Kithnos. Ormos Aporousi (E 152). Milos. Akradia, the E island; Aliki (E 63); Chivadolimni, sand and flooded soil. Naxos. Akr. Ag. Ioannis. In a sandy field (E 73); above the shore S of the town. In sand (E 99); Akr. Pardénos. In sand; Psiliammos. Littoral cliffs. Pontikoutha. Schists, hard limestone, garigue.


A
B
C
D
E
F

Thera, round the town, 100–200 m (E 52); the island of Thirasia. Between the harbour and Manolas (E 69). Serifos. The shore at the harbour (E 64); Livadion, sandy shore (E 48). Sirina. Tria Nisia, the N island. Hard limestone, garigue. Tinos. Platia Ammos (E 163); Ag. Ioannis (E 160).

East Aegean islands. Gaidharonisi. The island of Claro Nisos. Hard limestone.

2. **Erodium malacoides** (L.) L'Hér.

L'Héritier in Aiton 1789. *Geranium malacoides* Linnaeus 1753 p. 680.

Cotyledons of Type 2. *Plant* 5–60 cm, hairy, eglandular hairs sometimes dominant, sometimes glandular hairs. *Leaves* usually undivided, rarely irregularly divided with deep incisions or pinnatifid. Lamina 10–66 mm long, suborbicular, ovate or elliptical with truncate or cordate base and obtuse apex. Margin irregularly crenate. *Bracts* 3–7, ± ovate, often hairy, especially along the margins, transparent, uncoloured or partly light brown. *Inflorescences* 3–8-flowered. Pedicels glandular. *Sepals* 5–7 mm long, acuminate, light green with dark green veins. *Petals* 4–7 mm long, elliptical or oblong with obtuse apex, magenta without distinct veins. *Beak* 25–36 mm. *Mericarp* 4–6 mm, with long, white or brownish semi-spreading hairs; pit wide and deep, with multiglandular hairs and with a deep wide furrow at the base. 2n=40.

In garigue, open fields, sandy banks along streams, cliffs and olive groves.

Crete. Sitia. Achladi, WSW of Chamaetulo, 500–600 m; the mountain slope above the village of Dri. Cliffs, 450–750 m (E 4).

Cyclades. Anidros. The SW part of the island. Limestone, garigue. Antiparos, the island of Isimindiri. Astipalea. Baia di Caminacia. Limestone schists, garigue, 0–100 m; between Maltesana and Vriseu Punda. Schists. Hard limestone, garigue, 0–100 m (E 30). Dio Adelfi. The E island. Limestone, garigue (E 122). Ios. N of the harbour. By the road (E 83). Iraklia. Ormos Pegadi. Limestone cliffs, 5 m above the shore (E 90). Kamila. Limestone. Kimolos. Between the town and the harbour (E 61); the island of Ag. Georgios. Volcanic rock; the island of Ag. Georgios. Volcanic rock. Kithnos. E of Merixas, 0–200 m (E 150). Milos. Akradia, the W island; Kastro, c. 200 m (E 68). Naxos. The town, the small island with the antique ruin (E 155); E of Mytria, along a small stream. Limestone. Sand at the stream, c. 100 m (E 107); 0–1 km N of Panormo. Garigue, 0–100 m. Ofidousa. Hard limestone, garigue. Ounia Nisia. The East island (E 66). Paros, the island of Gaidaronisi; the island of Glaropounda (E 62); above Levka, 300 m; the island of Mavronisi; Parikia. Above the monastery. Garigue, 250–350 m; 1–2 km E of Parikia, 50–100 m; Tourlos, the N island; Tourlos, the S island. Poliagos, the NW part. Garigue field (E 51). Sifnos. The bay inside C. Khondropo. Garigue, 0–20 m; Ormos Kondos. In a sandy field by the sea (E 104). Sikinos, the E promontory. S-exposed cliffs facing the sea. Sirina. The valley N of the village. Garigue, 20–200 m; Tria Nisia, the S island. Limestone, garigue; Tria Nisia, the S island. Limestone, littoral cliffs (E 72). Siros. 0–1 km W of Finikas, 10–150 m (E 180); Oros Kapari, 1–2 km N of the town. Garigue, 150–300 m (E 87); the island of Strongylo WSW of Komito, c. 50 m (E 141); Ag. Varvaras (E 154).

East Aegean islands. Arki. The island of Morene. Yellow limestone. Arki. The S part. Limestone and schists. Gaidharonisi. The island of Claro Nisos. Hard limestone. Ikaria, 300 m N of Ag. Kirikos, c. 70 m. Olive grove; 4 km SW of Ag. Kirikos, c. 30 m. Meadow. Leros. The island Ag. Kiriaki. The W part. Hard limestone. Leros. The island of Strongilo. Hard limestone. Lipsos. SE of the town. Loose schists, partly limestone; the N Apra Nisia. The N island. Soft yellow limestone; the island NE of Lunga. Yellow soft limestone; the island of Lera. Limestone. Pharmako. The central part. Hard limestone. Telendos. Apano Nisia. The main island. Limestone.

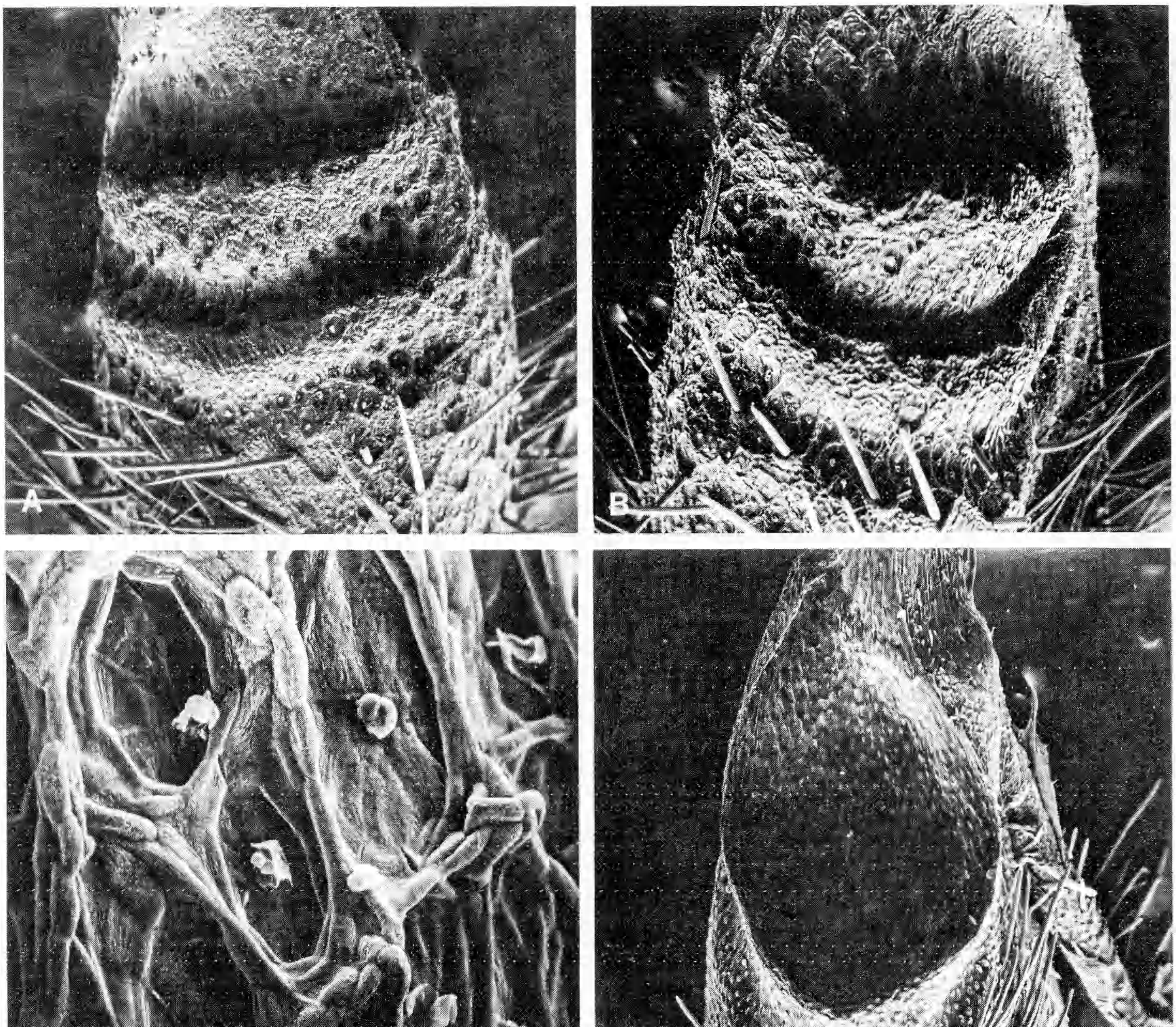
Kasos. The west part of the Armanthia island. Soft limestone.

N Sporades. Skopelos, 0–1 km N–NW of the town, 20–100 m. Allonisos, 0–1 km WNW of the harbour, 10–100 m. The island of Adelphi SE of Allonisos. The island of Adelphopoulo SE of Allonisos. Skopelos, near the sea c. 1 km NW of Linarakia. The island of Ag. Georgios between Allonisos and Skopelos. The small island of Pappous SW of Youra. The islet in Ormos Kira Panagia c. 1.5 km NE of Pelerissa.

Skiros. In the valley W–NW of the village of Krini.

West Aegean islands. Idhra. The island of Pontikous. Hard limestone. Idhra. The island of Ventza. Hard limestone. Poros. The island of Modhi. Hard limestone.

Fig. 19. Mericarp, upper part. A: *E. malacoides* ×90. — B: *E. neuradifolium* ×78. — C: *E. chium* ×90. — D: *E. chium*, detail of pit with unicellular papillae ×180. — E: *E. botrys*, with two furrows ×60. — F: *E. botrys*, with three furrows ×48.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3. **Erodium neuradifolium** Delile

Delile, in Godron 1853 p. 17. *E. subtrilobum* sensu Vierh. *E. malacoides* var. *ribifolium* Brumh.

Cotyledons of Type 2. *Plant* 10–15 cm, hairy with eglandular and glandular hairs. *Leaves* undivided or ± 3-lobate. Lamina 25–70 mm, ovate–suborbicular with cordate base and obtuse or acute apex. Margin deeply and irregularly crenate, the apical tooth of the lamina or of a lobe often acute. *Bracts* 3–7, broadly ovate, colourless or light brown, usually with white hairs along the margin. *Inflorescences* 4–8-flowered. Pedicels glandular. *Sepals* 5–7 mm long, acuminate, light green with dark veins, densely hairy. *Petals* 4–7 mm long, elliptical with obtuse apex, ± dark pink with a dark red spot at the base. Veins distinct near the spot. Filaments of *stamens* with characteristic teeth. *Beak* 28–36 mm. *Mericarp* 4–6 mm, with white appressed to slightly spreading hairs; pit narrow and deep, without glandular hairs; with a narrow furrow below the pit. 2n=40.

On limestone cliffs.

Erodium neuradifolium has often been included in *E. malacoides*, sometimes as a subspecies or a variety. It seems, however, that they can be separated on several characters, at least in the Aegean islands, and have here been accorded species rank:

E. neuradifolium	*E. malacoides*
Leaves often 3-lobate, 'ribifoliate'	Leaves irregularly divided
petals pink with dark spot basally	petals magenta
filaments of stamens with characteristic teeth	filaments without teeth
mericarp with appressed to semi-spreading hairs	mericarp with appressed hairs
pit deep, narrow; eglandular	pit deep, wide; glandular
furrow of mericarp narrow	furrow of mericarp wide

Cyclades. Anafi. Kalamos, S-exposed limestone cliffs facing the sea. Scree; The island of Makra. S-exposed slopes and the highest peak (E 79). Kamila (E 53). Naxos, NE of the town (E 44). Safora (E 14). Serifos, the island of Serifopoula. Hard limestone (E 47). Sikinos. The island of Kalogeros. Hard limestone and schists (E 3).

4. **Erodium chium** (L.) Willd.

Willdenow 1794 p. 10. *Geranium chium* Linnaeus 1759 p. 1143.

Cotyledons of Type 2. *Plant* 5–50 cm, sparsely hairy with eglandular hairs. *Leaves* undivided, 3-or 5-lobate or pinnatifid, the lobes dissected again or deeply crenate or dentate, rarely pinnatisect. Lamina 20–100 mm long, orbicular to ovate with cordate base and obtuse apex. Margin crenate, in forms with deeply dissected leaves often dentate. *Bracts* 3–8, broadly ovate, colourless, sparsely hairy. *Inflorescences* 3–8-flowered. Pedicels sparsely glandular hairy. *Sepals* 4–7 mm long, acuminate, very light green with distinct dark green veins, hairy with deflexed hairs. *Petals* 4–8 mm, 3 oblong, 2 subrotundate with slightly retuse or obtuse apex, usually overlapping near the base; wrinkled, pale to deep pink (sometimes with a yellowish tone) rarely purplish with a diffuse red spot basally and three ± distinct red veins. The flowers are more distinctly zygomorphous than in other taxa. *Beak* 30–44 mm. *Mericarp* 4–5 mm, with fine white appressed hairs; pit narrow and rather deep, eglandular; furrow lacking or indistinct. 2n=20.

Chiefly a ruderal plant but can also be found on cliffs, in garigue, etc.

The species shows great variation in size, shape and incision of leaves between and within populations. The colour of the petals varies more than in any other of the taxa studied and is ± correlated with differences in colour of stigmas (pink to yellow).

Two subspecies are distinguished in Flora Europaea: ssp. *chium* and ssp. *littoreum*, separated on duration (annual or biennial versus perennial), differences in incision of leaves and ciliated versus glabrous staminodes. Ssp. *littoreum* is restricted to the western Mediterranean area.

Guittonneau (1972) treats two varieties of *E.*

Fig. 20. Mericarp, upper part. A: *E. gruinum*, with one furrow ×36. — B: *E. gruinum*, with two furrows ×36. — C: *E. gruinum*, detail of pit with reticulate structure and multicellular glands in the sunken parts ×240. — D: *E. cicutarium* ×90. — E: *E. moschatum* ×60. — F: *E. moschatum*, detail of pit with multicellular glands ×240.

chium corresponding to the above subspecies. He questions the possibility of establishing them as separate taxa.

The variation in the Aegean islands is continuous and it is not possible to separate distinct taxa within *E. chium* there.

Cyclades. Amorgos. Katapola. Schists. 10–15 m; Katapola. Schists, 10–50 m; Katapola. Hills on the north promontory of the bay of Katapola. Partly limestone karst 10–100 m; N of Oros Korax. Fields, c. 200 m (E 70); Profitis Elias. Limestone, 400 m; The island of Biokastro S of Amorgos. Limestone cliffs. Anafi. Kalamos. N-exposed slope facing the sea E of the monastery, 0–100 m; Kalamos, S-exposed hard limestone cliffs facing the sea. Scree; Kalamos. 1–1.5 km E to ESE of the monastery. N-exposed slope. Antiparos. At the town (E 60). Andros. c. 1.5 km ESE of Akra Apothikes, 8–200 m; the islet of Akramatis S of Gavrion; N of Batsi, 0–5 m .E 144); the islet of Gaidharos S of Gavrion (E 132); Kallivari, in the valley W and NW of the village, c. 200 m (E 167); Opiso Meria, 200–300 m (E 137). Astipalea. E of S. Giovani (pt 856), limestone cliffs, ca 200 m (E 121); Khondro Nisos (E 106); Kounopia, the southern part. Hard limestone (E 22); between Maltesana and Vriseu Punda. Schists–hard limestone, garigue, 0–100 m (E 113); E of Panormos, the point of Doma. Hard limestone, garigue (E 27); Vathi–Baia di Zofiri. Hard limestone, garigue, 0–100 m. Denousa. The innermost part of Ormos Rousa. In a field (E 102). Dio Adelfi. The W island. Hard limestone, garigue (E 117). Folegandros. The N coast, below the town, 0–200 m; the SE promontory (Pelagia). Hard limestone, deserted field. Ios. N of the harbour. Limestone cliffs, 200 m (E 82); the pass NNW of the highest peak of Ios. Siliceous rock, in a valley, 400 m. Iraklia. The schist island NW of Alimni Ormos (E 105); Ormos Pegadi. Limestone, in a valley, 5 m above the shoreline; between the harbour and "Spilea Cove", garigue, 0–100 m (E 32); S of the harbour. Limestone garigue (E 115); S of the harbour. In a dry valley 1 km S of the harbour, near the sea. Kato Koufonisi. The eastern part of the island, limestone (E 29); the west part of the island, limestone (E 95). Kea. Korissia, dry river bed and cultivations, 0–10 m (E 184); cliffs and phrygana 1 km SW of the islet of Spanopoula, ca 150 m. Limestone (E 133). Keros. The island of Drima. Hard limestone, garigue. Kimolos. The island of Prasonisi. Kithnos. Loutra (E 153). Mikonos. Ormos Ornos (E 151); NNE of Ornos limani. Siliceous rock. In a small wet valley (E 25). Naxos. Between Apollona and Komiaki, c. 300 m; between Apollona and Komiaki. By the main road, 400 m; c. 3 km NW of Ormos Kalando. E-exposed cliffs. Below the cliffs, 200–250 m; 2 km NNW of Kato Potamia by the rivulet. In a crevice, c. 30 m (E 114); 2 km NNW of Kato Potamia. Below N-exposed high limestone cliffs, 30–100 m (E 116); 2 km NNW of Kato Potamia by the rivulet. In a slope, c. 30 m; 2 km WSW to W of Liona. S- and SE-exposed cliffs. Below the cliff. 270 m (E 101); in the middle of the town of Naxos; Ag. Theodoro. In the valley, 1–20 m (E 100). Ofidousa. Hard limestone. Garigue (E 111). Ounia Nisia. The W island (E 56). Paros. Parikia, roadsides, field edges. Pontikoutha. Schists, hard limestone, garigue, 50–100 m. Santorin. In and E of the village. Serifos. Ormos Psarometokhion; the island of Piperi, 0–160 m (E 65); the island of Serifopoula; the island of Vous (E 40). Sifnos. E of C. Khondropo. Limestone, W-exposed cliffs, c. 200 m. Sikinos. The E-promontory, S-exposed cliffs facing the sea (E 67); the N part, below Kastro, 10–90 m. Sirina. The shore N of Agios Ioannis Ormos. Garigue. Siros. The southern part of the town in the harbour. Ruderals (E 88); near the town (E 156); Akra Grammaton (E 142); Ialissas (E 149); 1.5–2 km N of Kini (E 140); between Ag. Varvaras and Kini (E 148). Skinousa. Between the main village and the harbour. NW-exposed cliffs. Stakida. The central part of the island; the NW promontory, limestone rocks, garigue (E 97). Tinos. Below Isternia, 100–300 m (E 145); S of the town (E 158); 3 km S of the town (E 162); Oxoburgo, 400–500 m; between Panormos and Pirgos (E 146).

East Aegean islands. Kalimnos. The island of Ag. Kiriaki. Limestone. The Leros-Kalimnos strait. The island of Velona. Limestone. Leros. Pharios Nisia. The main island. Soft limestone.

Karpathos. Saria. The mountain ridge E of Armyro Ormos. In a ravine on a W-exposed slope, 50–270 m (E 76); Armyro Ormos. In a ruderal locality (E 96).

West Aegean islands. Angistri. The island of Dhorousa. Hard limestone. Angistri. The island of Spalathonisi. Hard limestone. Poros. The island of Bisti. Hard limestone.

The E. gruinum series

5. **Erodium botrys** (Cav.) Bert.

Bertoloni 1819 p. 35. *Geranium botrys* Cavanilles 1787 p. 218.

Cotyledons of Type 3. *Plant* 5–50 cm, hairy, especially densely on the stem; eglandular hairs dominant. *Leaves* deeply pinnatifid. Lamina 50–80 mm long, oblong or ovate with shortly tapering or truncate base and ± obtuse apex. Margins of lobes irregularly crenate or dentate. *Bracts* 3–6, ovate, acute, transparent, colourless or light brown with ± hairy margins. *Inflorescences* 2–4-flowered. Pedicels densely glandular. *Sepals* 7–16 mm long, apiculate, green, sometimes with darker veins. *Petals* 8–12 mm, obovate with obtuse apex, purplish-pink with distinct carmine veins. *Beak* 60–110 mm. *Mericarp* 8–10 mm with coarse, white, spreading hairs, basally dense, upwards less dense, pit wide and deep without glandular hairs, two or three furrows at the base, the upper one wider than the lower. 2n=40.

By roadsides, in sand along rivers, on mountain slopes, etc. On the Cyclades *E. botrys* has only been found on siliceous ground.

Cyclades. Andros. Mt. Kouvara, the top area, 950–980 m; c. 1.5 km ESE–E of Palaiopoulis, 450–600 m. Antiparos. Between the highest peak and the S-peak, 50–130 m. Ios. Between Chora and Profitis Elias. Siliceous rock, at the road, 250–300 m (E 81). Mikonos. Dilos, Fourni (E 164); the S-slope of mt. Ag. Elias, 200–300 m (E 157); the island of Ag. Georgios; Rinia, the island of Kounellonisi; Rinia, the N-part (E 165). Naxos. 1 km NE of Apiranthos. At the road, c. 600 m; SSE of Axapsis, along a small stream. In sand at the stream, 50–150 m; 3 km W of Axapsis, c. 500 m from the sea. Siliceous gravel, garigue; 3 km S of Akr. Axapsis. Siliceous rock (E 74); between Chalki and Sangri. Siliceous rock; N of the monastery of Chrysostomos. 180; the pass between Filoti and Apiranthos. Mt. Fanari, schists. At a field, 650 m (E 92); 1–2 km S of Moni. Deserted fields, garigue, 370–430 m; NE of the town (E 41); NE of the town of Naxos. At a road (E 129); W of the main peak of Oros Zeus. In a meadow, 320–450 m (E 130); W of the main peak of Oros Zeus. In a ravine, 320–450 m (E 131); W of the main peak of Oros Zeus. In a meadow, 320–450 m; Akr. Pardénos. At a field (E 89); 2 km NE of Sangri. Schists, in a valley–meadow, c. 240 m (E 128); the shore N of Ag. Sofia. Marsh-meadow. Poliagos. The W-shore, inside the small island. Fields–garigue (E 127). Serifos. Koutalas (E 54); the island of Serifopoula (E 71). Thera. In and E of the village (E 45). Tinos. The mount E of Falatados. 400 m; the mount E of Kardiani. The S part.

East Aegean islands. Ikaria. 500 m SW of Ag. Kirikos, 0–10 m. Roadside.

6. **Erodium gruinum** (L.) L'Hér. in Ait.

L'Héritier de Brutelle in Aiton 1789 p. 415. *Geranium gruinum* Linnaeus 1753 p. 680.

Cotyledons of Type 1. *Plant* 12–50 cm, hairy with eglandular hairs. *Leaves* pinnatifid though often with the upper half undivided and the lower half ± pinnatisect resulting in a free leaf pair basically. Lamina 20–100 mm long, ovate or elliptical with cordate or truncate base and obtuse or rarely acute apex. Margins usually irregularly crenate, sometimes dentate. *Bracts* 3–6, ovate, acute, transparent with hairy margins. *Inflorescences* 2–5-flowered. Pedicels lack glandular hairs. *Sepals* 15–22 mm long, setiferous, white with distinct green veins. *Petals* 10–14 mm long, ovate or obovate with obtuse or rotundate apex, pale violet with ± distinct carmine veins from the base to the middle of the petal. *Beak* 70–110 mm. *Mericarp* 12–15 mm, densely covered with white to creamy, coarse spreading hairs; pit wide and deep, without glandular hairs, with one or rarely two wide furrows at the base. 2n=36.

Mainly on limestone cliffs and garigue but also in meadows and forest.

Flowers and mericarps are the largest found in the *Erodium* species in the area. *E. botrys* and *E. gruinum* have been separated on the presence of one or two furrows below the pit. In this material a few populations of *E. gruinum* have had two distinct furrows but in all other features are typical.

Crete. Sitia. Koprokefala. The E-exposed slope and the peak area 600–1170 m; the valley W of Maronia, 300–500 m (E 6); N-exposed cliffs of Mt. Spathi. Cultures below the cliffs, 300–500 m (E 8); Mt. Spathi, forest on a N-exposed slope, 700–850 m (E 7); Mt. Spathi, N- to NW-exposed slope, 850–1150 m (E 98).

Cyclades. Anafi. The central part of the island. Schists and limestone, garigue (E 35). Andros. Palaiopoulis, 200–250 m (E 170); c. 3 km S of the top of Mt. Rakhi. Cultivations, 100–200 m (E 134). Astipalea. Between Maltesana and Vriseu Punda. Schists–hard limestone, garigue, 0–100 m (E 24, E 112). Iraklia. 1–2 km W of Chora. Limestone, garigue, 100–270 m (E 120); on a small wet locality c. 1 km W of Ormos Pegadi. In a wet meadow (E 126). Kea. Cliffs and phrygana 1 km SW of the islet of Spanopoula. C. 150 m, limestone (E 175). Milos. Kastro, c. 200 m (E 39). Naxos. 1–2 km S of Filoti, garigue, 450–600 m; 2 km NNW of Kato Potamia in the valley, at a road, 50 m (E 119); 2 km WSW to W of Liona. S- and SE-exposed cliffs. Below the cliffs, 270 m (E 103); NW of Melanes; the hill SW of Potamos. Garigue-field, 200–300 m. Paros. 1–2 km E of Parikia, meadow, 50–100 m. Sifnos, Livadia, N of the bay (E 42). Sikinos. N-exposed cliffs E of Kastro, 200–350 m; Ormos Skala, 0–100 m. Sirina. The central part of the island. Hard limestone, garigue, 50–350 m; the shore N of Agios Ioanni Ormos. Garigue (E 125).

East Aegean islands. Lipsos. SE of the town. Loose schists, partly limestone. Pharmako. The central part. Hard limestone. Samos. 1–3 km W of Maratokampos, 300–450 m (E 10); 3–4 km W of Maratokampos. S-exposed cliff of Mt. Kerki, 350–450 m (E 11).

Karpathos. Saria. On the highest part of mt. 1853. Limestone, in an old field, 500–600 m (E 77).

N Sporades. Skopelos, near the sea c. 1 km SE of the town, macchia and cultivations, 20–50 m. Skopelos, the valley SW of Ag. Joannis, 1–50 m.

West Aegean islands. The island of Parapola. Loose volcanic rock and small areas of hard limestone.

Subsection Absinthioidea Brumh.

7. **Erodium vetteri** Barbey et Fors.-Maj.

Barbey et Forsyth-Major, in Stefani et al. 1891 p. 36. *E. sibthorpianum* Boiss. ssp. *vetteri* (Barbey et Fors.-Maj.) Davis 1967 p. 36.

Cotyledons of Type 2. *Plant* 5–10 cm, perennial, growing in dense hard cushions; hairy with eglandular hairs. *Leaves* bipinnatisect with segments repeatedly pinnatifid. Lamina 10–30 mm long, ovate with truncate base and obtuse apex, greyish-green with short white hairs. *Bracts* usually 5, broadly triangular, transparent, colourless with hairy margins. *Inflorescences* 2–5-flowered. Pedicels with glandular hairs. *Sepals* 4–6 mm (up to 11 mm in fruit), acuminate, greyish with dark green veins and transparent margins. *Petals* 6–8 mm, elliptical, with obtuse apex, white. *Beak* 35–45 mm. *Mericarp* 6–7 mm, densely covered with fine white to brownish, appressed hairs; pit wide and shallow, without glandular hairs; furrows lacking. 2n=18.

E. vetteri, endemic to Samos, is found on the mountains of Kerki and Ambelos. It has been treated as a subspecies of *E. sibthorpianum* by Davis but can easily be distinguished on the smaller white corollas compared with the large pale lilac corollas of *E. sibthorpianum* which is endemic to Turkey. The chromosome numbers also differ, *E. sibthorpianum* having 2n=27 (Gauger 1937) and *E. vetteri* 2n=18 (Table 1). The two taxa are therefore treated here as separate species.

East Aegean islands. Samos. The E part of Mt. Kerki, 800–1200 m (E 12); Mt. Kerki, the peak and E of the peak, 1000–1450 m.

Subsection Cicutarium Willk. & Lange

8. **Erodium cicutarium** (L.) L'Hér.

L'Héritier de Brutelle in Aiton 1789 p. 414. *Geranium cicutarium* Linnaeus 1753 p. 680.

Cotyledons of Type 5. Plant 7–50 cm, ± hairy with eglandular and sometimes also glandular hairs. *Leaves* imparipinnate with 2–8 pairs of leaflets, the distal pair partly fused with the apical leaflet. Lamina 25–120 mm long, lanceolate or oblong with ± truncate base and obtuse apex. Leaflets deeply pinnatifid, always divided more than half-way to the midrib. *Bracts* 4–6, ovate, with acute apex, colourless with green veins or pale brown with brown veins. *Inflorescences* 3–8-flowered. Pedicels with or without glandular hairs. *Sepals* 5–7 mm long, acuminate, green with transparent, hairy margins. *Petals* 5–10 mm, obovate with obtuse apex, not overlapping; purplish-pink, somewhat lighter basally, usually with indistinct veins. *Beak* 35–45 mm. *Mericarp* 5–6 mm with fine white to brownish appressed hairs; pit narrow and low without glandular hairs, a ± distinct wide furrow present below the pit. 2n=40.

In waste places and on cultivated ground, on limestone rocks and sand near the coast, in garigue and *Pinus* forest.

E. cicutarium comprises a large complex of morphologically variable forms. A great number of taxa have been described. Flora Europaea, however, distinguishes only three subspecies. The populations on the Aegean islands fall within the range of variation of ssp. *cicutarium,* according to Flora Europaea.

All samples investigated have the chromosome number 2n=40. The variation is mainly in pubescence of leaves, bracts, pedicels and mericarps, symmetry of flowers, appearance of petals and mericarp. The maculate pattern at the base of the petals usually found in material from other parts of Europe is rare here and when occurring is indistinct. Instead there is generally a light pink or whitish area.

Cyclades. Naxos. Ammomaxis Ormos, 1 km ESE of Votri. A wet stone wall, 650 m; 2 km E of Apiranthos, valley with a rill. In sand at the rill, 400–500 m; 2 km NE of Apiranthos. Mountain with N to NW-exposed cliffs, 450–550 m; 1 km NE of Apiranthos. At the road, c. 600 m; 1 km NE of Apiranthos. At a road, c. 600 m; between Apollona and Komiaki. At the large road, 400 m (E 118); SSE of Axapsis, along a small stream. At the stream, 50–150 m; SSE of Axapsis, along a small stream. At the stream, 50–150 m; the pass between Filoti and Apiranthos. Mt. Fanari, limestone cliffs, 600 m; 2 km NNW of Kato Potamia, in the valley at a field, 50 m; along the old path N of Komiaki. 400 m; mt. 1 km SSE of the village of Koronos. Limestone rocks, 750 m; mount 1 km SSE of the village of Koronos, limestone rocks, 750 m; NW of the village of Koronos, along the Mt. Koronos, in garigue at a road, c. 800–850 m; the valley W of Liona. In shady cliffs, 0–50 m; 1.5 km NW of Liona. N-exposed slope, 100–200 m; 1 km ENE of Moni. Limestone, meadow-like vegetation, 530 m; E of Mytria, along a small stream. N-exposed limestone slope, c. 100 m (E 108); the hill SW of Potamos. Garigue-field, 200–300 m; ENE of Skado, valley with a rill. Limestone, at the rill, 350–500 m; the ravine 1 km W of Skado. At the rill, 700–780 m; the valley W of Zeus Oros. 2 km SSW of Filoti, garigue 300–350 m; the NW-promontory of Oros Zeus. In a slope, 580 m; Zeus Oros. In a meadow (at the small chapel) c. 600 m (E 110); 700–750 m. Ofidousa. Hard limestone, garigue (E 19). Paros. The island of Ovriokastro. Limestone; Parikia, roadsides, field edges; above Parikia, above the monastery. Garigue, 250–300 m. Poliagos. The NW-part, garigue (E 57); Psilovouno. 120–350 m. Santorin. Between Pyrgos and Ag. Elias, 300–600 m (E 58). Serifos. The island of Piperi, 0–160 m. Sifnos. NE of the bay inside C. Khondropo, in a ravine, 5–50 m; the island of Kitriani. Sikinos. The N-part, below Kastro, 10–90 m. Sirina. The NW-point, N-exposed slopes. Hard limestone and soft schists, scree; Tria Nisia, the S-island, limestone, garigue. Tria Nisia. The E-island. Hard limestone, garigue (E 2). Siros. The island of Didymi; between Kini and Kefalos Glarontas; Oros Kapari 1–2 km N of the town, garigue, 150–300 m (E 93); Oros Kapari, 1–2 km N of the town, at a field, 150–300 m (E 85); Oros Kapari, 1–2 km N of the town, at a road, 150–300 m (E 86). Skinousa. The island of Agrilosa. Limestone, littoral cliffs; between the principal village and the harbour. Garigue. Stakida. The central part of the island. Tinos. The mount E of Falatados, 400 m; Oxoburgo, 400–540 m (E 182); the island of Planitis. Ikaria. Avlaki. Below olive trees, 20–50 m; 500 m S of Cap Phanar. In cliffs; S of Evthelo, Ag. Nikolaos. At a road, 80–200 m; 2 km WNW of Ag. Kirykos. At a road, 400–750 m.

East Aegean islands. Gaidharonisi. The island of Strongilo, hard limestone; the island of Psatonisi, hard limestone. Ikaria. 200 m W of Mavroto, c. 450 m. SE-exposed *Quercus coccifera* forest; 3 km SW of Ag. Kirikos, c. 50 m. *Pinus* forest; 300 m N of Ag. Kirikos, c. 70 m. Garigue; 4–5 km S of Christos Rachov, c. 650 m. Rocky garigue. Avlaki. Below olive trees, 20–50 m; 500 m S of Cap Phanar. In cliffs; S of Evthelo, Ag. Nikolaos. At a road, 80–200 m; 2 km WNW of Ag. Kirykos. At a road, 400–750 m. Leros. Mt. Skoumbarda. 50–250 m.

Karphatos. Saria. On the highest part of mt. 1853. Limestone, in an old field, 500–600 m (E 75).

N Sporades. The island of Adelphopoulo SE of Allonisos. Peristeri, the SE part, 0–100 m. Skopelos. E-slope of mt. Delphi 0.5–1.5 km N–NNW of the top, 400–600 m. Limestone, in pine forest; near the sea c. 1 km NW of Linarakia; near the sea c. 1 km SE of the town, macchia and cultivations, 20–50 m.

West Aegean islands. The island of Parapola. Loose volcanic rock and small areas of hard limestone. Spetsai-Idhra. The island of Trikkeri. Hard limestone.

9. **Erodium moschatum** (L.) L'Hér.

L'Héritier de Brutelle in Aiton 1789 p. 414. *Geranium moschatum* Linnaeus 1753 p. 680.

Cotyledons of Type 4. *Plant* 10–50 cm, hairy, glandular hairs dominant. *Leaves* pinnate with 2–7 pairs of leaflets, the distal pair partly fused with the apical leaflet. Lamina 30–170 mm long, lanceolate, leaflets ovate, irregularly dentate or serrate or pinnatifid maximally half-way to the midrib. *Bracts* 3–7, broadly ovate with obtuse top, transparent with a narrow brownish vein. *Inflorescences* 3–7-flowered. Pedicels densely glandular. *Sepals* 4–9 mm long, apiculate, greyish-green with darker veins, densely hairy. *Petals* 6–11 mm long, elliptical, magenta, becoming lighter towards the base and with a few distinct white veins. *Beak* 30–45 mm. *Mericarp* 5–7 mm, hairs variably dense, white to brownish, semi-spreading; pit wide and deep with multicellular glandular hairs; a wide furrow present below the pit. 2n=20.

Ruderal plant but also in valleys, on cliffs and in garigue.

Cyclades. Amorgos. Katapola. Schists, 10–50 m; the valley SW of Katapola. Schists, 100–250 m (E 91). Andros. In the valley SSW of the town of Andros. 0–50 m; Opiso Meria, 200–300 m (E 136). Milos. Akradia, The E-island (E 49). Naxos. Mount 1 km W of Axapsis. Siliceous rock (E 123); 1 km NE of Chalki. In a field, 300–400 m (E 20); NE of the town of Naxos. In a ravine; ENE of Skado, valley with a rill. Limestone, at the rill, 350–500 m; the valley W of Zeus Oros. 2 km SSW of Filoti, garigue-field, 300–500 m (E 124). Serifos. Between Livadion and the town. Tinos. Kardiani, 250 m (E 176).

East Aegean islands. Ikaria. Kampos and N of Kampos, at a road, 0–100 m.

Comments

In Flora Aegaea (1943 b) Rechinger treats 11 species from the area: in addition to the taxa presented by me he includes '*E. ciconium* (Jusl.) Willd.' and '*E. romanum* (L.) L'Hér.' None of the samples of *E. ciconium* originate from the Cyclades.

E. romanum is a synonym of *E. acaule* (L.) Becherer & Thell., which is often treated as a subspecies of *E. cicutarium*. *E. acaule* is described as a robust perennial, acaulescent or nearly so. The few acaulescent forms found by me do not seem to be perennial and in other characters they fall within the range of variation of *E. cicutarium* and have thus been included in this species.

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The genus Reichardia (Asteraceae) in the Aegean area

BRITT SNOGERUP

Snogerup, B. 1980 12 15: The genus Reichardia (Asteraceae) in the Aegean area. *Bot. Notiser 133:* 515–520. Stockholm. ISSN 0006-8195.

The following species of *Reichardia* occur in the Aegean area: *R. intermedia* (Schultz Bip.) Hayek, *R. orientalis* (L.) Hochr. and *R. picroides* (L.) Roth. The differences between *R. orientalis* and *R. tingitana* (L.) Roth are discussed. Variation in leaf shape within and between populations of *R. picroides* has been studied. The previously reported chromosome numbers for *R. picroides* 2n=14 and *R. tingitana* 2n=16 are confirmed.

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The genus *Reichardia* is represented in the Aegean area by *R. picroides* (L.) Roth, *R. intermedia* (Schultz Bip.) Hayek and *R. orientalis* (L.) Hochr. *R. picroides* is a common perennial species in the Aegean area, separated from all the others on the narrow scarious margins of the involucral scales and will be discussed below. *R. intermedia* is a coastal annual found in the Aegean area on Kriti, Safora, Sirina, Rodhos and Samos. *R. orientalis* has a wide distribution throughout the Mediterranean area. In the Aegean area it has been found on Kriti and on the Central Aegean islands of Sikinos, Ounia Nisia and Safora. *R. orientalis* and *R. tingitana* (L.) Roth have sometimes been confused as by Rechinger (1943). Sell (1976) treats *R. orientalis* and part of *R. tingitana* under the name of *R. tingitana* while some European *R. tingitana* are named *R. gaditana* (Willk.) Cout. A correct interpretation was given by Murbeck (1897). The two species were also recognized by Rechinger (1949) and Greuter (1973). The differences hold for all material studied by me. *R. tingitana* is always a perennial, its outer achenes are brown, 4–5-angled and tuberculate. The inner achenes are white, smooth or almost so, star-shaped in transection. *R. orientalis* is an annual or sometimes a biennial, its achenes are all tuberculate, 4–5-angled, the outer ones being brown and the inner ones light brown to white. *R. tingitana* does not occur in the Aegean area but in NW Africa, the S and W parts of the Iberian peninsula and on the Canary Islands. All reports of *R. tingitana* from the Aegean area are misinterpretations. They should be *R. orientalis*.

Material and methods

This investigation has been based on material of the genus in LD. The team working on the Central Aegean flora has paid special attention to *Reichardia* because of the variation observed and the discrepancies in taxonomic treatment of previous authors. Material for comparative cultivation has been available from *R. picroides* (25 populations) and the W Mediterranean *R tingitana* (2 populations) in addition to extensive herbarium material. For chromosome studies root tips were fixed in ethanol: acetic acid (3:1) after pretreatment in 0.1 % colchicine solution for 50–60 minutes. Squashes were made in aceto-orcein. Voucher specimens are preserved at LD.

Key to the Aegean species and R. tingitana

1. All achenes tuberculate .... *R. orientalis*
– Outer achenes tuberculate, inner ones smooth or almost so 2
2. Inner achenes star-shaped in transection .... *R. tingitana*
– Inner achenes rounded to quadratic in transection 3
3. Scarious margin of outer involucral scales 0.5 mm, ligules greyish-green beneath ... *R. picroides*
– Scarious margin of outer involucral scales 0.6–0.9 mm, ligules purplish beneath .... *R. intermedia*

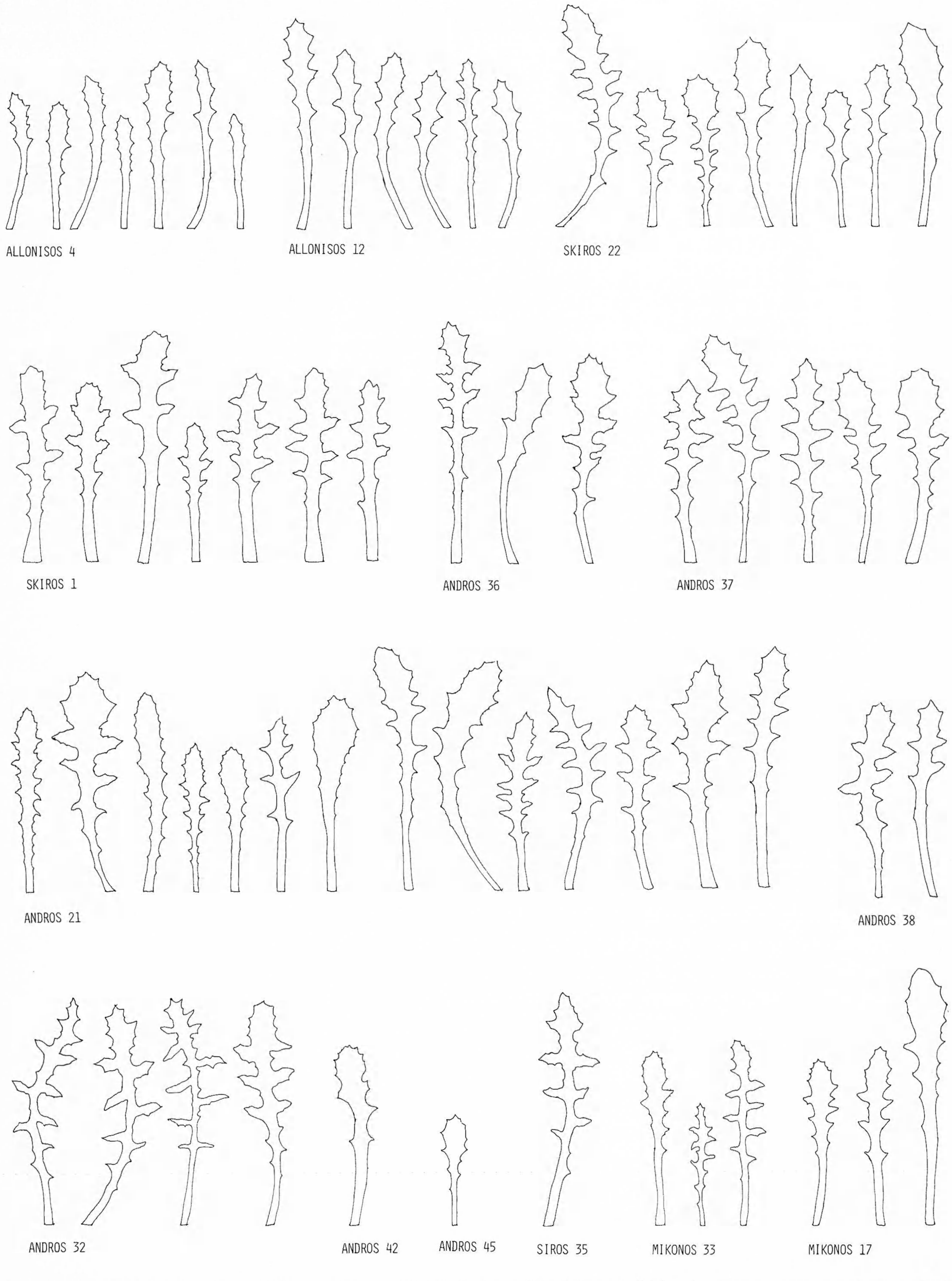

Fig. 1. *Reichardia picroides*. Cultivated material. Variation of leaf shape within the Aegean area. — Scale unit 5 cm.

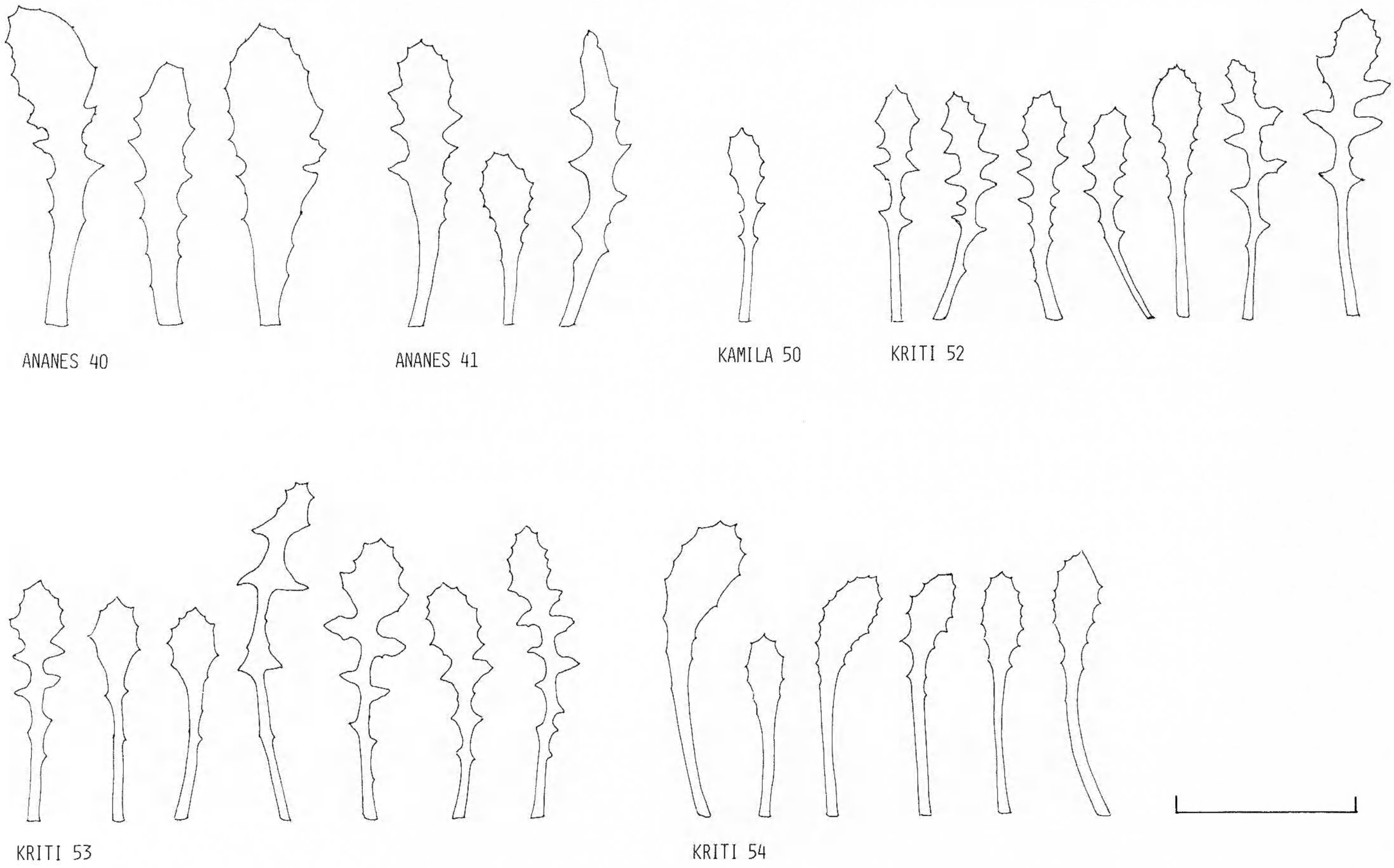

Fig. 1 (contd.).

Morphological variation in R. picroides

During field work it was noted that *R. picroides* was very variable, e.g. in plant height, ramification and leaf shape. The variation has lead to the description of a number of varieties. Rechinger (1943) reported the following ones from the Aegean area: var. *cupaniana* (Nicotra) Fiori, var. *integrifolia* (Mch.) O. Kuntze, var. *hypochoeriformis* Ginzb., var. *leontodontiformis* Ginzb. and var. *crassifolia* (Willk.) Fiori. I have studied the variation in the characters used for the separation of these varieties in herbarium samples as well as material in comparative cultivation.

R. picroides occurs mainly on rocks and cliffs and in stony places near the seashore. The populations are usually confined to a limited area but consists of a large number of individuals. The species also grows on islets, even on those that are very small and exposed with sparse vegetation. In these cases the populations are usually effectively isolated and consist of few individuals.

Variation was observed in various characters like plant height, ramification, the number of heads, but leaf shape was selected for illustration as it has been used as the main character for varietal taxonomy. It can also give an objective picture of the variation pattern provided the leaf to be illustrated is well defined. I have used cultivated material and selected the largest basal leaf occurring after replanting of the individual at the beginning of a vegetation period.

Variation within populations

The variation is in many cases slight, but the leaf shape in populations nos. 22 from Skiros, 21 from Andros, 52 and 53 from Kriti varies from entire to deeply pinnatisect (Fig. 1). In these cases individuals from the same population can be referred to var. *cupaniana*, var. *integrifolia*, var. *hypochoeriformis* and var. *leontodontiformis*. These variable populations all occur along coasts of large islands. The populations of the islets are, on the other hand, rather uniform in leaf shape as well as in habit.

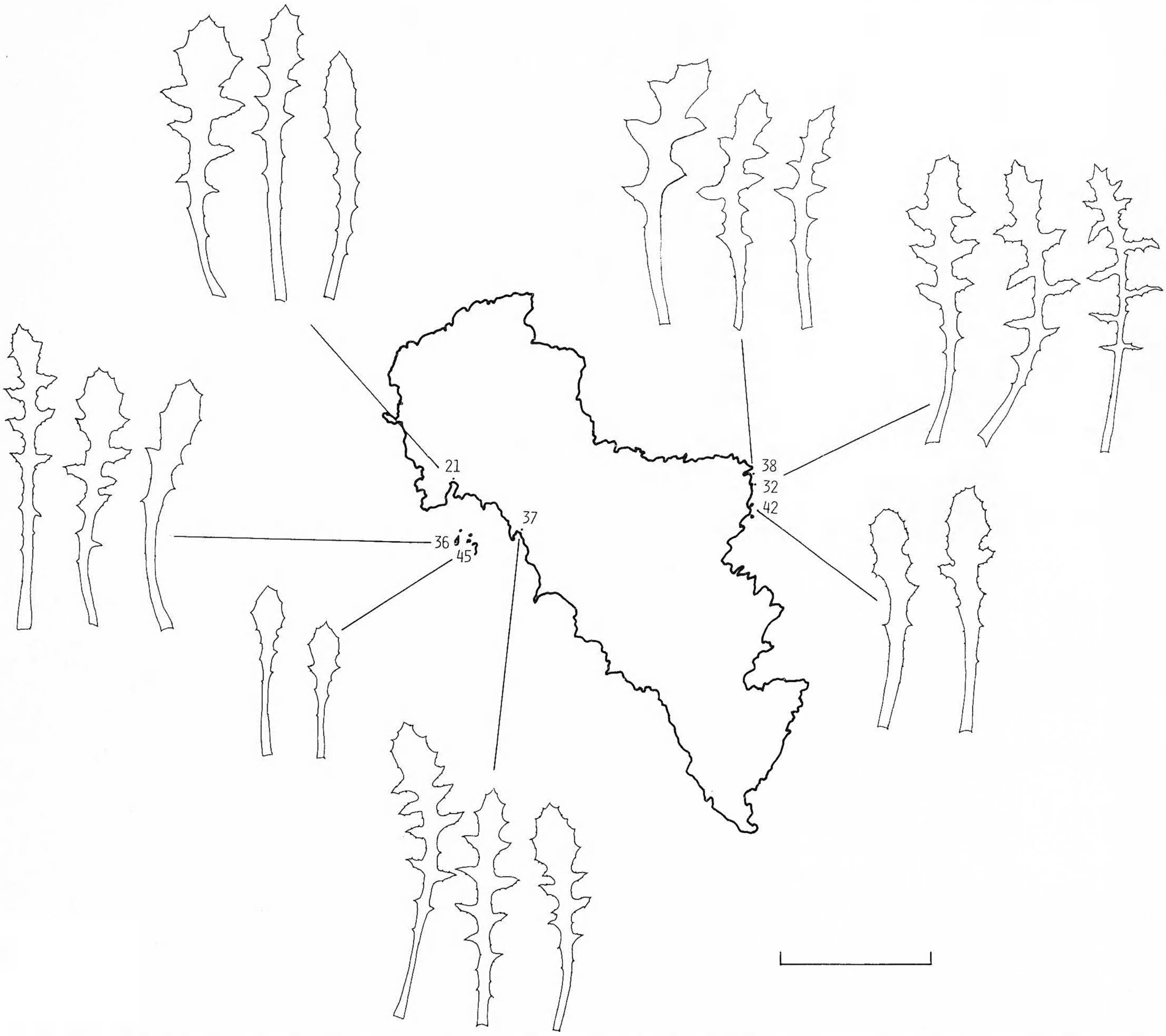

Fig. 2. *Reichardia picroides*. Cultivated material. Variation of leaf shape in the Andros area. — Scale unit for map 10 km, for leaf 5 cm.

Variation between populations

The variation within a small area has been studied in detail in the Andros area. Populations from islets off the eastern and western sides of Andros and from the main island itself have been included. The variation in leaf shape in this material is illustrated in Fig. 2. When possible three individuals have been selected to cover variation in the population. The differences between populations are conspicuous, and the widest variation occurs between the islets. Between the closely situated islet populations 38, 32 and 42 from the E side of the island there are great differences, and similarly in the populations 36 and 45 from the W side. Neighbouring populations in the Andros area can be referred to the varieties *cupaniana, integrifolia, hypochoeriformis* and *leontodontiformis*.

The cultivated populations 40 and 41 from the Ananes islets SW of Milos deviate strikingly from the other cultivated material in having rather thick bluish leaves (Fig. 1). They can be referred to var. *crassifolia*, but herbarium material from Ananes shows different leaf shapes. Rechinger (1943) reports var. *crassifolia* from Amorgos, Chozoviotissa, but material from the same locality studied by me cannot be identified with this taxon. One sheet with the same leaf shape as

Table 1. *Reichardia picroides*. Cumulative germination of achenes.

Ages of achenes	Type of achene	No. of seeds	Germination after days													Total
			4	7	10	12	14	17	19	21	27	34	42	49	63	%
1 year	inner	89	0	41	46	47	47	47	47	47	47	48	48	48	48	54
	outer	96	11	63	72	73	73	74	75	75	75	75	75	75	75	78
2 years	inner	117	0	2	20	34	46	76	84	91	96	96	99	99	99	85
	outer	120	0	1	18	24	40	67	72	74	104	108	108	108	108	90
3 years	inner	24	0	1	1	3	3	3	3	3	3	3	3	3	3	13
	outer	75	0	1	1	2	2	2	2	2	2	2	2	2	2	3

the cultivated plants from Ananes has been seen from the small island of Liadi W of Amorgos. But from Liadi there is also one collection with deeply pinnatisect leaves. An investigation on further material from the Amorgos and Ananes areas would probably show a pattern similar to that from Andros.

Variation between areas

The variation within the Aegean area is illustrated in Fig. 1. All the cultivated specimens from a series of populations from the Northern Sporades in the north to Kriti in the south are illustrated. Any tendencies towards a regional differentiation are disguised by the great differences between populations of the same area and partly also by the wide variation within some large populations.

Conclusions

No regional differentiation can be traced in the Aegean area. In large populations on large islands the variation is mainly between individuals, in the islet material mainly between populations. The wide morphological variation may largely be generated in small populations on islets and rocky outcrops along larger islands. Another possible interpretation is that the small isolates represent extreme variants which are derived by founder effect from variable populations on main islands.

The 5 varieties in Rechinger (1943) do not deserve taxonomic recognition. In some large populations studied different individuals referable to up to 4 of these varieties have been found.

Germination tests in Reichardia picroides

R. picroides has two kinds of achenes, the outer ones are brown, 4–5-angled, tuberculate, the inner ones white, 4–5-angled, smooth. The difference in shape of the inner and outer achenes may imply differences in function such as dormancy tendencies. Such tendencies among the achenes may also have an influence on the population dynamics in the material, tending to conserve variability by a buffering effect against drift or temporary selective forces. The achenes available for the test were 1, 2 and 3 years old. The 1-year-old achenes had been harvested from greenhouse cultivation, the others from wild populations. All achenes had been stored under uniform conditions, dry and at room temperature.

The results are shown in Table 1. Most of the germination occurred during the first 3 weeks after sowing. Both kinds of achenes germinated to a high percentage during the first 2 years. Most of the remaining ones had lost their viability already after 3 years. This may suggest that no long-lived seed bank is built up. No difference between the two kinds of achenes was found.

Cytological observations

The chromosome number has been determined for most of the cultivated material. The result is in accordance with previous counts from other parts of the Mediterranean area (Table 2).

The chromosome morphology could be adequately studied in 10 specimens of *R. picroides* from 7 localities. Idiograms were constructed for each of them from 6–10 good plates in aceto-

Table 2. *Reichardia*. Chromosome numbers and localities of investigated material.

Locality	2n
Reichardia picroides	
Skiros. W and NW of Krini. 1972, S. Snogerup & Gustafsson.	14
Skiros. Akr. Korakia. 1972, S. Snogerup & Gustafsson.	14
Allonisos. WNW of the harbour. 1972, S. Snogerup & Gustafsson.	14
Allonisos. Ormos Tsoukalia. 1972, S. Snogerup & Gustafsson.	14
Andros. NW of Gavrion. 1971, S. Snogerup & v. Bothmer.	14
Andros. The islet of Kilandra Vrakhos. 1971, S. Snogerup & v. Bothmer.	14
Ananes. The NW island. Runemark & Bentzer 29769.	14
Ananes. The S small island. Runemark & Bentzer 29750.	14
Kriti. Agia Marina, 5 km W of Chania. 1973, Gustafsson.	14
Kriti. 2 km E of Sitia. 1973, Gustafsson.	14
Sicily. Castel Mola. S. Snogerup & Gustafsson 1304.	14
Sicily. 14 km E of Caltanisetta. 1973, S. Snogerup & Gustafsson.	14
Sicily. 5 km SW of S Caterina Villarmosa. 1973, S. Snogerup & Gustafsson.	14
Sicily. Marianopoli. S. Snogerup & Gustafsson 1349.	14
Reichardia tingitana	
Morocco. 1.5 km N of Mdiq. Cabo Negro. 1972, Dahlgren & Lassen.	16
Morocco. 15 km N of Asilah. Oued Tahadart. 1972, Dahlgren & Lassen.	16

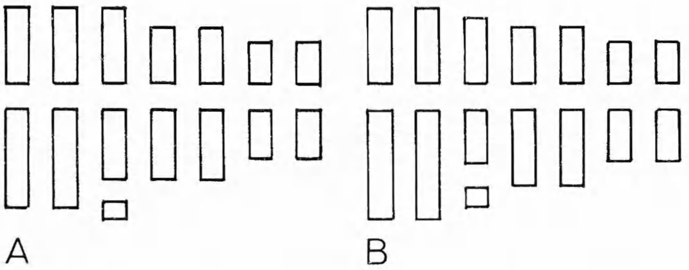

Fig. 3. Idiograms of *Reichardia picroides*. — A: Andros, NW of Gavrion. — B: Kriti, E of Sitia.

orcein squash preparations. All 7 chromosome pairs are submetacentric (Fig. 3), varying in length from 1 to 10 μm, mainly depending on the degree of contraction. In one and the same plate the longest chromosome pair is about twice as long as the shortest one. It has not been possible to identify each chromosome pair but the following grouping can be made: pairs 1–2, pair 3, satellite chromosome with the satellite on the longer arm, pairs 4–5, pairs 6–7. There are apparently differences in the idiograms but the only well-documented ones are those for pair 3. However, the differences are not great and the karyotype in general is fairly constant. There are also indications of cytological stability from the fertility of the cultivated material. Of 72 observed individuals 67 had a pollen stainability of over 95 %, 4 had between 90 and 95 % and 1 had 72 %.

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New species of Aethionema and Peucedanum from the Greek mountains

ARNE STRID and KOSTAS PAPANICOLAOU

Strid, A. & Papanicolaou, K. 1980 12 15: New species of Aethionema and Peucedanum from the Greek mountains. [Materials for the Mountain Flora of Greece, 5.] *Bot. Notiser 133:* 521–526. Stockholm. ISSN 0006-8195.

Aethionema carlsbergii sp. nov. (Brassicaceae) and *Peucedanum lavrentiadis* sp. nov. (Apiaceae) are described. The former has been collected in the summit area of Mt Taiyetos on Peloponnisos only. The latter occurs on Kajmakčalan, Smolikas and Grammos in N and NW Greece and is divided into two subspecies, ssp. *lavrentiadis* on Kajmakčalan and ssp. *multicaulis* on the other two mountains. The affinities of the new taxa are discussed.

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Aethionema carlsbergii Strid & Papanicolaou sp. nov., Fig. 1.

Orig. coll.: Greece, Nom. Messinias, Ep. Kalamon: Mt Taiyetos, along rocky ridge leading up to the main summit from the south, above place called Vrisi tou Dhespoti just W of the crest, 2300 m. Damp calcareous scree. Strid & Papanicolaou no. 15331, 1.7.1979. Holotype in C; isotypes in ATH, G, LD and Herb. Greuter (Berlin).

Herba perennis, glabra. Culmi floriferi 6–10 cm alti, plerumque non ramificati. Folia inferiora opposita, late obovata vel suborbiculata, 6–10×4–6 mm magna. Flores 12–35 in racemum simplicem bracteis carentem dispositi. Petala 3,6–5,4 mm longa, pallide rosea. Silicula orbicularis, 4,9–6,2 mm lata, unilocularis, semen unicum fovens, ala purpurea latitudine aequali marginata, apice emarginata stylo 0,3–0,4 mm longo e sinu haud eminente.

Glabrous perennial herb with a long, thin, woody rhizome. Base of stem more or less woody, producing a few ascending to suberect, usually unbranched herbaceous flowering shoots 6–10 cm long. *Lower and middle leaves* opposite, short-petiolate, ovate-orbicular to broadly elliptical, entire, obtuse, 6–10×4–6 mm, glaucous, somewhat fleshy, with inconspicuous veins; *upper leaves* subopposite to alternate, subsessile, ovate to broadly oblong, 7–9×3.0–4.5 mm. *Inflorescence* a simple, ebracteate raceme, condensed in early anthesis, later elongating (fruiting raceme 20–40 mm long). *Sepals* 2.0–2.6 mm long, greenish-purple, with scarious margins; outer ones moderately saccate, boat-shaped, 0.5–0.6 mm wide (when not flattened), elliptical, obtuse; inner ones flat, narrowly obovate, 0.8–0.9 mm wide. *Petals* 3.6–5.4×1.8–2.6 mm, pale pink; claw more or less equalling the sepals; blade suborbicular. *Filaments* of outer two stamens 1.1–1.3 × c. 0.2 mm, cylindrical or somewhat flattened, slightly inward-curving, purplish in fully developed flowers; filaments of four inner stamens 1.5–1.8 × c. 0.4 mm, flattened, with a conspicuous tooth in the upper third. *Anthers* c. 0.6 mm long, ovoid, acute, pale yellow. *Nectaries* scarcely visible in dried material. *Ovary* at anthesis ellipsoid, c. 1.6 mm long; style c. 0.4 mm long; stigma small, capitate. *Fruiting pedicels* erecto-patent, straight, 4–7 mm long, distinctly thickened at the apex. *Infructescence* rather dense, with more or less imbricate siliculae. *Silicula* orbicular, 4.9–6.2 mm wide, unilocular and 1-seeded, shallowly emarginate at both ends; loculus area elliptical, c. 4×2 mm, greenish-yellow, suture conspicuous; wing c. 1.8 mm wide at the middle, uniform or slightly widening towards the apex, subentire, greenish-purple. Free part of *style* 0.3–0.4 mm long, scarcely exceeding the apical notch. *Seeds* oblong, smooth, light brown, slightly mucilaginous, 1.7–2.0 mm long, 0.8–1.0 mm wide and 0.5–0.8 mm thick.

Our new species had apparently been collected as early as 1829 by the French botanist Despréaux who, together with Bory de St-Vincent, explored parts of Peloponnisos and the Kikladhes. It was not mentioned in Chaubard's *Nouvelle flore du Péloponnèse et des Cyclades*, where collections from this expedition are otherwise listed, but the plant later came to the attention of Boissier who, in Flora Orientalis (1: 337, 1867) placed it under *Crenularia orbiculata*, a species described by himself from Mount Athos (see Ann. Sci. Nat. Sér. II, 17: 181, 1842). The citation in Flora Orientalis is: "*Hab. in cacumine montis Athos Macedoniæ (Auch. exs. 336! Griseb.!), in cacumine Taygeti (Despreaux!)*". The only specimen in the Boissier Herbarium which may originate from the Despréaux collection is marked "*Hutchinsia cepeæfolia*. Sommet du Taygète. Lenormand 1844". It is possible that Lenormand acquired a specimen from the Despréaux collection for his herbarium and that this is now the only one preserved in the Boissier Herbarium. It is a flowering specimen probably conspecific with our new species but not possible to determine with certainty; the poor condition of the specimen explains why Boissier believed it to be conspecific with *Crenularia orbiculata (Aethionema orbiculatum)* from Mount Athos. This mistake was repeated by subsequent authors (Halácsy 1901, Hayek 1925, Rechinger 1950, Chater 1964). When the plant was rediscovered in 1979 (after 150 years!) it became clear that it is totally distinct from *Aethionema orbiculatum*.

The species with 1-seeded siliculas originally described under *Crenualria* or *Eunomia* are now placed in the genus *Aethionema* (see Hayek 1925 p. 472, Chater 1964 p. 322, Hedge 1965 p. 314 ff.). Of the previously described species *Ae. carlsbergii* most closely resembles *Ae. polygaloides* DC. The latter is a somewhat obscure species represented in the De Candolle Herbarium (G-DC) by a single, rather miserable specimen labelled "Scio" [Chios]. This plant is woody at the base with a few flowering shoots c. 7 cm long. The leaves are alternate, short-petiolate, subacute, and 5–8×1.5–2.5 mm. The ripe siliculas (see Fig. 1 E) are suborbicular, 4–5×4.5–5.5 mm, emarginate at both ends, with a uniformly wide, subentire wing and free part of style c. 0.9 mm. The fruiting pedicels are erect and 4–5 mm long. The single seed is c. 1.7×1.1 mm, broadly elliptical and obtuse at both ends.

In the Boissier Herbarium (G-Boiss.) there are three specimens under the name *Ae. polygaloides*. One is labelled "Sipyle" ("in monte Sipylo supra Magnesiam", cf. Fl. Or. 1: 337, 1867) and matches the type specimen in the shape of the silicula, but has wider, obovate leaves which are sometimes opposite in the lower part of the plant. Another specimen from Chios (leg. Orphanides) lacks flowers and fruits and cannot be determined with certainty. A flowering specimen from Poros (leg. Wiedemann) has opposite, obovate lower leaves, but the siliculas are too young for it to be possible to determine with certainty whether it belongs to *Ae. polygaloides*. There seem to be no recent collections of this species from Greece, but a collection by Davis from the Antalya province is cited in the Flora of Turkey (Hedge 1965).

Aethionema orbiculatum (Boiss.) Hayek is endemic to the summit area of Mount Athos where it grows in crevices of limestone rocks. It differs from *Ae. carlsbergii* in a number of characters, notably the habit (strongly woody at the base, much-branched, bushy) and the small, acute siliculas (see Fig. 1 G).

Another related species is *Ae. retsina* Phitos & Snogerup (1973) from the island of Skiros and adjacent small islands. It grows in maritime limestone cliffs and is somewhat similar to *Ae. orbiculatum* in habit, but differs conspicuously in the shape of the siliculas (see Fig. 1 F). It resembles the Turkish *Ae. eunomioides* Boiss., but differs in the style which is up to 2 mm long and clearly exceeds the shallow apical notch; in *Ae. eunomioides* it is less than 0.5 mm and included in the narrow, acute notch.

Aethionema carlsbergii was found on somewhat damp but rather barren calcareous scree just west of the main ridge of Mt Taiyetos and due south of the summit at c. 2300 m. It was fairly common in a small area of roughly 300×100 m, but was not observed in other places and is probably strictly local since it has been overlooked for a century and a half by all previous visitors. Apparently it is a short-lived perennial, thus differing from the long-lived, strongly woody-based *Ae. orbiculatum* and *Ae. retsina*. Growing together with it in the type locality were only a few other species, including *Ranunculus subhomophyllus* (Halácsy) Vierh., *R. brevifolius* Ten. and *Geocaryum peloponesiacum* Engstrand.

The specific epithet is in honour of the Carlsberg Foundation and its long-standing patronage

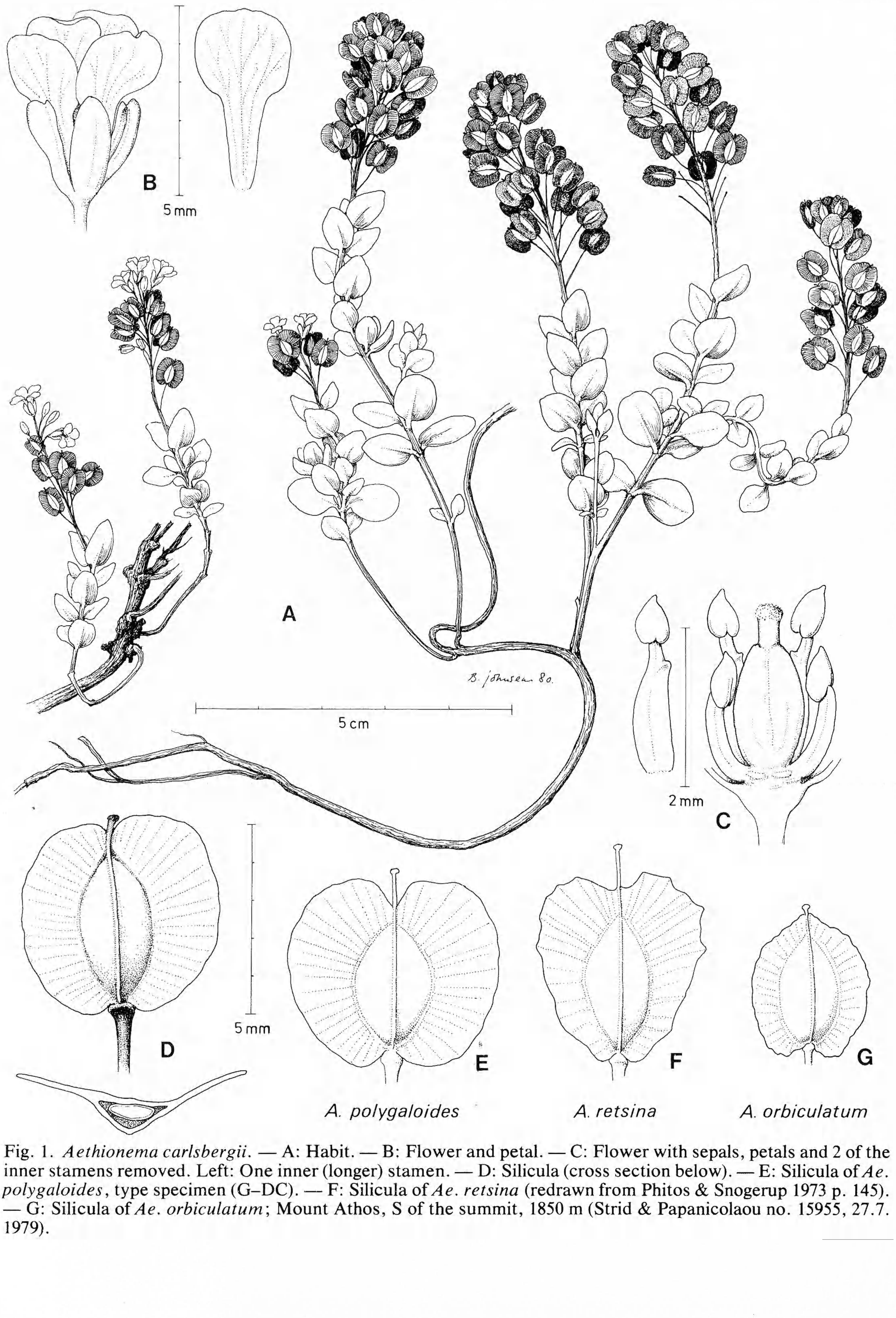

Fig. 1. *Aethionema carlsbergii.* — A: Habit. — B: Flower and petal. — C: Flower with sepals, petals and 2 of the inner stamens removed. Left: One inner (longer) stamen. — D: Silicula (cross section below). — E: Silicula of *Ae. polygaloides*, type specimen (G–DC). — F: Silicula of *Ae. retsina* (redrawn from Phitos & Snogerup 1973 p. 145). — G: Silicula of *Ae. orbiculatum*; Mount Athos, S of the summit, 1850 m (Strid & Papanicolaou no. 15955, 27.7. 1979).

of Danish science. *Aethionema carlsbergii* was the first new species to be found on our Greek mountain expedition of 1979 financed by the Foundation.

Peucedanum lavrentiadis Strid & Papanicolaou sp. nov., Fig. 2 A–E

Orig. coll.: Greece, Nom. Florinis/Pellis: Mt Kajmakčalan (Voras Oros), summit area, 2450–2520 m, a few hundred metres from the Jugoslavian border. Smooth alpine grassland dominated by *Nardus stricta* and *Festuca* spp.; some rocky outcrops at the summit. Micaceous schist. Strid & Papanicolaou no. 16599, 17.8.1979. Holotype in C; isotypes in ATH, G, LD and Herb. Greuter (Berlin).

Herba perennis, glabra, radice palari. Folia basalia 2,0–7,5 cm longa, 2- vel 3-pinnata, laciniis terminalibus oblongis vel late linearibus, 1,2–2,3 mm longis. Culmi 1–8(–12), non ramificati, foliis destituti, 6–21 cm longi. Umbella e 5–7 radiis composita, bracteis plerumque nullis; bracteolae cuiusque umbellulae 4–5, lineari-lanceolatae. Petala alba vel roseola. Fructus e dorso valde complanatus, ellipticus vel obovatus, 6–8×4–5 mm magnus, alis lateralibus 0,7–1,3 mm latis marginatus. Valleculae univittatae.

Glabrous perennial herb. *Tap-root* fairly stout, vertical, terete, 3–10 mm in diameter, transversely striate, pale brown. *Rhizome* short, woody, branched or unbranched; apex at least in young plants clothed with the dark brown, fibrous remains of leaf sheaths from previous years. *Stems* 1–8(–12), ascending to erect, 6–21 cm long, unbranched, terete, slightly sulcate, 0.8–2.2 mm in diameter, pale green to straw-coloured. *Basal leaves* (3–)6–15, 2.0–7.5×0.8–1.8 cm; blade as long as or longer than the petiole, oblong to broadly oblong in outline, 2- or 3-pinnate; primary segments 3–5 pairs, ovate in outline; ultimate lobes oblong to broadly linear, 1.2–2.3 mm long, with very narrow, minutely toothed hyaline margins, acute or obtuse. *Cauline leaves* lacking. *Umbel* 12–25 mm in diameter when flowering; rays 5–7, 5–8 mm long, unequal, minutely scabrid-papillose especially on the inside. *Bracts* usually lacking (rarely few and caducous). *Partial umbel* with 8–14 flowers on 1.2–3.0 mm long pedicels. *Bracteoles* 4–5, 2–7 mm long, linear-lanceolate, green or tinged with pink, sometimes with scarious margins in the lower part, acuminate. *Petals* white or pale pink, strongly incurved, glabrous. *Ovary* obovoid or ellipsoid, 0.6–1.0 mm long, glabrous; styles very short, erect. *Fruiting umbel* with rays 8–13 mm long, somewhat thickened; pedicels 2.5–4.0 mm long. *Fruit* strongly compressed dorsally, elliptical to narrowly obovate, 6–8×4–5 mm, glabrous; dorsal ridges rather prominent, not winged; lateral ridges winged, wings closely adpressed to one another, 0.7–1.3 mm wide; valleculae 1-vittate with 1 resin-canal; commisures flat, with 2 small vittae. *Stylopodium* small, conical; styles c. 0.7 mm long, more or less spreading, often absent at maturity.

Peucedanum lavrentiadis appears to be a distinct species without close relatives. The only other *Peucedanum* species without cauline leaves, at least in the Balkan Peninsula and Turkey, is *P. alpinum* (Sieber ex Schultes) Burtt & Davis. The latter differs in a number of important characters, however, and must be placed in a different section of the genus (cf. Chamberlain 1972 p. 479).

The new species was found immediately SW of the summit of Kajmakčalan at an altitude of 2480–2500 m in an alpine meadow with some flat outcrops of micaceous schist. It was abundant (several hundred individuals) in a small area, but is probably strictly local. For a list of other species collected in the summit area of Mt Kajmakčalan see Strid (1978 p. 214).

The specific epithet is in honour of the distinguished Greek botanist Georgios Lavrentiades, professor at the University of Thessaloniki.

Plants from Kajmakčalan are characterized by an unbranched or sparingly branched, densely fibrous woody stock, 1–3 erect stems and acute leaf laciniae. Plants from Smolikas and Grammos, which must also be referred to this species, differ in a number of characters and may be referred to a separate subspecies:

Peucedanum lavrentiadis spp. **multicaulis** Strid & Papanicolaou ssp. nov., Fig. 2 F

Orig. coll.: Greece, Nom. Ioannina, Ep. Konitsa: Mt Smolikas, SE side, place named Gangarantza, alt. 2200–2400 m. On peridotite and serpentine. E. Stamatiadou no. 13511 bis, 25.7.1971. Holotype in ATH; isotypes in C and G.

Other collections: Nom. & Ep. Kastorias: Mt Grammos, near a small lake called Limni Gestona NE of the summit, very close to the Albanian border, 2350 m. Rocky ridge. Schist. A. Strid & E. Zacharof no. 16804, 23.8.1979 (ATH, C, LD). A single, somewhat poor specimen collected by Hartvig and Seberg on Mt Smo-

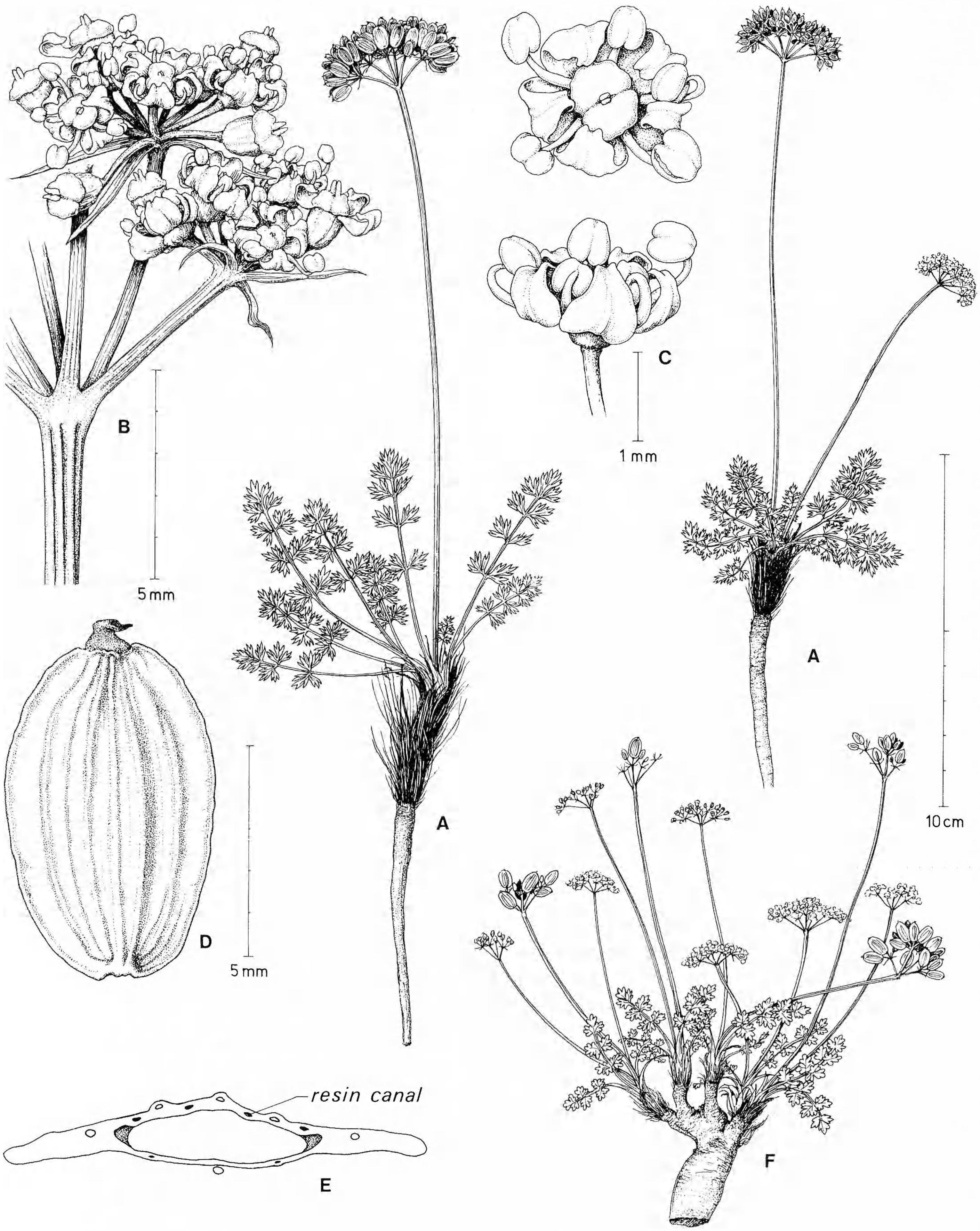

Fig. 2. A–F: *Peucedanum lavrentiadis*. — A–E: ssp. *lavrentiadis* (Strid & Papanicolaou no. 16599). — F: ssp. *multicaulis* (Stamatiadou no. 13511 bis). — A: Habit. — B: Part of flowering umbel. — C: Flower seen from above and in side view. — D: Fruit, dorsal face. — E: Mericarp in cross section. — F: Habit.

likas (no. 4525, C) probably belongs to this taxon as well.

A ssp. *lavrentiadis* differt rhizomate ramificato, caulibus ascendentibus 2–8(–12), laciniis foliorum obtusis.

Differing from ssp. *lavrentiadis* in the following characters: Rhizome branched, fibrous when young, but often lacking fibres in old specimens. Leaves usually less than 4 cm long, 2-pinnate; primary segments usually 3 pairs; laciniae relatively short and broad, obtuse or subobtuse. Stems (1–)3–8(–12), ascending to suberect, up to 14 cm long.

Subspecies *multicaulis* grows on moderately dry rocky ridges, whereas ssp. *lavrentiadis* was found in a damp alpine meadow on micaceous schist. This may explain the difference in habit, but there are probably hereditary differences as well. The diagnostic details of umbels, flowers and fruits are so similar in the two forms that they can scarcely be separate species. More material should be looked for in the border area between Greece, Albania and Jugoslavia (e.g. on Bela Voda).

Acknowledgements. The field work was financed by grants from the Carlsberg Foundation. The Latin diagnoses were prepared by Dr T. Christensen and the drawings by Mr B. Johnsen.

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Floristic reports from Mount Siniatsikon and Mount Vermion, northern Greece

ROY FRANZÉN

Franzén, R. 1980 12 15: Floristic reports from Mount Siniatsikon and Mount Vermion, northern Greece. [Materials for the Mountain flora of Greece, 6.] *Bot. Notiser 133:* 527–537. Stockholm. ISSN 0006-8195.

Notes on 32 taxa, all with few previous records from Greece, are given. Distribution in Greece is shown for the following species: *Asplenium viride* Hudson, *Thymus parnassicus* Halácsy, *Asphodelus albus* Miller, *Coeloglossum viride* (L.) Hartm. and *Avenula aetolica* (Rech. fil.) J. Holub.

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The mountains are situated in N C Greece, i.e. in W Macedonia (see Fig. 1). Mt Siniatsikon (2111 m) consists mainly of hard limestone and schist, the northern slopes and the summit, i.e. the area visited, were steep and stony at altitudes above c. 1500 m. No floristic data from this area have previously been published. The near-lying Mt Vermion, on the other hand, has been visited by several botanists, e.g. Ganiatsas (1939, 1955), Rechinger (1939 b), Quézel & Contandriopoulos (1968) and Voliotis (1975, 1976). Rocky meadows cover much of the alpine zone, some in parts being strewn with boulders. The spaces between the rocks are often deep and shady and shelter many montane species such as *Poa nemoralis, Actaea spicata, Lamiastrum galeobdolon, Galium odoratum, Paris quadrifolia* and *Polygonatum verticillatum*.

On the northern slopes, SW of the peak known as Mavri Petra (2026 m), are damp meadows by numerous rivulets with species such as *Eriophorum latifolium, Geum coccineum, Polygonum bistorta, Cardamine raphanifolia* ssp. *acris, Ajuga reptans, Carex serotina* ssp. *serotina, Luzula sudetica, Luzula luzulina, Aegopodium podagraria* and *Dactylorhiza* sp. These damp meadows are among those parts of the mountain that are richest in species. Mavri Petra is also of floristic interest. The name is derived from the Greek words *mavri*, 'black', and *petra*, 'stone', evidently because of the blackish lichens covering the summit rocks. Though Mt Vermion consists mainly of limestone Mavri Petra consists of more acid rock. Species restricted to this part of the mountain are *Asplenium septentrionale, Polypodium vulgare, Polygonum alpinum, Sempervivum marmoreum, Jovibarba heuffelii* and *Centaurea napulifera* ssp. *napulifera*. Further details of the vegetation on Mt Vermion can be obtained in the literature cited.

Mt Siniatsikon and Mt Vermion were visited by L.-Å. Gustavsson and myself in 1979 during the periods 27–30.6 and 17–22.7.

The nomenclature follows Tutin et al. (1964–1980). Our collections (marked GF) are preserved at LD and/or C (marked in the collection lists). Hartvig's and Strid's material is at C (with most duplicates at ATH), while that of Aldén, Gustavsson and Snogerup is preserved at LD (in the text abbreviated H, S, A, G and Sn respectively). Stamatiadou's collections are at ATH with some duplicates at C.

Apiaceae

Peucedanum oligophyllum (Griseb.) Vandas ssp. **oligophyllum**

Collections: Mt Vermion, 10 km W of Naousa, 1950–2052 m, GF 8653 (LD, C); 11 km W of Naousa, c. 1975 m, GF 8446 (LD).

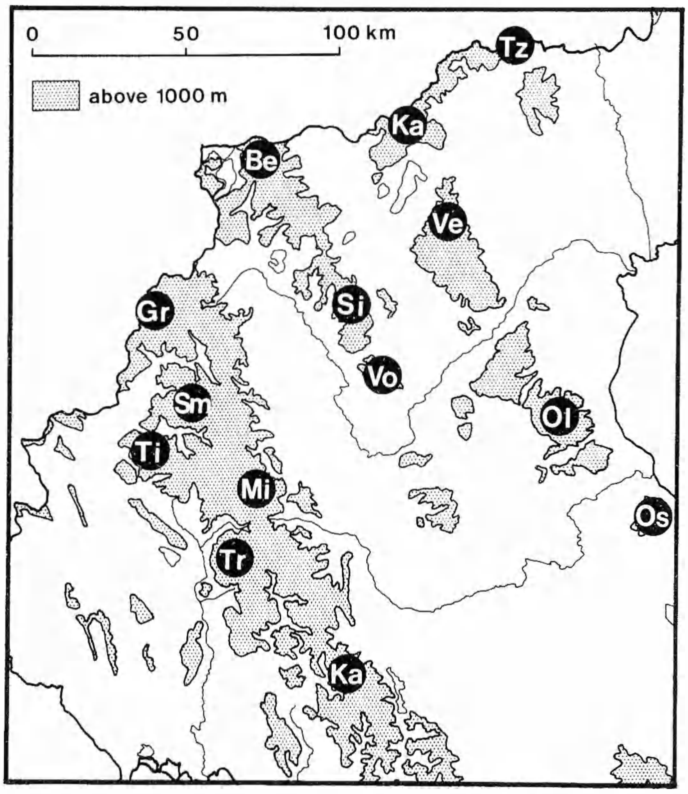


Fig. 1. Some of the mountains mentioned in the text. Be: Bela Voda; Gr: Grammos; Ka (north): Kaimakčalan; Ka (south): Karava; Mi: Milea; Ol: Olympus; Os: Ossa; Si: Siniatsikon; Sm: Smolikas; Ti: Timphi; Tr: Trapos; Tz: Tzena; Ve: Vermion, and Vo: Vourinos.

This taxon has recently been recorded from the mountains of Iti, Vardousia, Oxia and Timfrestos in Sterea Ellas by Gustavsson (1978 a), and was previously only recorded from Mt Pangaion (Markgraf-Dannenberg 1976 p. 103) and Mt Kaimakčalan (Rechinger 1936). It has also been collected on Mt Grammos (H 6790, S 16768 and 16884, see Strid & Papanicolaou in press), Mt Smolikas and Mt Bouchetsi (H 4332 and 6709 respectively).

On Mt Vermion it grows in grassy places on the subalpine slopes.

General distribution: N & C Greece, Albania and S Jugoslavia.

Seseli peucedanoides (Bieb.) Kos.-Pol.

Collection: Mt Vermion, 11 km W of Naousa, c. 1975 m, GF 8445 (LD).

This species has previously only been recorded from Mt Falakron (Rechinger 1939 b), Mt Iti in Sterea Ellas (Maire & Petitmengin 1908, later by others), Mt Bela Voda (Zaganiaris 1940), Mt Sina in Pindhos (Halácsy 1901) and Mt Leila (Voliotis 1976). It has resently been collected in Sterea Ellas on Mt Kaliakouda, Mt Oxia and Mt Yiorla (G 2863, 6357 and 5991 respectively), and in Pindhos on the following mountains: Baros, Trapos, Karava (A 3082, 3882 and 4294 respectively), on Grammos (S 16787), Paikon (Greuter 14036) and Kaimakčalan (Stamatiadou 19429).

On Mt Vermion *S. peucedanoides* occurred sporadically in stony subalpine meadows.

General distribution: S & C Europe, through N Anatolia to the Caucasus.

Aspleniaceae

Asplenium lepidum C. Presl

Collections: Mt Siniatsikon, 6 km SSE of Vlasti, c. 2075 m, GF 8011 (LD); 5.5 km SSE of Vlasti, c. 2000 m, GF 8083 (C).

A. lepidum seems to be rare in Greece, and is known only from a few localities in Sterea Ellas and N Greece. Quézel & Contandriopoulos first reported it from Mt Giona in Sterea Ellas (1965 a), and the species was later collected on Mt Vardousia (Quézel 1973, G 1306 and 3221) and Mt Parnassos (G 2093, 3545, 3546 and 7086) in the same area. In N Greece it has been collected on Mt Grammos (H 6858) and Mt Pangaion (Sn 71-317). On a map in Brownsey (1976 p. 238) the species is indicated by a dot in N Greece, but no exact locality is known to me.

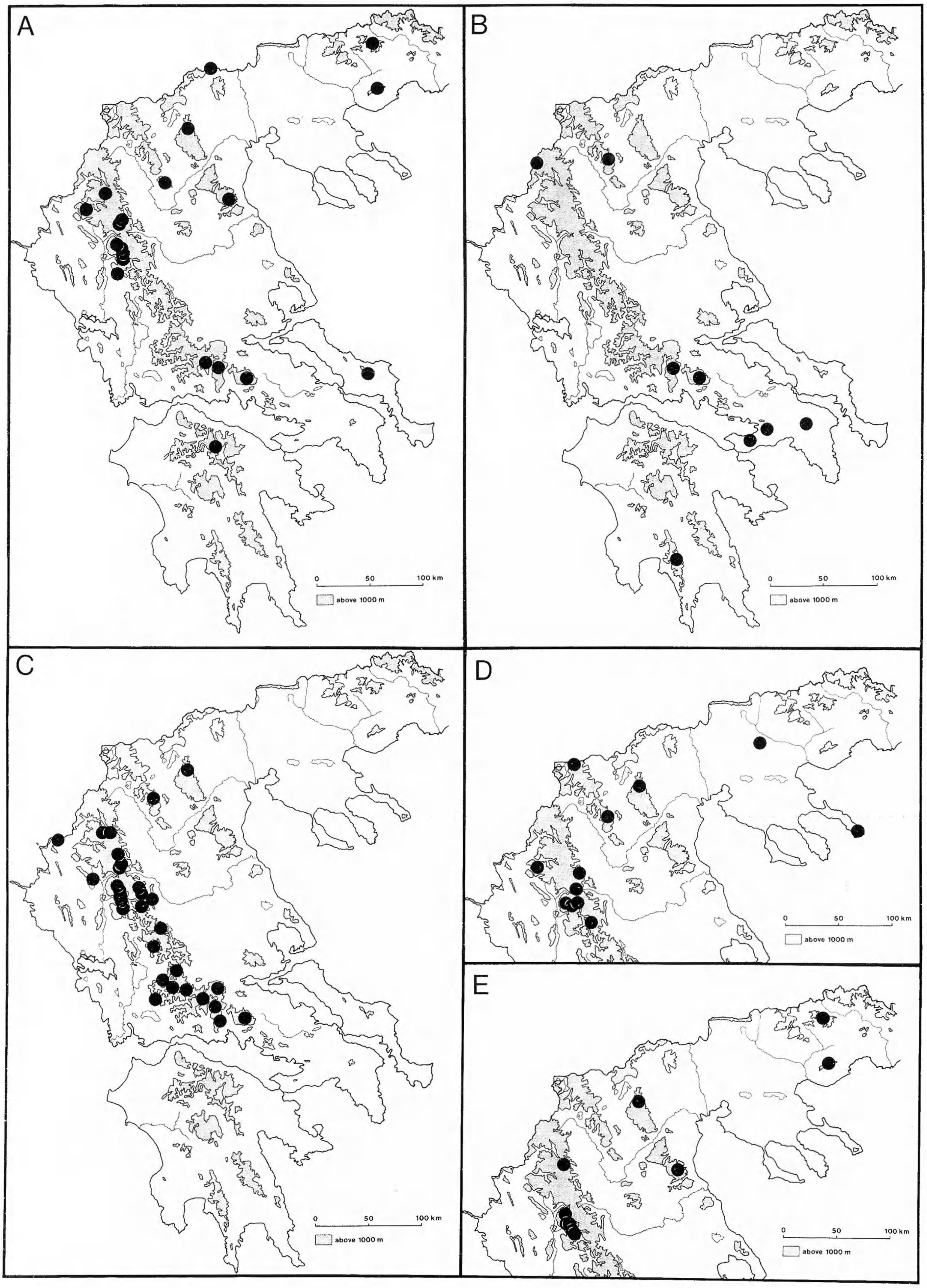
This species is a strict chasmophyte and occurs on Mt Siniatsikon in crevices of N-facing limestone rocks at altitudes above 2000 m.

General distribution: SE Europe, extending westwards to SE France; Crete. Map in Brownsey (1976 p. 238).

Asplenium viride Hudson

Collection: Mt Vermion, 11 km W of Naousa, c. 1975 m, GF 8520 (LD).

Fig. 2. Known localities in Greece for five species. — A: *Asplenium viride*. – B: *Thymus parnassicus*. — C: *Avenula aetolica*. — D: *Asphodelus albus*. — E: *Coeloglossum viride*.


A
0
50
100 km
above 1000 m
B
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C
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above 1000 m

This species has several localities scattered all over Greece, mainly in the northern parts. The distribution map (Fig. 2 A) is based on material collected by G, H, S and Sn and on records in the following literature: Aldén (1976), Halácsy (1904), Kitanov (1943), Maire & Petitmengin (1908), Quézel & Katrabassa (1974) and Rechinger (1943).

On Mt Vermion *A. viride* was rare and grew in shaded rock crevices.

General distribution: N-temperate regions (map in Hultén 1962 p. 101).

Asteraceae

Achillea chrysocoma Friv. × **Achillea millefolium** L. ssp. **pannonica** (Scheele) Hayek

Collection: Mt Vermion, 11 km W of Naousa, c. 1975 m, GF 8384 (LD, C).

This hybrid is intermediate between the parental species in many features, e.g. ligules pale yellow, 2.0–2.5 mm, involucre 3.0–3.5 mm wide and cauline leaves 2–3 cm long. It is, however, less vigorous with fewer capitula, shorter stem and fewer and less robust basal leaf rosettes than both parents.

It was found among stones in a grassy place growing together with both parental species.

Inula hirta L.

Collection: Mt Vermion, 10 km W of Naousa, 1950–2052 m, GF 8705 (LD, C).

In Greece this species is restricted to the northernmost mountains, and has previously been recorded only from Mt Grammos on the Albanian border (Zaganiaris 1940) and Krousa Oros near Lake Doiran in Macedonia (Turrill 1918). It has recently been collected on some mountains near the Jugoslavian and Bulgarian borders by Strid et al., i.e. on Mt Tzena, Mt Pinovon, Mt Kerkini and W Rodhopi (S 16698, 16577, 16130 and 16427 respectively) and also by Stamatiadou in Nomos Evros in NE Greece (nos. 15408 and 15442). See also Strid & Papanicolaou (in press). *I. hirta* was recorded from *Archipelagi insulis* by Sibthorp & Smith (1813 p. 182), but according to Rechinger (1943) this record is probably erroneous.

On Mt Vermion *I. hirta* was found on a steep S-facing slope among grass and stones.

General distribution: S, C and E Europe, Siberia and the Caucasus.

Caryophyllaceae

Cerastium rectum Friv. ssp. **petricola** (Pančić) H. Gartner

Collection: Mt Siniatsikon, 6 km SSE of Valsti, 1800–2100 m, GF 8027 (LD, C).

Known only from a few localities in N Greece, viz. Mt Kaimakčalan (Strid 1978), Mt Lioutza near the Jugoslavian-Albanian border (Quézel & Contandriopoulos 1968) and Mt Leila (Rechinger 1939 b, Voliotis 1976). It was also collected by Strid near the village of Vlasti NNW of Mt Siniatsikon between 1000 and 1500 m (no. 509 and 1193).

On Mt Siniatsikon it grows on dry grassy slopes facing N–NE at c. 1900 m.

General distribution: The species is endemic to the Balkan Peninsula, but ssp. *petricola* has a more restricted area of distribution, viz. N Greece, S Jugoslavia and S Bulgaria. In Tutin et al. (1964 p. 144) its occurrence in Jugoslavia is queried, but several localities are given in the literature (e.g. Bornmüller 1925, Formánek 1894).

Minuartia viscosa (Schreber) Schinz & Thell.

Collection: Mt Siniatsikon, 5.5 km SSE of Vlasti, 1600–1650 m, GF 8122 (LD, C).

This annual species is often confused with *M. hybrida* which is common in Greece but can be distinguished on the almost smooth seeds and the shorter capsule and sepals. *M. viscosa* is known only from NC and NE Greece, recorded from Mt Karlik-Dagh and the vicinity of Lake Daoiran by Rechinger (1939 b), Mt Falakron (Kitanov 1943), Leptocaryon near Mt Olympus (Zaganiaris 1940) and from the island of Thasos (Stojanov & Kitanov 1950).

On Mt Siniatsikon *M. viscosa* grows on dry heavily grazed meadows on sandstone and schist together with *Euphrasia stricta, Galium parisiense* and *Genista carinalis*.

General distribution: Mainly NC Europe, but locally westwards to W France and northwards to S Sweden; the Balkans and C Russia. Map in Meusel et al. (1965 p. 148).

Cyperaceae

Carex lepidocarpa Tausch

Collections: Mt Vermion, 13 km W of Naousa, 1880–1975 m, GF 8761 (LD, C); 8 km WNW of Naousa, c. 1300 m, GF 8797 (LD, C).

New for N C Greece. Previously recorded from Mt Smolikas (Quézel & Contandriopoulos 1965 b) and Mt Zygos (Halácsy 1904). It was also collected on Mt Avgo (Møller & Bohl Petersen no. 1079, C), Mt Grammos (S 16774, H 6819), Mt Mavrovouni and Mt Vasilitsa (H 6079 and 5278 respectively). All these localities are in N Pindhos.

C. lepidocarpa was found in damp meadows, in both the alpine and montane zone.

General distribution: C & N Europe, locally in the mountains of S Europe; N America (map in Meusel et al. 1965 p. 78).

Carex tomentosa L.

Collection: Mt Vermion, 11 km W of Naousa, c. 1900 m, GF 8555 (LD, C).

New to N C Greece. A rare species in Greece, reported only from Mt Athos (Zaganiaris 1940, Rechinger 1943) and Neuropolis in Pindhos (Halácsy 1904).

On Mt Vermion it was found in a sandy heavily grazed meadow by a spring.

General distribution: C & S Europe, except parts of the Mediterranean region; Anatolia and the Caucasus.

Fabaceae

Astragalus mayeri K. Micevski

Collections: Mt Siniatsikon, 6 km SSE of Vlasti, 1750–1850 m, GF 8073 (LD, C), Franzén no. 245 (LD).

New for N Greece. This species was described from Mt Galiča in S Jugoslavia by Micevski (1970) and has since only been reported once, viz. from Mt Iti by Gustavsson (1978 b). It is closely related to *A. sericophyllus* Griseb., an endemic to Albania, S Jugoslavia and N & C Greece.

Both species are discussed in Micevski (1970) and Gustavsson (1978 b). *A. mayeri* is said to have a more robust habit, narrower almost linear leaflets and a legume with irregular patches of either black or white hairs. The plants from Siniatsikon have a legume with the characteristic indumentum pattern, but can with difficulty be distinguished from *A. sericophyllus* on habit and the shape of leaflets. *A. mayeri* was flowering during our first visit in June 1979, and fruiting specimens were collected in September, 1980.

On Mt Siniatsikon *A. mayeri* grows in crevices of limestone outcrops.

General distribution: Endemic to S Jugoslavia and N & C Greece.

Oxytropis purpurea (Bald.) Markgr.

Collections: Mt Siniatsikon, 6 km SSE of Vlasti, 1800–2100 m, GF 8029 (LD), GF 8107 (LD) and GF 8113 (C); 5.5 km SSE of Vlasti, c. 2000 m, GF 8095 (C).

This species is rare in Greece. It was first collected by Guiseppi on Mt Olympus in 1929 and described in the following year as *O. olympica* Turrill (Turrill 1930 p. 122). This name proved to be a homonym of *O. olympica* St. John from Mount Olympus in Washington (NW U.S.A.), and the epithet for the Greek plant was changed to *O. thessala* Turrill (Turrill 1935 p. 54, cf. Stojanov & Jordanov 1938 pp. 192–193). Apparently this is conspecific with *O. purpurea* (Bald.) Markgr., described from Albania. The occurrence of this species on Mt Olympus has been confirmed by Quézel & Contandriopoulos (1965 b) and by Strid (nos. 153, 11447). Recently it has also been collected on Mt Pinovon near the Jugoslavian border by Strid & Papanicolaou (S 16578).

On Mt Siniatsikon it grows on exposed stony ground in the summit area, i.e. from 2000 to 2100 m (also collected here by Stamatiadou, no. 16199).

General distribution: Endemic to Albania and N Greece.

Geraniaceae

Geranium reflexum L.

Collections: Mt Vermion, 10 km W of Naousa, 1950–2052 m, GF 8681 (C); 11 km W of Naousa, c. 1975 m, GF 8500 (LD).

In Greece this species is known only from Pindhos and the N C part. The localities in Pindhos are Mt Zygos, Mt Turnara (Halácsy 1901), Mt Karava (Quézel & Contandriopoulos 1965 b), Mt

Timphi (Goulimy 1955), Mt Grammos and Mt Smolikas (H 7179 and 5643 & 5997 respectively). In N C Greece it has previously only been reported from the vicinity of Pissoteri (Quézel & Contandriopoulos 1968) and Siatista (Zaganiaris 1939).

G. reflexum was found in the shade of boulders in stony meadows.

General distribution: Endemic to C Italy and the S part of the Balkan Peninsula.

Juncaceae

Luzula luzulina (Vill.) Dalla Torre & Sarnth.

Collection: Mt Vermion, 13 km W of Naousa, 1880–1975 m, GF 8756 (LD, C).

This species has previously been recorded only once from Greece, viz. Bela Voda near the Albanian-Jugoslavian border (Quézel & Contandriopoulos 1968). *L. luzulina* can be distinguished from the superficially similar *L. forsteri*, which is more abundant in Greece, on the long slender stolons and the capsule being distinctly longer than the yellowish-brown perianth.

On Mt Vermion *L. luzulina* grows in damp subalpine meadows by streams.

General distribution: Endemic to S & C Europe (map in Meusel et al. 1965 p. 86).

Luzula sudetica (Willd.) Hartm.

Collection: Mt Vermion, 13 km W of Naousa, 1880–1975 m, GF 8757 (LD).

First recorded for Greece from Mt Bela Voda by Quézel & Contandriopoulos (1968), and later reported from Mt Iti and Mt Vardousia in Sterea Ellas by Gustavsson (1978 b).

On Mt Vermion it was found in damp meadows with tall vegetation by rivulets.

General distribution: N Europe and mountains of C and S Europe.

Lamiaceae

Marrubium thessalum Boiss. & Heldr.

Collection: Mt Siniatsikon, 6 km SSE of Vlasti, c. 2100 m, GF 8140 (LD, C).

Very similar to *M. cylleneum*, a species endemic to S Albania and S Greece. *M. thessalum* has a more restricted distribution area, being endemic to a small part of Thessalia and Macedonia. Even if there are only slight differences between these taxa the allopatric occurrence and the apparent constancy of the key characters (chiefly calyx teeth, indumentum and leaf shape) seem to justify treating them as separate species.

M. thessalum has been reported from the following localities: Mt Olympus (Halácsy 1902, later by others), Mt Godaman S of Mt Olympus (Formánek 1896), Mt Ossa (Halácsy 1902) and Mt Vourinos (Goulimy 1960, H 6586).

On Mt Siniatsikon *M. thessalum* was found on exposed stony ground in the summit area, i.e. above 2100 m.

Stachys alpina L.

Collections: Mt Siniatsikon, 5.5 km SSE of Vlasti, c. 1700 m, GF 8007 (LD). Mt Vermion, 11 km W of Naousa, c. 1975 m, GF 8477 (LD, C).

Not recorded for Greece in Tutin et al. (1972) although reported from Mt Karlik-Dagh (Rechinger 1939 b, Zaganiaris 1940), Mt Vermion (Ganiatsas 1939), Mt Pieria and Mt Varnous (Goulimy 1960 a). There is also a doubtful record from the mountains in Laconia in S Peloponnisos (Sibthorp & Smith 1809 p. 408). The species has recently been collected by Strid on Mt Pangaion, in W Rodhopi and in a locality between Mt Olympus and Mt Titaros (S 15997, 16378 and 11833 respectively; see also Strid & Papanicolaou in press).

S. alpina differs from the other species in the *S. germanica*-group by the presence of glandular hairs on the upper part of the stem. Plants from Cranj planina in Hercegovina, Jugoslavia, with narrow and villous leaves have been described as ssp. *dinarica* by Murbeck (1891 p. 61). However, according to material in LD plants with this combination of characters occur in the whole area of distribution of the species, as do intermediate forms between these and plants with broad minutely pubescent leaves. Thus the plants described as ssp. *dinarica* represent an extreme form in a continuous variation series.

The plant collected on Mt Siniatsikon has leaves which are densely tomentose beneath and hirsute above. In these features it resembles *S. germanica* and *S. tymphaea*, but the stem is glandular pubescent above. It has been collected in the same area by Stamatiadou (no. 16204; see also Strid & Papanicolaou in press).

S. alpina grows in grassy places among stones.

General distribution: W, C & S Europe and the Caucasus.

Thymus parnassicus Halácsy

Collection: Mt Siniatsikon, 6 km SSE of Vlasti, c. 1800 m, GF 8078 (LD).

New to N C Greece. It has a few localities scattered all over Greece. The distribution map (Fig. 2 B) is based on records in the following literature: Halácsy (1902, 1912), Hayek (1931), Quézel & Contandriopoulos (1965 a) and Zaganiaris (1940).

In Tutin et al. (1972) J. Jalas suggests that *T. parnassicus* is perhaps only a subspecies of the more widespread *T. cherlerioides*. On Mt Siniatsikon, however, they both grow in the summit area and can be distinguished on the following characters:

T. parnassicus: Leaves velutinous, 6–9×0.9 –1.5 mm. Internodes of flowering shoots 3–7 mm. Bracts greenish, ovate, 5.5–7.5×2.2–3.3 mm.

T. cherlerioides: Leaves subglabrous, 5–8×0.4 –0.6 mm. Flowering shoots short, internodes ± indistinguishable. Bracts purplish, linear to lanceolate, 4.0–5.5×1.2–1.5 mm.

The collection of *T. parnassicus* from Mt Siniatsikon matches a collection from the *locus classicus* on Mt Parnassos (GF 8112, LD).

General distribution: *T. cherlerioides* is known from the mountains of the C part of the Balkan Peninsula and from Krym, while *T. parnassicus* is only known from the mountains of the S Balkan peninsula.

Lentibulariaceae

Pinguicula balcanica Casper ssp. **balcanica**

Collection: Mt Vermion, 13 km W of Naousa, 1880–1975 m, GF 8777 (LD, C).

This Balkan endemic is known only from a few localities in Greece, viz. Mt Kaimakčalan (Strid 1978), Mt Smolikas (Quézel & Contandriopoulos 1965 b) and Mt Vardousia in Sterea Ellas (G 1243, 1480 and 3316).

It grows in damp meadows in swampy places where there is no competition fram tall vegetation.

General distribution: Ssp. *balcanica* is endemic to the Balkan Peninsula, while ssp. *pontica* is known only from Turkey and the Caucasus (map in Meusel et al. 1978 p. 416).

Liliaceae

Asphodelus albus Miller

Collections: Mt Siniatsikon, 6 km SSE of Vlasti, 1500–1550 m, GF 8137 (C). Mt Vermion, 10 km W of Naousa, 1950–2052 m, GF 8693 (LD).

This species is recorded from several localities in N Greece. The distribution map (Fig. 2 D) is based on records in the following literature: Aldén (1976), Halácsy (1904), Phitos (1962), Rechinger (1939 b, 1943), Zaganiaris (1940) and Turrill (1918).

A. albus grows in dry stony meadows, often with tall vegetation.

General distribution: S Europe, extending northwards to N W France and eastwards to the Balkans.

Paris quadrifolia L.

Collection: Mt Vermion, 11 km W of Naousa, c. 1900 m, GF 8559 (LD).

In Greece *P. quadrifolia* is reported from only a few localities in the northern parts, viz. Mt Falakron (Kitanov 1943, Quézel & Contandriopoulos 1968), Mt Leila (Voliotis 1976), Metsovon in S Pindhos and Mt Olympus (Quézel & Contandriopoulos 1965 b). Recently it has also been collected on Mt Smolikas by Hartvig et al. (H 451 and 5645).

P. quadrifolia is a montane species which on Mt Vermion was found in the shady spaces between tall rocks together with other montane species such as *Lamiastrum galeobdolon, Polygonatum verticillatum, Actaea spicata, Galium odoratum* and *Poa nemoralis*.

General distribution: Most of Europe; temperate Asia.

Polygonatum verticillatum (L.) All.

Collection: Mt Vermion, 11 km W of Naousa, c. 1975 m, GF 8431 (LD, C).

A rare species in Greece, reported from only two localities, viz. Mt Smolikas (Hartvig 1978) and Mt Lioutza near the Jugoslavian-Albanian border (Quézel & Contandriopoulos 1968, Quézel 1969). It has also been collected by Strid et al. in W Rodhopi, near the Bulgarian border (S 16496; see also Strid & Papanicolaou in press).

P. verticillatum was found in the alpine zone, in the shade between tall rocks (see *Paris quadrifolia* above).

General distribution: Most of Europe, but absent from parts of the Mediterranean region; Anatolia, Afghanistan, the Caucasus and the Urals.

Orchidaceae

Coeloglossum viride (L.) Hartm.

Collection: Mt Vermion, 11 km W of Naousa, c. 1975 m, GF 8430 (LD, C).

This species has several localities scattered in N Greece. The distribution map (Fig. 2 E) is based on records in the following literature: Aldén (1976), Kitanov (1943), Rechinger (1939 b) and Stojanov & Jordanov (1938). The northernmost dot in Pindhos refers to a collection by Hartvig et al. from Mt Skourtza (H 5545).

C. viride was rather common on Mt Vermion in grassy places from 1900 to 2000 m.

General distribution: Circumpolar. Map in Hultén (1962 p. 76).

Poaceae

Avenula aetolica (Rech. fil.) J. Holub

Collections: Mt Siniatsikon, 6 km SSE of Vlasti, 1800–2100 m, GF 8021 (C), det. P. Lassen. Mt Vermion, 11 km W of Naousa, c. 1975 m, GF 8376 (LD), det. P. Lassen.

Described as *Avenastrum aetolicum* by Rechinger (1936 pp. 680–682) from Aetolia in Sterea Ellas and said to occur on Mt Veluchi (= Mt Timfrestos) and Mt Korax in the Vardousia Massif. It has also been recorded from Mt Nemerzka on the Greek-Albanian border, probably on the Albanian side (Rechinger 1939 a). The species has, however, been collected on numerous mountains by Aldén, Gustavsson and Hartvig. Fig. 2 C is based on material collected by them and on the records by Rechinger.

In Greece *Avenula aetolica* grows on limestone, serpentine and sandstone in dry stony meadows, screes and cliffs from 1750 to 2450 m.

General distribution: Endemic to Greece and Albania.

Avenula pubescens (Hudson) Dumort

Collections: Mt Siniatsikon, 6 km SSE of Vlasti, 1800–2100 m, GF 8045, 8046 (LD, C). Mt Vermion, 10 km W of Naousa, 1950–2050 m, GF 8697 (LD).

A rare species in Greece, recorded from only Mt Falakron (Kitanov 1943), Mt Bela Voda (Quézel 1969) and Mt Lioutza (Quézel & Contandriopoulos 1968). It has also been collected by Gustavsson on Mt Iti and Mt Timfrestos in Sterea Ellas (G 7321 & 6599 and 5042 respectively).

It was found growing between the stones in grassy places above 1800 m.

General distribution: Most of Europe, but absent in parts of the Arctic and Mediterranean regions; E Turkey, the Caucasus and S Siberia. Map in Meusel et al. (1965 p. 45).

Polygonaceae

Polygonum alpinum All.

Collection: Mt Vermion, 11 km W of Naousa, c. 2000 m, GF 8752 (LD, C).

Restricted to the northern parts of Greece and reported from Mt Leila (Rechinger 1939 b, Voliotis 1976), Mt Bela Voda (Quézel & Contandriopoulos 1968), Mt Vourinos (Goulimy 1960), Mt Smolikas (Halácsy 1908, Quézel & Contandriopoulos 1965 b) and Mt Zygos in Pindhos (Quézel & Contandriopoulos 1965 b). It was also collected by Aldén in the Katara Pass and on Mt Milea in Pindhos (A 1293 and 5019 respectively) and by Hartvig et al. on Mt Bouchetsi and in Pindhos (H 6782).

On Mt Vermion *P. alpinum* was found in scree consisting of large stones near Mavri Petra.

General distribution: Locally in SW, C and SE Europe, S Russia, N Iran and Turkestan. Main area of distribution in Siberia. Maps in Meusel et al. (1965 p. 130) and Jalas & Suominen (1979 p. 30).

Ranunculaceae

Myosurus minimus L.

Collection: Mt Vermion, 11 km W of Naousa, c. 1900 m, GF 8723 (LD, C).

A rare species in Greece, reported by Hayek (1927) from Macedonia and Thrace. Exact localities are not given in the literature and the records may be from outside Greece. Its presence in Greece has only recently been confirmed by Gustavsson (1978 a) who collected it in a melt-water pool on Mt Iti in Sterea Ellas. On Mt Vermion *M. minimus* was found in a similar melt-water pool.

These pools, which dry up in the early summer, are rare in Greece. They have a distinctive flora of annuals: *Limosella aquatica, Ranunculus lateriflorus* and *Myosurus minimus* occur on both Iti and Vermion. In the pools on Iti other species of note are *Lythrum thymifolium, L. portula* and *Veronica oetea* (see Gustavsson 1978 a).

General distribution: Much of Europe, C & S Russia, Siberia, Caucasia, N Iran, W Syria, Turkestan, Cyprus, NW Africa, N America and Australia. Map in Meusel et al. (1965 p. 168).

Ranunculus lateriflorus DC.

Collection: Mt Vermion, 11 km W of Naousa, c. 1900 m, GF 8724 (LD, C).

A rare species previously only recorded in the literature from Mt Iti (Halácsy 1908 p. 3, Gustavsson 1978 a p. 22) but it has also been collected by Hartvig et al. on Mt Annitsa in N Pindhos (H 5210).

On Mt Vermion it was found in a dried-up melt-water pool (see above, *Myosurus minimus*).

General distribution: S & C Europe, Russia, Siberia, Caucasia, W Syria, C Asia and NW Africa.

Rosaceae

Geum coccineum Sibth. & Sm.

Collection: Mt Vermion, 13 km W of Naousa, 1880–1975 m, GF 8774 (LD, C).

This species is often found in the mountains of N Pindhos and N C Greece. For details see Ganiatsas (1939), Quézel (1969), Quézel & Contandriopoulos (1968), Zaganiaris (1940), Strid (1978) and Hartvig (1978).

G. coccineum is readily distinguished on the large, bright red flowers and the deflexed sepals after flowering. Plants deviating in petal colour and other characters have sometimes been described as separate species (see Bolle 1933 p. 51). Obvious differences exist between populations. On Mt Vermion all plants observed had pure orange petals, while Strid reports (pers. comm.) that on Mt. Kaimakčalan all plants had bright red petals. The red form seems to be the commonest in the Greek mountains, and the variant with orange petals probably does not merit taxonomic recognition. The plants from Mt Vermion have high pollen fertility values and are presumably not of hybrid origin.

General distribution: Balkan Peninsula northwards to C Jugoslavia and southwards to N Greece; NW to NE Turkey. Maps in Gajewski (1957 p. 45) and Davis (1972 p. 57).

Geum rivale L.

Collection: Mt Vermion, 13 km W of Naousa, 1880–1975 m, GF 8776 (LD).

Rare in Greece, and first recorded by Sibthorp & Smith (1806 p. 345) from Laconia in Peloponnisos (needs confirmation). *G. rivale* is also known from Mt Leila (Rechinger 1939 b, Voliotis 1976), Mt Vitsi (Zaganiaris 1940) and from Larissa in Thessalia (Beck 1895); it was recently collected by Strid et al. on Mt Kerkini (S 16205, see also Strid & Papanicolaou in press).

On Mt Vermion *G. rivale* grows in damp meadows, usually in tall vegetation by rivulets.

General distribution: Most of Europe except parts of the Mediterranean region; the Caucasus, N Asia and N America. Map in Meusel et al. (1965 p. 220).

Rubiaceae

Galium parisiense L.

Collection: Mt Siniatsikon, 5.5 km SSE of Vlasti, 1600–1650 m, GF 8119 (LD).

Reported from Macedonia (Hayek 1931) and Thrace (Turrill 1918). It has been recorded from the island of Thasos (Rechinger 1943, Stojanov

& Kitanov 1950) and collected by Strid et al. on Mt Olympus (S 220 and 9298).

This annual species usually occurs in dry open habitats. On Mt Siniatsikon it was found in a dry heavily grazed meadow on sandstone and schist (see also *Minuartia viscosa* above). *G. parisiense* has probably often been overlooked.

General distribution: S, W and C Europe, on the Balkan Peninsula southwards to N Greece; Anatolia and N W Africa.

Scrophulariaceae

Limosella aquatica L.

Collection: Mt Vermion, 11 km W of Naousa, c. 1900 m, GF 8720 (LD, C).

New to N C Greece. First recorded from Greece from Mt Timphi in N Pindhos by Quézel & Contandriopoulos (1965 b), both as *L. aquatica* and *L. tenella*. On the status of the latter name see Aldén (1976). *L. aquatica* has recently been recorded from Mt Karava in Pindhos (Aldén 1976) and Mt Iti in Sterea Ellas (Gustavsson 1978 a). It was also collected by Hartvig et al. on Mt Annitsa SW of Mt Smolikas in N Pindhos (H 5205).

On Mt Vermion *L. aquatica* was found growing in a small melt-water pool together with *Myosorus minimus, Sagina subulata* and *Ranunculus lateriflorus* (see above, *Myosurus minimus*).

General distribution: Eurasia, N Africa, Greenland and N America.

Acknowledgements. The field work was supported by the Svante Murbeck Foundation and the Carlsberg Foundation. Thanks are due to Lars-Åke Gustavsson whom I assisted in the field and to Arne Strid who critically read the manuscript.

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Botanical literature

Zohary, M., Heyn, C. C. & Heller, D. 1980: *Conspectus Florae Orientalis. An annotated catalogue of the flora of the Middle East. Fascicle 1, Papaverales and Rosales.* 107 pp. + 2 maps. Jerusalem. Price $15.

The area covered by this work includes the E Aegean islands, Turkey, Iran, Iraq, Syria, Lebanon, Israel, Jordan, the Arabian Peninsula, Cyprus and Egypt. The book is in the form of an annotated catalogue of the plants of the abovementioned countries. In the preface the authors indicate their intention of making quickly accessible information on all species and subspecies of each genus known from the area. Such information already published in national and regional Floras can, however, readily be extracted from them direct by anyone having access to a botanical library. The main value of a list of this type lies in the supplementary information which is not to be found in the standard Floras but which is scattered throughout the botanical literature. There is no indication in the preface or in the advertisements as to whether a complete compilation from the literature other than the standard Floras has actually been undertaken. I have therefore checked upon some cases where I am familiar with actual information because of my interest in the groups. The following examples will illustrate the general tendency.

Arabis sudetica Tausch is reported from both Turkey and Iran by Titz in Bot. Jahrb. Syst. 1978, 110–139. This is not mentioned in the Conspectus.

The *Malcolmia flexuosa* of the E Aegean islands and Turkey is referred to subsp. *naxensis* (Rech. fil.) Stork (*M. naxensis* Rech. fil.) in the revision by Stork in *Opera Botanica 33,* 1972. In the same revision *M. graeca* is stated as not reaching the area of the Conspectus. Neither of these points are mentioned in the Conspectus.

In the revision of *Erysimum* Sect. *Cheiranthus* by Snogerup in *Opera Botanica 13,* (1967) *E. rhodium* and *E. senoneri* are reported from the E. Aegean islands. This is not included in the Conspectus.

Alchemilla (*Aphanes*) *minutiflora* Aznavour was described from Turkey in Bull. Soc. Bot. France 1899. Its recombination under *Aphanes* appeared too late for the Conspectus, but the original name is not mentioned either.

The above examples indicate that the list excludes such reports and revisions which are either not in the Floras or not accepted by the authors. The Conspectus would have been more useful if all revisions and all reports that are not obviously accidental had been included. It is still helpful for giving a quick indication of the species content of a given group in the area, but the reader must keep in mind that it is mainly confined to a compilation from the standard Floras which are in part far from new and which are of uneven quality. The only additions are from the few works cited after the preface. Everything else must be followed up from indexes and journals by anyone requiring full information on a plant group of this area.

Sven Snogerup

Revision of Hordeum sect. Anisolepis Nevski

ROLAND VON BOTHMER, NIELS JACOBSEN and ELISA NICORA

Bothmer, R. von, Jacobsen, N. and Nicora, E. 1980 12 15: Revision of Hordeum sect. Anisolepis Nevski. *Bot. Notiser 133:* 539–554. Stockholm. ISSN 0006-8195.

Four diploid South American species of *Hordeum* are revised, viz. *H. muticum* Presl, *H. cordobense* sp. nov., *H. stenostachys* Godr., and *H. chilense* Roem. & Schult. The name *H. compressum* Griseb. is shown to be a synonym of *H. stenostachys*.

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The present paper is the third in a series of a taxonomic revision of the genus *Hordeum* (Bothmer 1979; Bothmer & Jacobsen 1979 b; cf. also Bothmer & Jacobsen 1979 a).

Southern South America (Argentina and Chile) is one of the centres of the genus *Hordeum* (cf. Nicora 1978). Within this area all South American species are represented, some of which, however, extend their distribution further north (cf. Bothmer & Jacobsen 1980). Four main groups of species occur in South America, three of which have connections with North America, viz. sect. *Critesion*, the *H. parodii*-group, and the *H. pusillum*-group. The former two probably also have connections with Eurasia. The group, sect. *Anisolepis* dealt with here, is exclusively South American.

Nevski (1941) referred four species to sect. *Anisolepis*, viz. *H. muticum* Presl, *H. stenostachys* Godr., *H. compressum* Griseb., and *H. chilense* Roem. & Schult., with *H. stenostachys* as the type species. Nevski's circumscription of sect. *Anisolepis* is retained here, but the delimitation of the sections in the genus may subsequently be changed.

The following characteristics are common to the species of sect. *Anisolepis*: Perennials, with narrow, linear spikes and brittle rachis. The glumes of the lateral spikelets are dissimilar, the upper one is often ± setaceous, and the lower flattened. Glumes of the central spikelets are also more or less flattened. The rachis is often distinctly winged.

Material and methods

Material from the following herbaria has been studied: A, B, BAA, BAB, BM, BRLU, C, CAS, CORD, F, G, GH, IADIZA (Instituto Zonas Aridas, Mendoza, Argentina), K, LD, LIL, M, P, R, S, SGO, SI, UC, UPS, US, W, WU. A list of studied material will be available upon request from the Botanical Museum, University of Copenhagen. Concerning the methods used in the investigation and cultivation of material see Bothmer (1979).

The effect of modification is considerable, especially in quantitative characters. The plants are much more luxurient under greenhouse conditions than in nature. All descriptions are, however, based on material from nature.

Key to the species treated

1. Lemma with 7 or 9 (rarely 5) conspicuous nerves .... *H. cordobense* Bothmer et al.
– Lemma with 5 (rarely more) inconspicuous nerves .... 2.
2. Lemma glabrous; glumes often spreading in fruiting stage ...... *H. chilense* Roem. & Schult.
– Lemma pubescent (rarely glabrous), at least in its apical half; glumes not spreading in fruiting stage 3
3. The whole lemma pubescent (rarely glabrous), the lower glume of lateral spikelets distinctly flattened; spikes pale green; rachilla ± thick. .... *H. stenostachys* Godr.

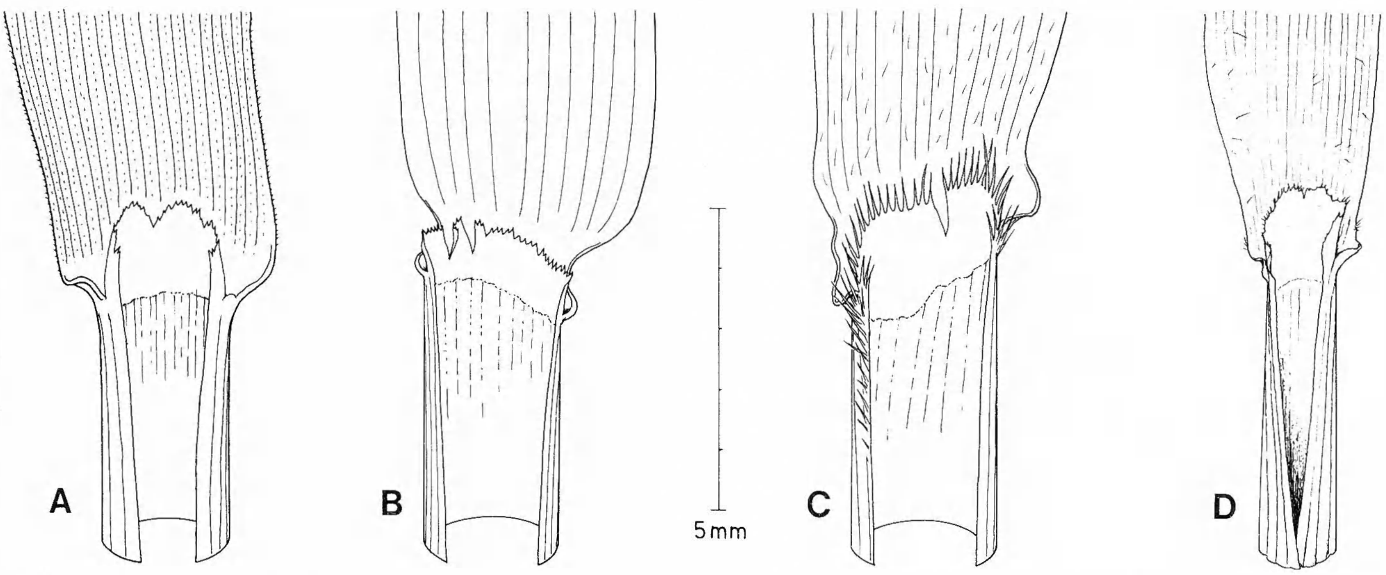


Fig. 1. Ligules. — A: *H. muticum* (Argentina, prov. Tucuman, no H 1789, cult.). — B: *H. cordobense* (Argentina, prov. Cordoba, no H 1702, cult.). — C: *H. stenostachys* (Argentina, prov. Cordoba, no H 1703, cult.). — D: *H. chilense* (Chile, reg. Coquimbo, no H 1820, cult.).

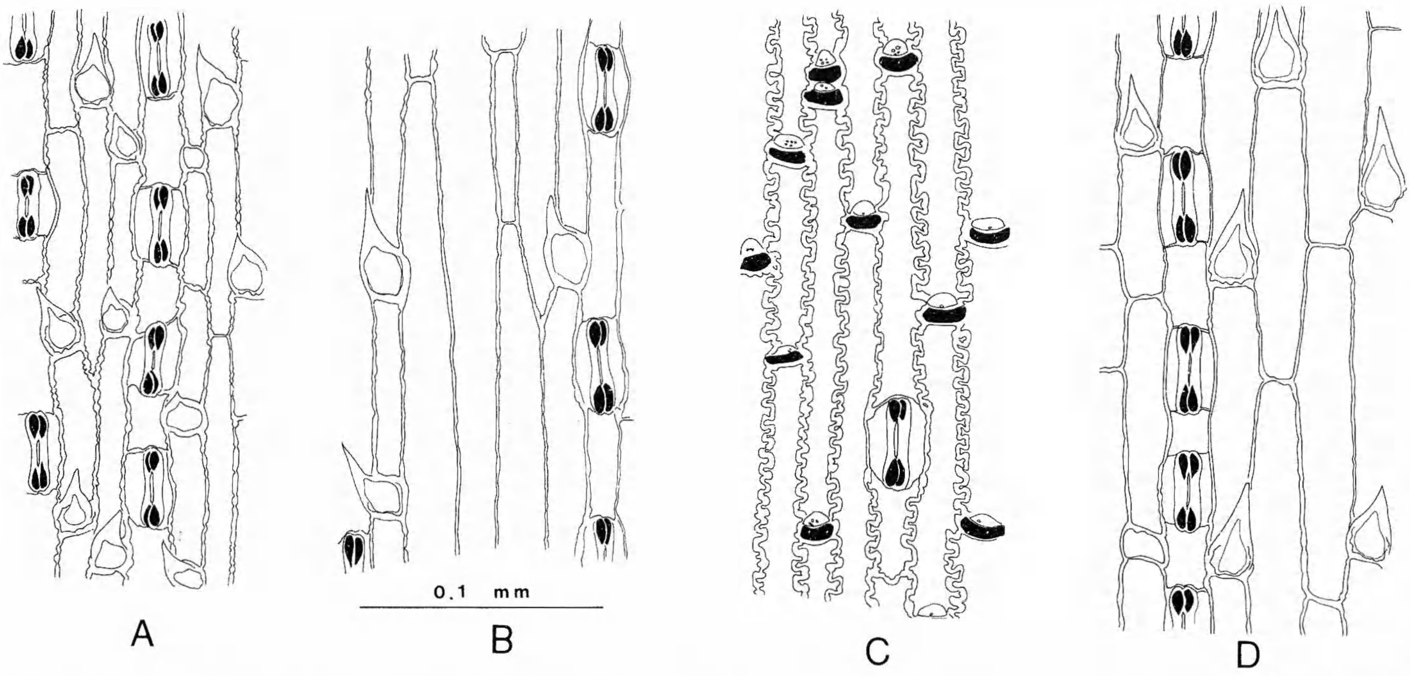


Fig. 2. Epidermis of the abaxial side of the leaves. — A: *H. muticum* (Argentina, prov. Jujuy; Meyer no 21500, LIL). — B: *H. cordobense* (Argentina, prov. Tucuman; Venturi no 448, SI). — C: *H. stenostachys* (France, Port Juvenal; isotype, G). — D: *H. chilense* (Chile, reg. Santiago; Bothmer no 3705, C).

- Only the upper half of the lemma scabrid-hairy (rarely the whole lemma pubescent); the lower glume of lateral spikelets only somewhat flattened to ± setaceous; spikes purple or bluish; rachilla thin or wanting .... *H. muticum* Presl

Hordeum muticum Presl

Presl, Rel. Haenk. 1: 327 (1830). *H. chilense* Brongn. var. *muticum* (Presl) Haum., Anal. Mus. Nac. Hist. Nat. Buenos Aires 28: 273 (1916). Type: "Peruane montano oronoccenses" (PRC lectotype, selected here).

H. andicola Griseb., Abh. Ges. Wiss. Göttingen 24: 285 (1879). *H. muticum* Presl var. *andicola* (Griseb.) Thell., Mem. Soc. Nat. Sci. Nat. Math. Cherbourg 38: 157 (1912). *H. secalinum* Schreb. var. *andicola* (Griseb.) Haum., Anal. Mus. Nac. Hist. Nat. Buenos Aires 28: 304 (1916). Type: "Flora Argentina; Umgebungen des Nevado del Castillo; Prov. Salta, 10–15000′; Leg. P. G. Lorentz & G. Hieronymus no

80, 19/23.3.1873" (CORD, GOET lectotype, selected here, W).

H. secalinum Schreb. var. *parviflorum* Hack., in Stuck., Anal. Mus. Nac. Hist. Nat. Buenos Aires 13: 533 (1906). *H. nodosum* L. var. *parviflorum* (Hack.) Henr. & Thell., Med. Rijks. Herb. Leiden 40: 75 (1921). Type: "Theodoro Stuckert exs. no. 15412; prov. de Tucuman, dep. Tafi, Cerro Munoz alt. 3800 m, leg. M. Lillo no 4255, 27.2.1905" (BRLU, G lectotype, selected here, W).

Caespitose perennial, growing in relatively large, dense tufts; lower leaf sheaths dense, hairy, often fibrous. *Culms* (6–)15–52(–69) cm long, erect to geniculate or somewhat ascending. Culm nodes (2–)3–5(–6), glabrous. Leaf sheaths covering 1/2–9/10 of the culm. Uppermost internode (5–)8–29(–34) cm long. Uppermost leaf sheath (4–)5–15 cm long. *Leaves*: uppermost leaf (8–)10–51(–74) mm long and 1.0–2.9 mm broad. 2nd leaf 19–84(–135) mm long and (1.4–)1.7–3.0 mm broad. 3rd–4th leaf 26–120(–143) mm long and 1.6–3.0 mm broad. The uppermost leaves usually with involute margins. Leaf surface ± densely scabrid to ± densely hairy with long soft hairs, rarely glabrous on the adaxial as well as on the abaxial side. Epidermal cells on abaxial side of leaves: long-cells usually very short, sometimes intermediate in size, with thin to relatively thick, straight walls, silica-cells lacking. Ligules 0.4–1.8(–2.3) mm long, straight. Auricles lacking. *Spikes* (18–)30–70(–91) mm long and 3–6 mm broad; greenish to greyish purple to bluish, rachis brittle. Number of nodes per spike: (25–)30–73. Spike internodes 0.7–1.4(–1.7) mm long and 0.4–1.0 mm broad; somewhat winged. *Central spikelets* sessile, lanceolate, 0.8–1.3 (–1.6) mm broad. Glumes ± flattened, to ± setaceous (3.6–)4.0–7.7(–9.5) mm long and 0.2–0.3 mm broad. Palea of about the same length as the body of the lemma or shorter, (3.7–)4.0–7.2(–7.9) mm long, ± truncate at apex. Apex of lemma muticuous, acuminate to aristate 0.6–3.7(–5.0) mm long. Abaxial side of lemma sparse scabrid-hairy on the upper half, the lower part glabrous, rarely the whole lemma scabrid-hairy; conical cells present. Lemma with 5 inconspicuous nerves. Prolongation of rachilla often lacking, when present up to 4.5(–5.1) mm long, thin. Anthers (1.1–)1.3–2.7(–3.3) mm long, yellow to violet. Lodicules 0.6–1.3 mm long, broad to relatively narrow, obtuse to acute at apex, the margins covered by long hairs, sometimes glabrous. Caryopses 2.9–3.6 mm long and (0.8–)1.1–1.2 mm broad; olive to pale brownish olive. *Lateral spikelets* usually rudimentary, when developed male, or rarely perfect; pedicellate, 0.8–0.9 mm broad, pedicels (0.8–)1.3–2.3(–2.7) mm long. Upper glume (3.5–)4.2–7.6(–9.3) mm long and 0.1–0.3 mm broad, ± setaceous to somewhat flattened. Lower glume 3.5–7.6(–9.0) mm long and 0.2–0.3(–0.5) mm broad, somewhat flattened

Fig. 3. Flowering (A–D) and fruiting (E–H) spikes. — A, E: *H. muticum* (Argentina, prov. Tucuman, no H 1789, cult.). — B, F: *H. cordobense* (B: Argentina, prov. Cordoba, no H 1702, cult.; F: CI 15730, cult.). — C, G: *H. stenostachys* (C: Argentina, prov. Buenos Aires, no H 1160, cult.; G: Argentina, prov. Buenos Aires, no H 1125, cult.). — D, H: *H. chilense* (D: Chile, reg. Coquimbo, no H 1825, cult.; H: Chile, reg. Coquimbo, no H 1820, cult.). × c. 0.7.

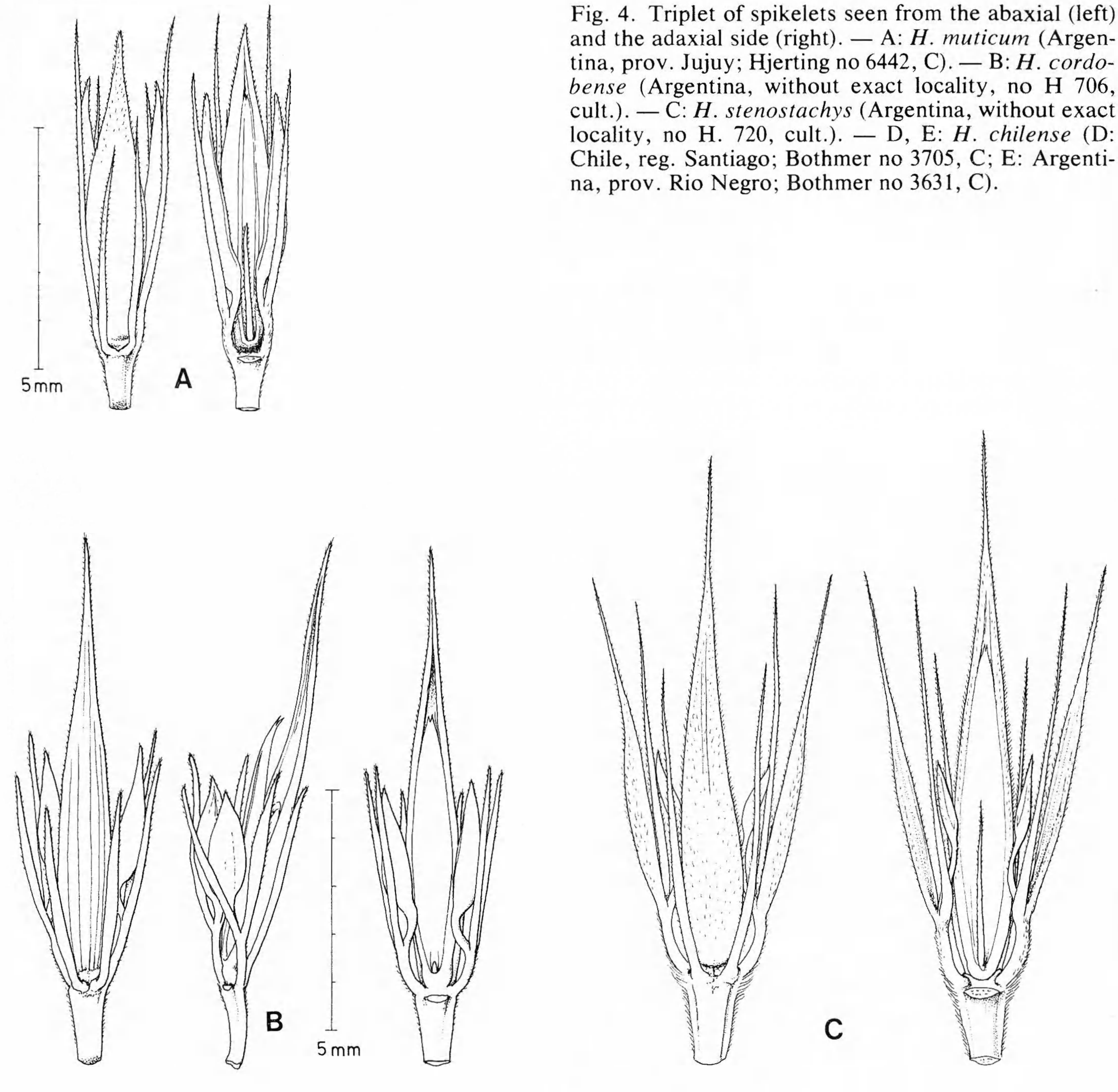


Fig. 4. Triplet of spikelets seen from the abaxial (left) and the adaxial side (right). — A: *H. muticum* (Argentina, prov. Jujuy; Hjerting no 6442, C). — B: *H. cordobense* (Argentina, without exact locality, no H 706, cult.). — C: *H. stenostachys* (Argentina, without exact locality, no H. 720, cult.). — D, E: *H. chilense* (D: Chile, reg. Santiago; Bothmer no 3705, C; E: Argentina, prov. Rio Negro; Bothmer no 3631, C).

to ± setaceous. Palea shorter than the lemma, 3.2–4.1 mm long, lemma muticous to acuminate at apex, 0.4–0.6 mm longer than the palea. Prolongation of rachilla lacking, or up to 1.7 mm long. Anthers 1.1–1.4 mm long.

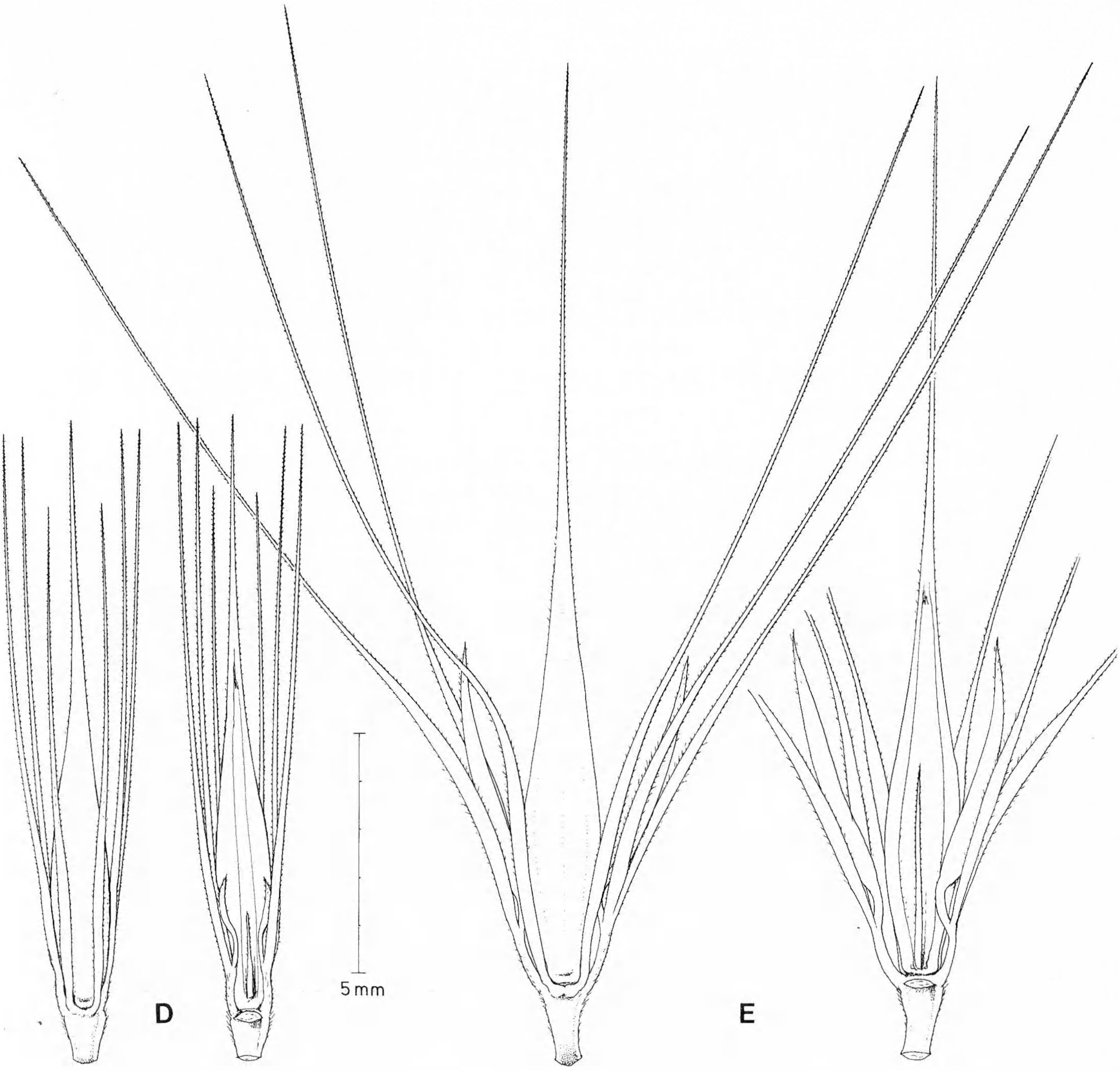
Illustrations. Figs. 1 A; 2 A; 3 A, E; 4 A; 5 A; 6 A; 7 A; 8 A–D.

Characteristics. H. muticum is often a ± low-growing plant (partly due to modification on high altitudes, and grazing) with greyish or greenish purple to bluish spikes. The upper leaves have involute margins and are densely pubescent. The spikelets are muticous to aristate at apex, rachilla is often lacking or rudimentary, and the glumes on both central and lateral spikelets are comparatively short and only somewhat flattened to ± setaceous. Most material is sparsely scabrid-hairy only on the apical part of the lemma.

Distribution (Fig. 9). NW Argentina, NE Chile, Bolivia, Peru, Colombia and Equador.

Habitat. H. muticum occurs along streams, wet Andine pastures, or in somewhat drier Puna steppes, in altitudes above c. 3000 m. It often grows together with *H. halophilum* Griseb.

Cytology. Our collections from N Argentina, Bolivia (Fig. 9) and one from Peru (without exact



locality) were all diploid (2n=14). This agrees with the reports by Hunziker & Maumus (1964), Bowden (1965) and Hunziker et al. (1973).

Variation. In most characters there is a large but ± continuous variation, and the distribution of different forms shows no distinct pattern. For example forms with ± glabrous to densely pubescent leaves and lemmas, forms with muticuous to long aristate lemmas, or forms with narrow to broad spikes occur in all areas. In some other characters, however, a slight tendency to a regional differentiation can be found. So, for example, plants with glabrous lodicules are not found in Argentina, but in Bolivia and Peru forms with glabrous and pubescent lodicules occur together.

H. andicola has sometimes been considered separate from *H. muticum* (cf. Hauman 1916). The distinguishing character would be that the former has shorter glumes of the central spikelets than the latter. It has not been possible to find discontinuities or distinct variation patterns in this or other characters. Forms with shorter and longer glumes occur in all areas, and even within some populations there is a considerable variation.

Hordeum cordobense Bothmer et al. sp. nov.

Gramen satis humile, plerumque minus quam 60 cm altum, culmis ut caespitibus tenuibus. Spicae longae, angustissimae. Lemma floris centralis 7, interdum 9 costas manifestas praebens. Glumae breves, rigidae, complanatae, acuminatae.

Type: "Kneucker exs. no 415. Argentina, prov. Cordoba, Est. San Teodora, Distr. Villamonte, Leg. Stuckert 8.10.1900" (B, G, GH, MISS, US, W holotype, WU).

H. compressum Griseb. var. *tenuispicatum* Hack. & Stuck., in Stuck., Anal. Mus. Nac. Hist. Nat. Buenos Aires 13: 531 (1906). *H. compressum* Griseb. f. *tenuispicatum* Hack. & Stuck., Allg. Bot. Zeitschr. 12: 131 (1906). *H. muticum* Presl var. *compressum* (Griseb.) Thell. subvar. *tenuispicatum* (Hack. & Stuck.) Thell., Mem. Soc. Nat. Sci. Nat. Math. Cherbourg 38: 159 (1912). Type: "Teodoro Stuckert no 15285; Rio IV, prov. de Cordoba; 14.12.1905" (G, SI, W lectotype, selected here).

Nomenclatural notes. The name *H. compressum* Griseb., previously used for this species has unfortunately to be changed. The collections by Lorentz & Hieronymus from Argentina were sent to Göttingen (GOET) for identification and one set was kept in Cordoba (CORD). From this material Grisebach (1874) described several new species. The name *H. compressum* Griseb. is based on the collection Lorentz no 524, and this collection is represented in GOET as well as in CORD. However, the specimen at GOET represents *H. stenostachys* Godr., and the sheet in CORD is a mixed collection of *H. stenostachys* and *H. cordobense*. These two species often grow together and mixed collections are frequent. Since Grisebach had only seen the material in GOET and not that in CORD (cf. Hunziker 1960), it is not possible to use the latter for a lectotypification.

Caespitose perennial, growing in small, relatively loose tufts with rather few culms; lower leaf sheaths somewhat fibrous; glabrous. *Culms* (20–)25–60(–80) cm long, erect, slender. Culm nodes (3–)4–5(–6), glabrous. Leaf sheaths covering 2/3–1/1 of the culm, flowering spikes sometimes half-way within the uppermost leaf sheath. Uppermost internode 9–30(–39) cm long. Uppermost leaf sheath (7–)9–15 cm long. *Leaves*: uppermost leaf 30–85 mm long and 1.7–3.7 mm broad. 2nd leaf (42–)50–130(–174) mm long and 1.8–4.0 mm broad. 3rd leaf 50–130 mm long and 1.7–4.4 mm broad. Leaf surface sparsely to densely scabrid with short and long prickly hairs and rarely with sparse, soft longer hairs on the adaxial side; scabrid to ± glabrous on the abaxial side. Epidermal cells on abaxial side of leaves: long-cells usually very long and with thin and straight walls, silica-cells lacking. Ligules 0.4–1.5 mm long, straight. Auricles lacking. *Spikes* (50–)55–85(–104) mm long and 3–4 mm broad; pale green; rachis brittle. Number of nodes per spike: 40–65. Spike internodes 1.2–1.8(–2.4) mm long and (0.7–)0.9–1.5 mm broad; winged, with scabrid-hairy margins and surfaces. *Central spikelets* sessile, broadly lanceolate, 1.0–1.6 mm broad. Glumes distinctly flattened, (3.3–)4.0–6.5 mm long and 0.2–0.4 mm broad; scabrid on the abaxial side. Lemma and palea of the same length 5.0–8.0 mm long; palea acute, truncate or bifid at apex. Apex of lemma muticous, aristulate to aristate, 1.6–4.7(–5.8) mm long. Abaxial side of lemma sparse scabrid-hairy, especially on the nerves, conical silica-cells present. Lemma with (5), 7 or 9 conspicuous nerves. Prolongation of rachilla usually lacking, when present up to 2.5 mm long, ± thin. Anthers (1.3–)1.8–3.0 mm long, yellow. Lodicules 0.7–1.4 mm long, narrow, acuminate. Adaxial side of lemma ± glabrous to somewhat scabrid in the upper parts. Caryopses 2.8–3.3 mm long and 0.8–1.2 mm broad; olive to reddish brown. *Lateral spikelets* almost always rudimentary, when well developed male, and 0.8–0.9 mm broad; pedicellate, pedicels 1.1–2.5 mm long. Upper glumes 3.9–7.1(–7.7) mm long and 0.2–0.4 mm broad, ± setaceous to somewhat flattened. Lower glume 3.7–7.1 mm long, somewhat shorter than the upper glume, 0.3–0.5 mm broad, flattened, somewhat scabrid. Lemma and palea of the same size c. 4 mm long, lemma aristulate, up to 0.7 mm long. Prolongation of rachilla 0.7–1.0 mm long. Anthers c. 1.5 mm long.

Illustrations. Figs. 1 B; 2 B; 3 B, F; 4 B; 5 D; 6 B, C; 7 B; 8 E–H.

Characteristics. H. cordobense has slender culms and grows in small tufts. The spikes are long and very narrow. The lemma of the central spikelets have 7, rarely 9 distinct nerves. All other species of *Hordeum* have 5 inconspicuous nerves. The glumes are short, rigid, flattened and acuminate.

Distribution (Fig. 10). Central and N Argentina.

Habitat. H. cordobense occurs in ditches, waste grassland and pastures in the lowland. It often grows together with *H. stenostachys*.

Cytology. The studied collections were diploid (2n = 14, Fig. 10). This is in agreement with the reports by Covas (1950), Covas & Schnack

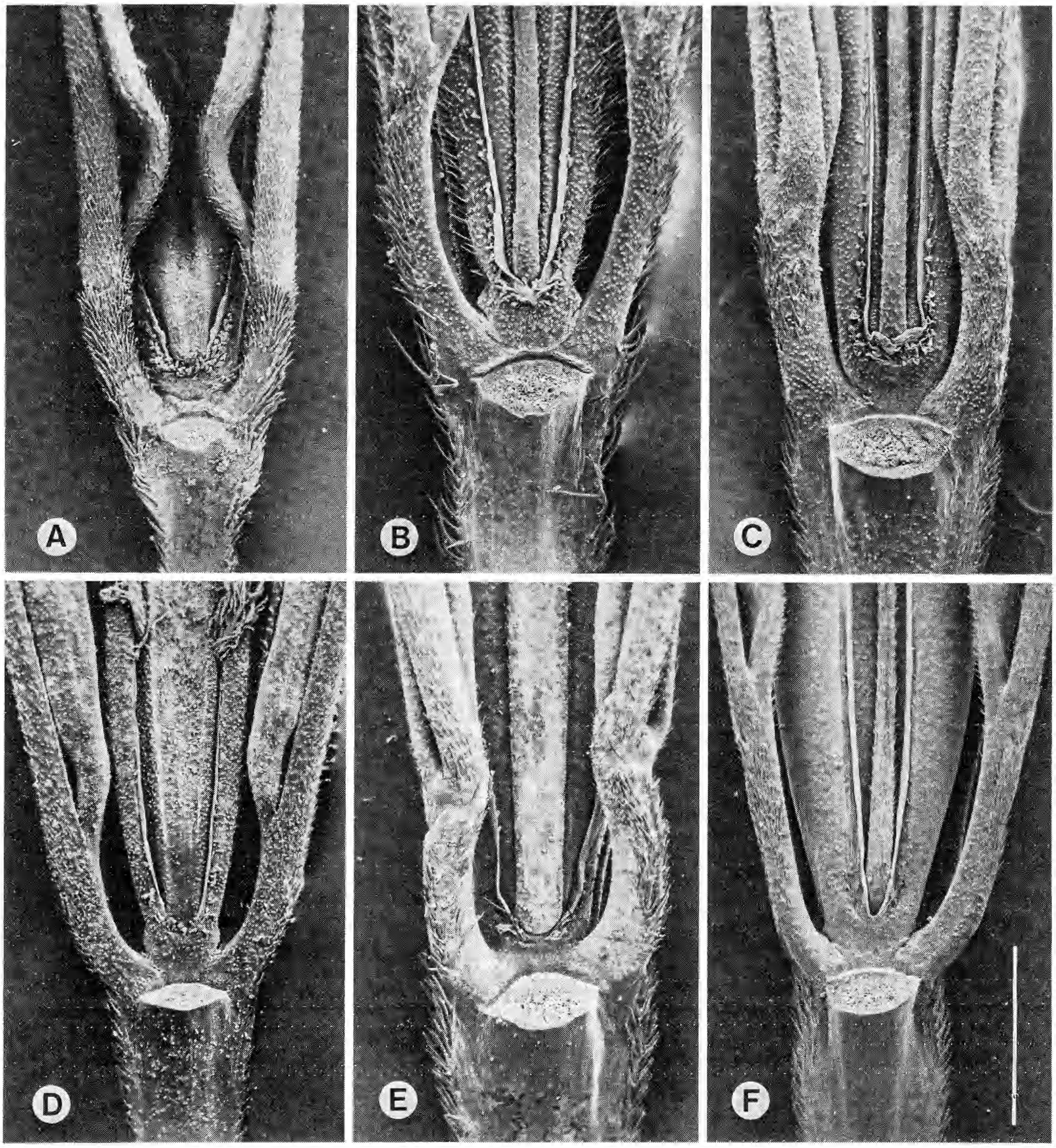


Fig. 5. SEM-photos of adaxial side of basal part of central spikelets. — A: *H. muticum* (Argentina, prov. Jujuy, no H 1842, cult.). — B, C: *H. stenostachys* (B: Argentina, prov. Buenos Aires; Jacobsen no 3034, C; C: Argentina, prov. Corrientes; Myndel-Pedersen no 2890, GH). — D: *H. cordobense* (Argentina, prov. Cordoba; Kneucker no 598, G). — E, F: *H. chilense* (E: Argentina, prov. Neuquen; Jacobsen no 3098, C; F: Chile, reg. Coquimbo, no H 1817, cult.). Scale unit equal to 1 mm.

(1951), Schooler (1960), Bowden (1965), Schooler et al. (1966), Hunziker et al. (1973), Starks & Tai (1974), Starks (1976), and Orton & Tai (1977). (All under the name *H. compressum*.)

Variation. *H. cordobense* is a distinct species which has a very restricted range of variation. No intermediate forms have been found between *H. cordobense* and *H. stenostachys*.

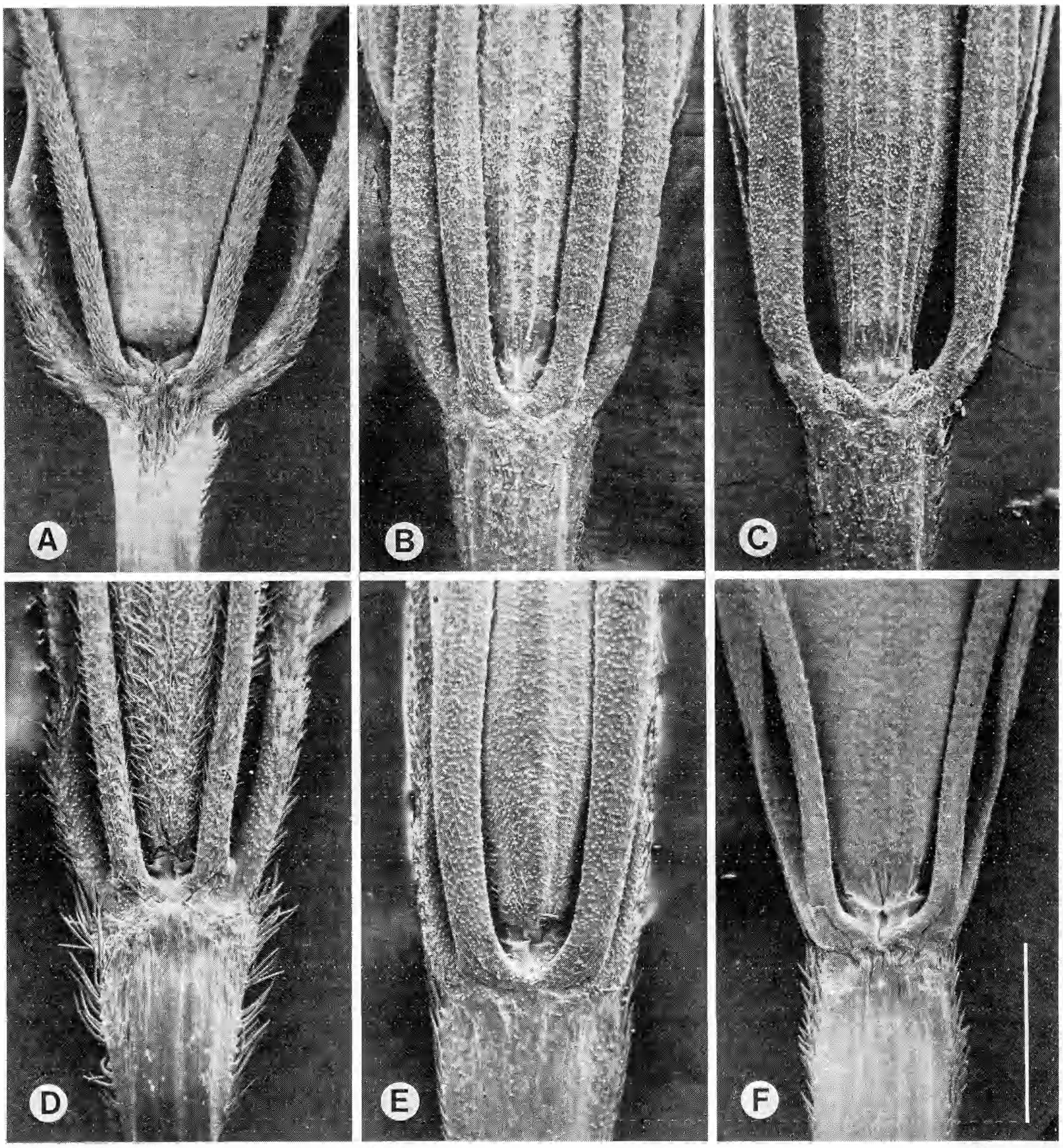


Fig. 6. SEM-photos of abaxial side of basal part of central spikelets. — A: *H. muticum* (Argentina, prov. Tucuman, no H 1789, cult.). — B, C: *H. cordobense* (Argentina, prov. Cordoba; Kneucker no 598, G). — D, E: *H. stenostachys* (D: Argentina, prov. Buenos Aires, no H 1134, cult.; E: Argentina, prov. Corrientes; Myndel-Pedersen no 2890, GH). — F: *H. chilense* (Chile, reg. Coquimbo, no H 1817, cult.). In C the glumes of the central spikelet are removed. Scale unit equal to 1 mm.

Hordeum stenostachys Godr.

Godron, Fl. Juvenalis: 47, in Mem. Acad. Montpell. sect. med., I: 455 (1853). Type: "Port Juvenal" (G, P lectotype, selected here, UPS).

H. compressum Griseb., Abh. Ges. Wiss. Göttingen 19: 201 (1874). Non *H. compressum* Boiss. & Orph., in Boiss., Fl. Orient. 5: 681 (1881), nom. nud. *H. muticum* Presl var. *compressum* (Griseb.) Thell., Mem. Soc. Nat. Sci. Nat. Math. Cherburg 38: 157 (1912). *H. chilense* Brongn. var. *compressum* (Griseb.) Haum., Anal. Mus. Nac. Hist. Nat. Buenos Aires 28: 276 (1916). Type: "Am Ufer von Acequien bei Cordoba;

T. G. Lorentz no 524, p.p. 27.10.1871" (CORD, GOET lectotype, selected here).

H. secalinum Schreb. *β puberulum* O. Kuntze, Rev. Gen. Pl. 3, 3: 355 (1898). Type: "Argentina: Villa Maria bei Cordoba; Otto Kuntze 15.12.91" (NY lectotype, selected here).

H. secalinum Schreb. *γ scabriusculum* O. Kuntze, Rev. Gen. Pl. 3,3: 355 (1898). Type: "Tandil Arg. Otto Kuntze, Nov. 92" (NY lectotype, selected here, specimen no. 1).

H. compressum Griseb. var. *superatum* Hack., in Stuck., Anal. Mus. Nac. Hist. Nat. Buenos Aires 13: 531 (1906). *H. muticum* Presl var. *superatum* (Hack.) Thell., Mem. Soc. Nat. Sci. Nat. Math. Cherbourg 38: 157 (1912). Type: "Teodoro Stuckert no 15326; Rio IV, Prov. de Cordoba; 19.12.1905" (G, W lectotype, selected here).

H. chilense Brongn. var. *muticum* (Presl) Haum., f. *longearistatum* Haum., Anal. Mus. Nac. Hist. Nat. Buenos Aires 28: 275 (1916). Type: "Argentina, prov. de Cordoba, Rufino no 145" (SI lectotype, selected here).

H. pampeanum Speg., in sched., quoad e.g. Rufino no 145 (SI).

H. chilense Brongn. var. *compressum* (Griseb.) Haum. f. *elongatum* Haum., Anal. Mus. Nac. Hist. Nat. Buenos Aires 28: 278 (1916). Type: "Mendoza 1868/69" (SGO lectotype, selected here, left specimen, "no. 2").

Caespitose perennial, growing in relatively dense tufts, lower leaf sheaths somewhat fibrous; usually pubescent. *Culms* (28–)35–120(–150) cm long, erect, slender to stout. Culm nodes 4–7, glabrous. Leaf sheath covering 3/5–1/1 of the culm, flowering spikes sometimes half-way within the uppermost leaf sheath. Uppermost internode (10–)14–38(–57) cm long. Uppermost leaf sheath 7–18(–21) cm long. *Leaves*: uppermost leaf 25–90(–102) mm long and 1.4–3.3(–4.8) mm broad. 2nd leaf 40–146 mm long and 2.1–4.5(–6.7) mm broad. 3rd–4th leaf 63–180(–201) mm long and (1.8–)2.3–7.1 mm broad. Leaf surface ± glabrous or sparsely to densely scabrid, sometimes also with ± dense, long, soft hairs on the adaxial side; glabrous to ± scabrid on the abaxial side. Epidermal cells on the abaxial side of leaves: long-cells short or of ± intermediate size with thick sinuous walls, dense, narrow silica-cells present. Ligules (0.5–)0.8–2.0(–3.0) mm long, straight. Auricles lacking. *Spikes* (45–)65–110 (–127) mm long and (3–)4–5 mm broad; pale green; rachis brittle. Number of nodes per spike: 30–73. Spike internodes 1.3–2.2(–2.8) mm long and 0.8–1.3 mm broad; winged, with scabrid hairy margins and surfaces. *Central spikelets* sessile, lanceolate, 0.9–1.3 mm broad. Glumes distinctly flattened at the base, (4.0–)4.6–10.5 mm long and 0.2–0.5 mm broad; scabrid on the abaxial side. Palea and the body of the lemma of about the same length, (5.0–)5.5–8.3(–9.5) mm long; palea acute. Apex of lemma aristate, arista (2.0–)2.5–6.8(–8.7) mm long. Abaxial side sparse to ± dense pubescent, or rarely glabrous, with conical cells. Adaxial side of lemma sparsely to densely hairy towards the apex. Lemma with 5 inconspicuous nerves. Prolongation of rachilla lacking or up to 5.5 mm long, relatively thick. Anthers yellow, (1.5–)2.2–4.4(–5.2) mm long. Lodicules 0.7–1.2 mm long, relatively broad, obtuse to acute at apex, sparsely to densely pubescent. Caryopses 3.3–4.6 mm long and 0.8–1.1 mm broad, reddish brown. *Lateral spikelets* rudimentary, pedicellate, pedicels 1.7–3.2(–3.7) mm long. Upper glume (4.3–)5.0–11.7(–13.8) mm long and 0.2–0.3 mm broad, ± setaceous to somewhat flattened. Lower glume (4.5–) 5.0–11.7(–13.3) mm long and 0.3–0.8 mm broad, distinctly flattened in its lower part; flattened part (2.7–)3.2–5.4(–6.7) mm long.

Illustrations. Figs. 1 C; 2 C; 3 C, G; 4 C; 5 B, C; 6 D, E; 7 C, D; 8 I–L.

Characteristics. *H. stenostachys* is a tall, often stout and broad-leaved plant (up to 1.5 m), with long, ± pale green spikes. The lemma of the central spikelet often has a long awn, up to 7–8 mm long. The abaxial side of the lemma is sparsely to densely pubescent with spreading hairs, sometimes glabrous.

The lower glumes of lateral spikelets, and often the glumes of central spikelets, are distinctly flattened in their lower parts and setaceous in the upper half, and in this respect resemble those of *H. chilense*.

Distribution. (Fig. 11): Central and N Argentina, Uruguay and southernmost Brazil.

Habitat. Roadsides, pastures and waste land at low altitudes. Sometimes growing together with *H. cordobense*, and *H. flexuosum*.

Cytology. Chromosome numbers have been determined in 34 collections and all were diploid ($2n=14$, Fig. 11). Diploids were reported earlier by Covas (1950) and Bowden (1965).

Variation. *H. stenostachys* is a rather variable species, but an intraspecific delimitation does not seem justifiable. Material from the NE part of the distribution area (Brazil, Uruguay, and the

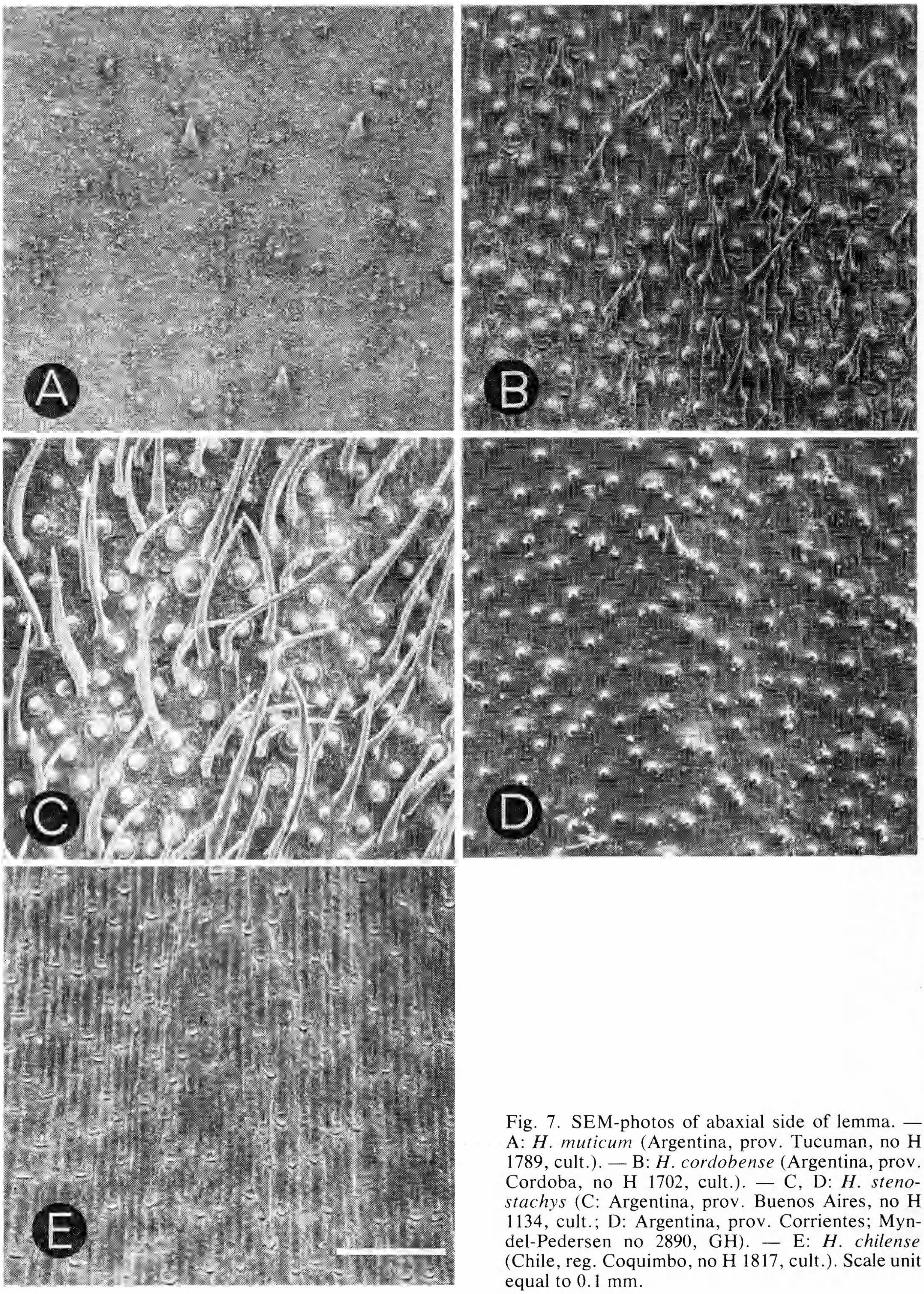


Fig. 7. SEM-photos of abaxial side of lemma. — A: *H. muticum* (Argentina, prov. Tucuman, no H 1789, cult.). — B: *H. cordobense* (Argentina, prov. Cordoba, no H 1702, cult.). — C, D: *H. stenostachys* (C: Argentina, prov. Buenos Aires, no H 1134, cult.; D: Argentina, prov. Corrientes; Myndel-Pedersen no 2890, GH). — E: *H. chilense* (Chile, reg. Coquimbo, no H 1817, cult.). Scale unit equal to 0.1 mm.

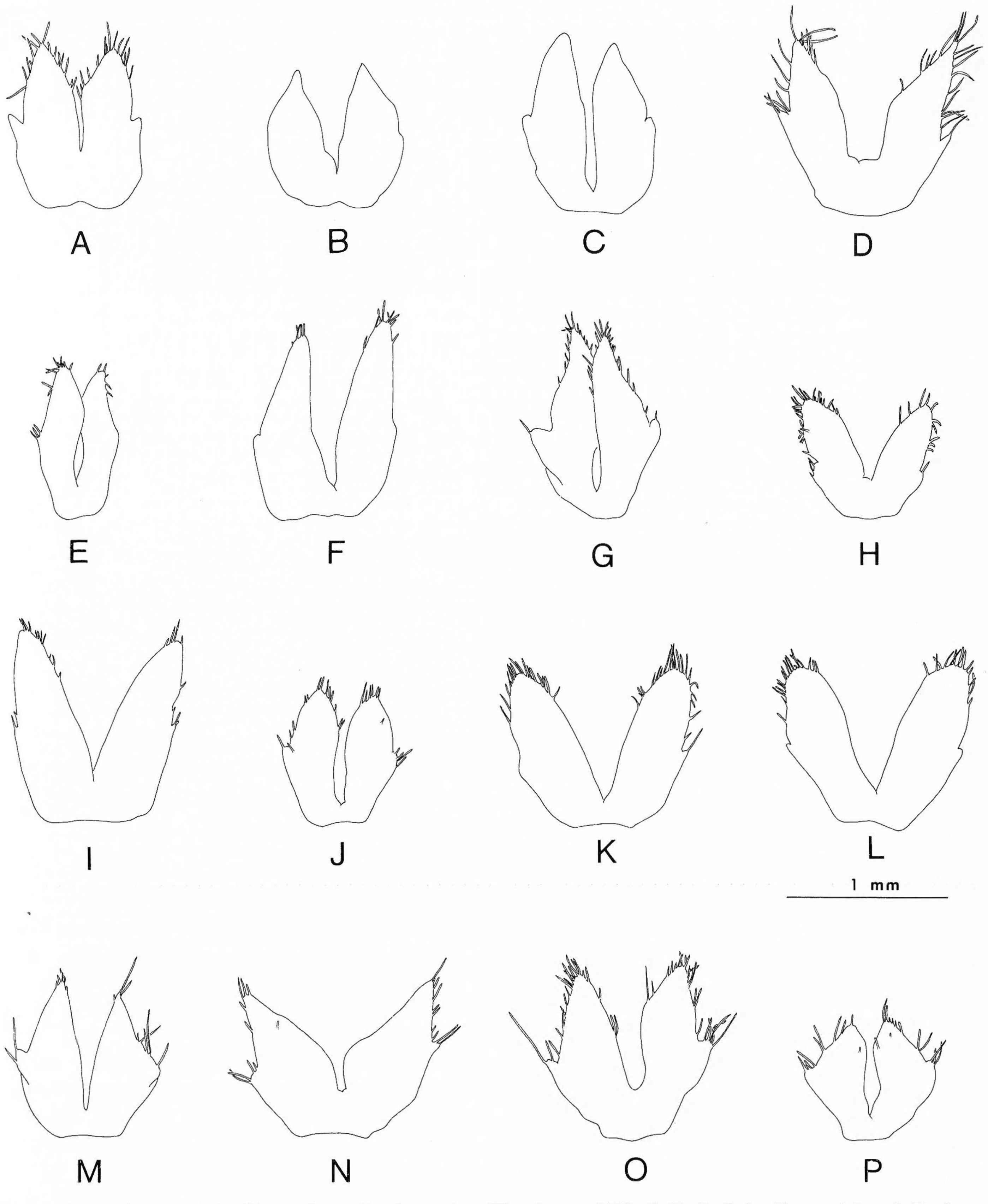


Fig. 8. Lodicules. — A–D: *H. muticum* (A: Argentina; Hjerting no 6489, C; B: Bolivia; Krapovickas & Fuchs no 6745, C; C: Peru; Tutin no 953, BM; D: Columbia; Apollinaire 9.10.1908, L). — E–H: *H. cordobense* (E: Argentina, prov. Mendoza; Ruiz-Leal no 17457, C; F: Argentina, prov. Cordoba; Kneucker no 415, G; G: Argentina, prov. Cordoba; Bothmer no 3603, C; H: Argentina, prov. Corrientes; Myndel-Pedersen no 6095, A). — I–L: *H. stenostachys* (I: Argentina, prov. Cordoba; Stuckert no 21300, G; J: Argentina, prov. Buenos Aires; Jacobsen no 3014, C; K: Argentina, prov. Corrientes; Myndel-Pedersen no 2890, GH; L: Uruguay, distr. Soriano; Gallinal et al. no PE 4819, F). — M–P: *H. chilense* (M: Argentina, prov. Neuquen; Jacobsen no 3098, C; N: Chile, reg. Bio Bio; Jaffuel no 3967, GH; O: Chile, reg. Aconcagua; Bothmer no 3700, C; P: Chile, reg. Santiago; Bothmer no 3705, C).

provinces of Missiones and Corrientes in Argentina) tends to have somewhat larger anthers than other material. In these areas a variation in pubescence of the lemma of the central spikelets is also found; ± glabrous forms predominate, but all intermediates to hairy ones occur. Length of glumes and length of lemma-awns also show considerable variation, also within populations.

Hordeum chilense Roem. & Schult.

Roemer & Schultes, Syst. Veg. 2: 796 (1817). Type: "Hordeum sp. in., ex Chili, Roem." (BM lectotype, selected here).

H. chilense Brongn., in Duperr., Voy. Cog. Bot. 2, 2: 54 (1829). *H. secalinum* Schreb. var. *chilense* (Brongn.) Desv., in Gay, Fl. Chil. 6: 458 (1853). *H. pratense* Huds. var. *chilense* (Brongn.) Maclosk., in Scott, Rep. Princeton Univ. Exp. Patagonia 8: 251 (1904). *H. pratense* Huds. var. *brongniartii* Maclosk., in Scott, Rep. Princeton univ. Exp. Patagonia 8: 251 (1904), nom. illeg. *H. chilense* Brongn. var. *pseudosecalinum* Hauman, Anal. Mus. Nac. Hist. Nat. Buenos Aires 28: 272 (1916), nom. illeg. Type: "Chili, D'Urville" (P lectotype, selected here).

H. depauperatum Steud., Syn. Pl. Glum. 1: 353 (1854). Type: "In pratis humidis planitici, Quillota . Oct. 1829. Bert. herbr. nr. 789" (BM, P lectotype, selected here).

H. cylindricum Steud., Syn. Pl. Glum. 1: 353 (1854), non. Murr. 1770. Type: "W. Lechler pl. chilense, nr. 694; ad oras marit. pr. San Carlos. Dec. 1851" (G lectotype, selected here, P, W).

H. apertum Phil., Anal. Univ. Chile 94: 345 (1896). Type: "Prope Concon haud procul a Valparaiso, Oct. 1884, F. Philippi" (Photographs of the type specimen in SGO and US, but the material has not been located, a fragment in US is *H. chilense* Roem & Schult.).

H. chilense Roem. & Schult. var. *pilosum* Nevski, Trudy Bot. Inst. Akad. Nauk. SSSR. Ser. 1, Fl. Sist. Vyss. Rast. 5: 189 (1941). Type: "Chili, Valdivia, Comm. R. A. Philippi 2/1888" (K holotype, W).

Nomenclatural notes. The identity of the species described as *H. chilense* Roem. & Schult. (published in 1817), and *H. chilense* Brongn. (published in 1829) has been a matter of discussion. Kunth (1833), Hauman (1916) and Covas (1952) considered *H. chilense* Roem. & Schult. a synonym of *H. marinum* Huds. (= *H. hystrix* Roth, *H. maritimum* With.). The type cited here was discovered at BM, and it, no doubt, constitutes the original material for Roemer & Schultes' description. It represents the endemic species of Chile and Argentina presented here, and probably comes from the Chilean coastal area.

Hauman (op. cit.) used *H. chilense* Brongn. for this South American species (in a wider sense, he treated it as "var. *pseudosecalinum* Hauman"). Covas (op. cit.) considered it a synonym of *H. pusillum* Nutt. The type material present at P represents the same species as *H. chilense* Roem. & Schult.

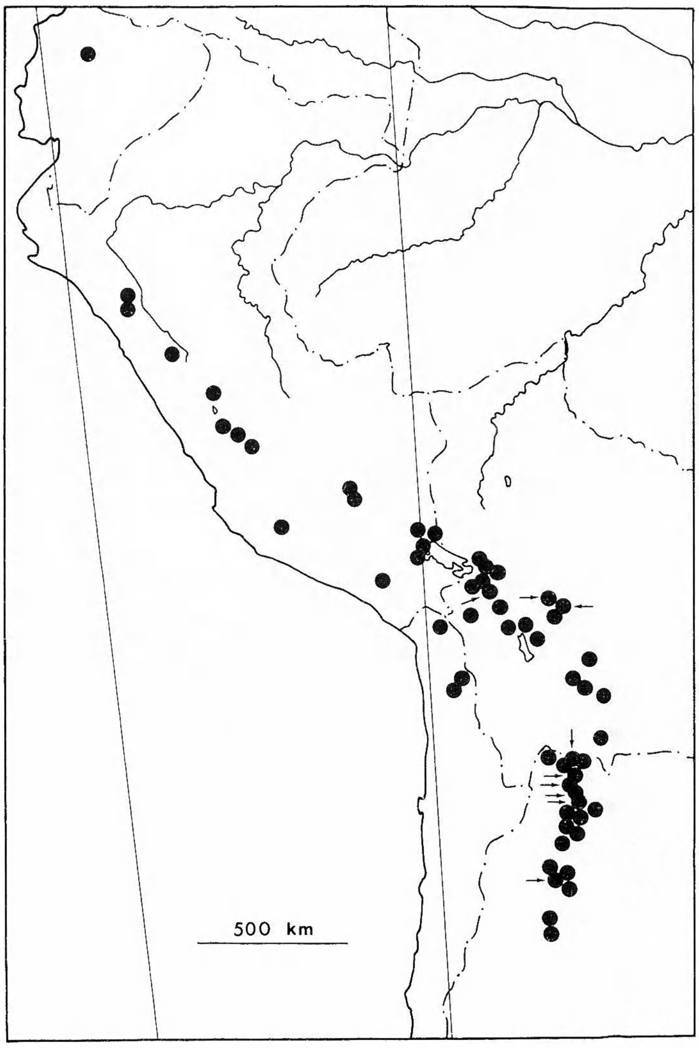


Fig. 9. *H. muticum*, known distribution. Arrows indicate populations from which chromosome numbers ($2n=14$) have been determined. One collection from Colombia (near Bogota) outside the map.

Caespitose perennial, growing in dense or loose tufts; lower leaf sheaths relatively dense often fibrous; pubescent. *Culms* 21–70(–83) cm long, erect, geniculate or ascending; often ± stout. Leaf sheaths covering 2/3–9/10 of the culm. Uppermost internode (8–)12–38 cm long. Uppermost leaf sheath 6–16 cm long. *Leaves*: uppermost leaf (9–)16–60(–67) mm long and 1.7–4.0(–5.4) mm broad. 2nd leaf (24–)28–110(–135) mm long and 2.0–4.2(–5.5) mm broad. 3rd–4th leaf 37–173 mm long and 2.0–5.0(–6.3) mm broad. Leaf surface ± glabrous, or scabrid, sometimes with long, soft hairs, ± dense on the adaxial side; glabrous to ± scabrid and rarely with soft hairs on the abaxial side. Epidermal cells on abaxial side of leaves: long-cells ± intermediate in size, rarely shorter or very long, straight, ± thin walls, silica-cells lacking. Ligu-

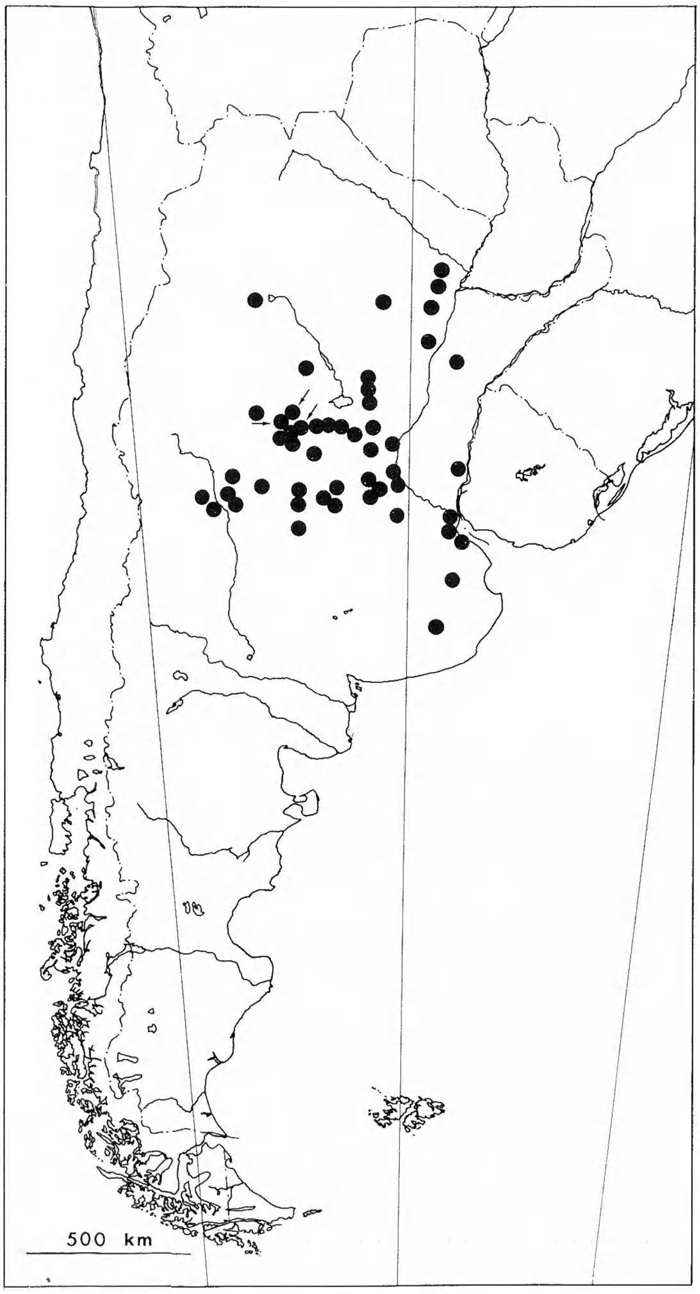


Fig. 10. *H. cordobense*, known distribution. Arrows indicate populations from which chromosome numbers (2n=14) have been determined.

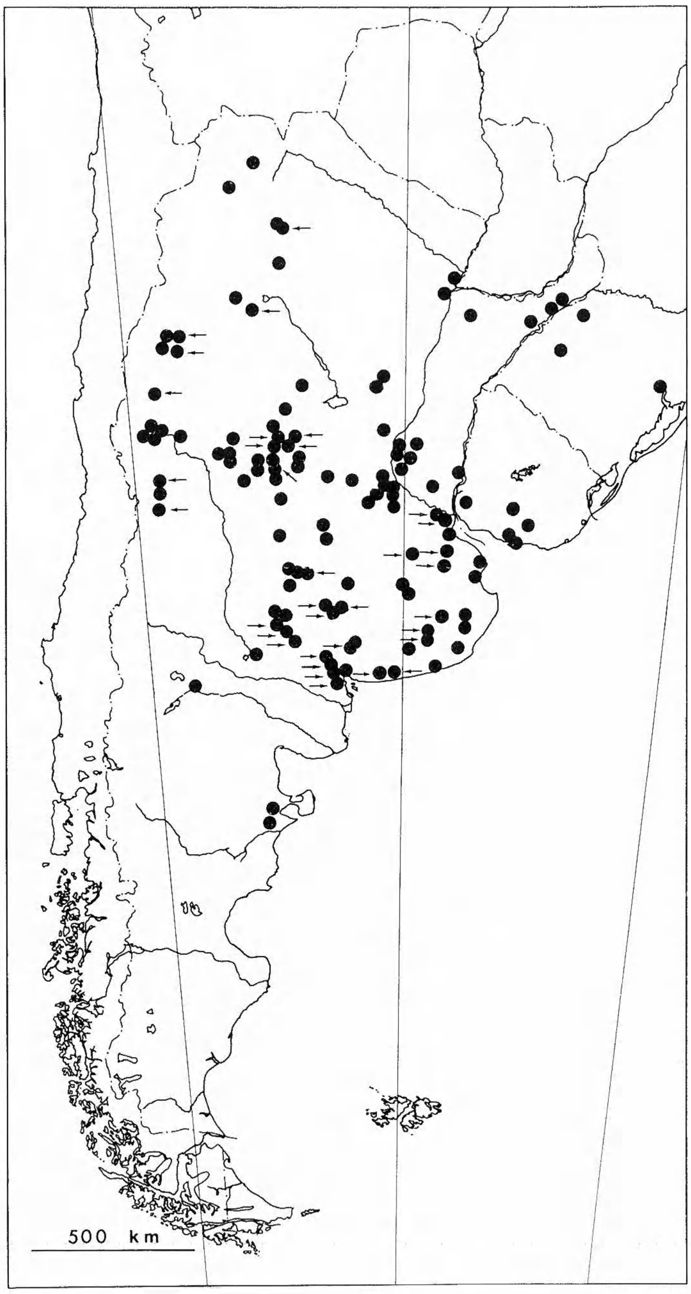


Fig. 11. *H. stenostachys*, known distribution. Arrows indicate populations from which chromosome numbers (2n=14) have been determined. One locality (at Sao Paolo, Brazil) outside the map.

les 0.4–1.8(–3.1) mm long, hairy, usually acute. Auricles lacking. *Spikes* 42–80(–105) mm long and 4–7 mm broad; pale green to purplish green; rachis brittle. Number of nodes per spike 24–61. Spike internodes (0.9–)1.2–2.3 mm long and (0.6–)0.8–1.4 mm broad; broadly winged, with scabrid hairy margins and surfaces. *Central spikelets* sessile, broadly lanceolate, 1.1–1.8(–2.0) mm broad. Glumes distinctly flattened in the basal part (7.6–)8.0–23.3(–26.3) mm long and 0.2–0.5 (–0.6) mm broad, flattened part 4.2–7.5 mm long; glumes spreading in fruiting stage; scabrid on the abaxial side. Palea and the body of lemma of about the same length 6.5–11.7 (–12.8) mm long; palea acute to truncate or somewhat bifid at apex. Awn of lemma (2.0–) 4.0–12.5(–15.0) mm long. Abaxial side of lemma glabrous, ± dense with conical cells, sparsely scabrid towards the apex. Lemma with 5 inconspicuous nerves. Prolongation of rachilla usually thick, sometimes ± flattened, rarely rudimentary, 2.0–6.6(–6.9) mm long and up to 0.3 mm broad. Anthers (1.1–)1.3–2.8(–4.6) mm long, yellow, rarely violet. Lodicules 0.6–1.2(–1.6) mm

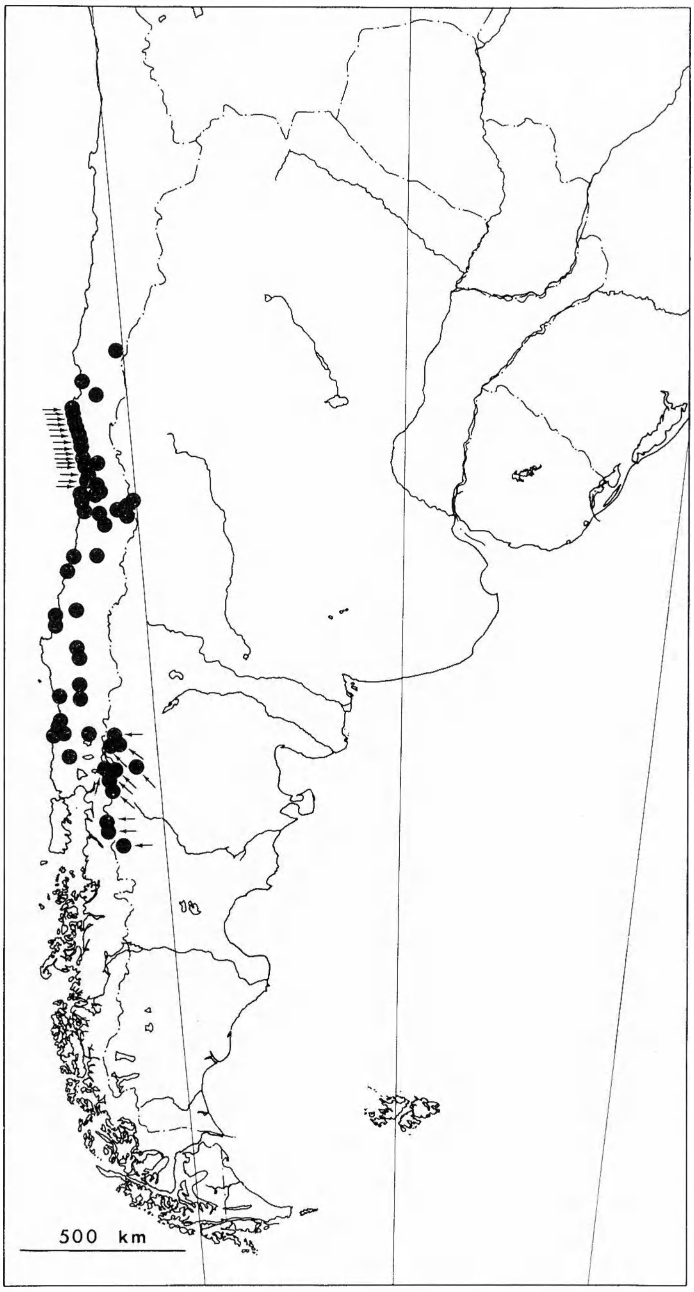


Fig. 12. *H. chilense*, known distribution. Arrows indicate populations from which chromosome numbers ($2n=14$) have been determined. The species also occurs on Juan Fernandez, where it may be introduced.

long; broad, usually acute, sometimes obtuse at apex, with long ± dense hairs. Adaxial side of lemma with short, adpressed hairs in the upper part. Caryopses (3.3–)3.8–5.2 mm long and 1.1–1.6 mm broad, usually olive green. *Lateral spikelets* usually rudimentary, rarely developed and male, c. 1 mm broad; pedicellate, pedicels (1.3–)1.5–2.8(–3.5) mm long. Upper glume (7.1–)10.0–22.0(–25.3) mm long and 0.2–0.3 mm broad, ± setaceous to somewhat flattened. Lower glume (7.1–)10.0–21.7(–26.0) mm long and 0.3–0.6(–0.8) mm broad, somewhat longer than the upper glume or of the same length; distinctly flattened at the base; flattened part 3.8–7.9 mm long, scabrid. The glumes usually spreading in fruiting stage. Palea 5.3–6.3 mm long, shorter than the body of the lemma; lemma muticuous at apex, c. 1.3–1.7 mm longer than the palea. Prolongation of rachilla absent or rudimentary. Anthers c. 2 mm long.

Illustrations. Figs. 1 D; 2 D; 3 D, H; 4 D, E; 5 E, F; 6 F; 7 E; 8 M–P.

Characteristics. *H. chilense* is a relatively low-growing, but usually stout plant, with broad leaves. The central spikelets are long and broad. The lemma is glabrous on the abaxial side and the rachilla is often thick and flat. The long glumes are usually spreading in fruiting stage. Glumes of central spikelets as well as the lower glumes of lateral spikelets are ± broadly flattened in their lower part (similar to *H. stenostachys*).

Distribution (Fig. 12). Central Chile and in the westernmost parts of the provinces of Neuquen and Rio Negro in Argentina. *H. chilense* also occurs on the island of Juan Fernandez, where it may be introduced (Baron B. Sparre, pers. com.).

Habitat. *H chilense* is found in a wide range of habitats. Most Argentinian populations were found on shores of lakes and streams near the water and in pastures, among other grasses and sedges, often a dominating element in the vegetation. In the inland of Chile the species also grows in ± mesic habitats, as wet pastures, by small streams etc. In the coastal areas, however, the species seems to grow in more xeric habitats, as roadside gravel, alluvial soil near the sea etc.

Cytology. (Fig. 12): All material studied was invariably diploid, ($2n=14$), which agrees with the report by Bowden (1965).

Variation. *H. chilense* has a wide variation in morphological characters, and a subdivision of the species has been considered. The species shows extreme variation in e.g. length of the glumes and length of the palea. The Argentinian material, as well as some material from Chile, has very long glumes of the central spikelets (more than 16 mm, Fig. 4 E), whereas most Chilean material, especially from the coastal areas, has shorter glumes (8.0–16.5 mm, Fig. 4 D). The paleas in the Chilean material varies between 6.5 and 11.8 mm, and the Argentinian between 9.5 and 11.8 mm. A few collections from the Valparaiso area in Chile have very long anthers (3.3–4.6 mm), but in material from other areas they are shorter (1.0–3.6 mm).

Since there is an overlapping in all morphological characters we prefer to keep *H. chilense* as one polymorphic taxon, in spite of the large variation found.

Discussion

The subdivision of the genus *Hordeum* into major groups (sections etc.), reflecting morphological similarities as well as phylogenetic relationships is at present not possible. The species here referred to sect. *Anisolepis* are quite distinct entities based on morphological data, distribution patterns, and karyotype differences (cf. Rajhathy et al. 1964; Hunziker et al. 1973), but more data are needed as to the cytological variation. All taxa seem to be invariably diploid. In some of the species, viz. *H. stenostachys*, *H. muticum*, and *H. chilense* a large morphological variation was found, but these taxa are comparatively widespread and certainly grow under different edaphic conditions, and thus the variation pattern may reflect ± local or clinal adaptations. Except for *H. stenostachys* and *H. cordobense* that have overlapping distribution areas and often grow intermingled, the species in sect. *Anisolepis* are allopatric. There is no morphological overlapping between the species, and natural hybrids or hybrid derivatives have not been found by the authors nor been reported earlier.

H. chilense which is extreme in its variation pattern, with all transitions from long- to short-glumed forms, and which occurs in a wide variety of habitats, deviates morphologically from the other species in the section but must by placed here. Further investigations will show if it is more closely related to the other species in sect. *Anisolepis* or to the taxa in the *H. parodii* group, to which *H. chilense* is similar in some characters.

H. chilense var. *magellanicum* Parodi & Nicora, which occurs in a small area and in ± extreme biotopes, e.g. sandy beaches on Tierra del Fuego, is morphologically very deviating and certainly a separate species. It is probably the result of an extreme adaption to its environment, with e.g. slender culms, nodding spikes, etc. It will be treated together with the *H. parodii* group.

Some interspecific, artifical hybrids including the taxa in sect. *Anisolepis*, have been reported (see e.g. Rajhathy et al. 1964, for earlier references), and some have hitherto also been produced within the current *Hordeum* project (cf. Bothmer & Jacobsen 1979 a). Within the section the hybrids *H. muticum* × *H. compressum* (Hunziker et al. 1973), and *H. compressum* × *H. stenostachys* (Covas 1950) have been reported. In spite of rather high meiotic pairing in the hybrids, these were completely sterile.

Hunziker & Maumús (1964) reported both artifical and natural hybrids of the combination *H. muticum* × *H. halophilum* Griseb. This hybrid is rather common in nature, both species occur sympatrically and often grow close together. Both the natural and artifical hybrids are completely sterile. Based on the results of meiotic pairing in the hybrids, Hunziker & Maumús (1964) claimed that the two species are closely related, and that *H. halophilum* should be placed in sect. *Anisolepis*. On morphological criteria, however, *H. halophilum* belongs to sect. *Critesion*, and is probably closely related to the species in the *H. comosum* group. The taxa in sect. *Critesion* show quite different patterns of crossing ability, meiotic pairing and fertility in the hybrids compared to other species in the genus (Bothmer & Jacobsen unpubl.).

The hitherto produced hybrids between the species in sect. *Anisolepis* and species in other groups are, in most cases, completely sterile.

In the taxonomic study of the Argentinian species of the genus *Hordeum*, Hauman (1916) suggested all taxa represented in South America had *H. secalinum* Schreb. as a common ancestor. He treated the South American taxa either as forms or varieties of *H. secalinum*, or as closely related derivatives. As already pointed out by Covas (1949), *H. secalinum* s. str. is not represented in South America. This European and North African species is, on morphological and phytogeographical grounds and in crossing ability, very distantly related to sect. *Anisolepis* (cf. Bothmer & Jacobsen 1979 b).

Acknowledgements. The present paper is part of a study of the wild species of *Hordeum* sponsored by the Danish Natural Science Research Council. Live material was gathered on the Danish Scientific Expedition to Patagonia and Tierra del Fuego 1978/1979. The Latin diagnosis was translated by Dr T. Christensen, Copenhagen. Drawings of spikelets and ligules were made by Mr B. Johnsen, Copenhagen. The English language was corrected by Mrs V. Gordon-Friis, Copenhagen. The SEM-photographs were taken at the Geological Institute, University of Copenhagen.

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Othonna burttii sp. nov. (Compositae) from the Drakensberg, South Africa

BERTIL NORDENSTAM

Nordenstam, B. 1980 12 15: Othonna burttii sp. nov. (Compositae) from the Drakensberg, South Africa. *Bot. Notiser 133:* 555–557. Stockholm. ISSN 0006-8195.

Othonna burttii B. Nord., sp. nov., is described from the Drakensberg range on the border between Lesotho and Natal, South Africa. It is related to *O. natalensis* Sch. Bip., from which it differs in morphology, ecology and phytochemistry. The chromosome number is 2n=20.

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Apart from *Senecio* itself, the genus *Othonna* with well over 100 species is the most polymorphic and taxonomically difficult genus among the African Compositae-Senecioneae. The centre of diversity is in the western Cape Province, particularly the Namaqualand region. From Natal only two species are recorded (Hilliard 1977 p. 513), one of which extends into Lesotho and northwards to the mountains of Zimbabwe. This species, viz. *O. natalensis* Sch. Bip., is so far the only representative of the genus in Lesotho. A second species, *O. scapigera* Harv., is listed by Jacot Guillarmod (1971 p. 295), but this is merely a synonym of *O. natalensis*.

In recent years an undescribed species allied to *O. natalensis* has been collected in a few localities at higher altitudes of the Drakensberg range, i.a. by the eminent explorers of the Natal flora, Dr. O. M. Hilliard and Mr. B. L. Burtt. They have generously put dried and living material as well as viable achenes of the new species at my disposal, and it is a pleasure to name it after Mr Burtt.

Othonna burttii B. Nord., sp. nov., Fig. 1

Holotypus: Hilliard & Burtt 9389 (S).

O. natalensis Sch. Bip. affinis, sed caule fruticoso ramoso, ramis apice foliatis tegetes formantibus, axillis foliorum glabris, foliis minoribus linearibus vel oblanceolatis, achaeniis dimidio minoribus.

A glabrous low shrub, repeatedly branching and forming mats. *Stems* short or elongated, up to ca. 20 cm long, soon becoming defoliated and clothed with remains of leaf-bases and sometimes also leaf remains, especially midribs. *Leaves* closely set, alternate, almost rosulate at branch ends, erecto-patent, entire, 2–8 cm long, 1–8 mm wide, flattened, linear–oblanceolate, somewhat leathery to subcarnose, faintly midveined, glaucous green, sometimes with a red line along leaf-margins, acute or subacute with an apiculate tip; leaf-base dilated, half-clasping.

Peduncles terminal, solitary, erect, 8–22 cm long, 1–2 mm wide, striate, simple or sometimes with a lateral branch from a leaf axil below the middle, otherwise nude or with an occasional reduced bract. *Capitulum* radiate, with bright yellow florets. Involucre broadly campanulate, 1.2–1.5 cm in diam. *Involucral bracts* uniseriate, 8, narrowly oblong-ovate, 7–10 mm long, 2.5–4.0 mm wide, basally connate, coriaceous, 3–5-veined, acute. *Receptacle* somewhat convex especially when young, shallowly honey-combed, glabrous.

Ray-florets 5–8, female, fertile. *Tube* 3.5–5.5 mm long, cylindrical or somewhat flattened, sometimes slightly tapering upwards. *Lamina* oblong, 10–14 mm long, 5–6 mm broad, 4–6-veined, minutely 3–4-fid at the rather truncate apex. *Style* terete or somewhat flattened, 2-veined; base somewhat swollen, on a short and indistinct stylopodium; branches linear–narrow-

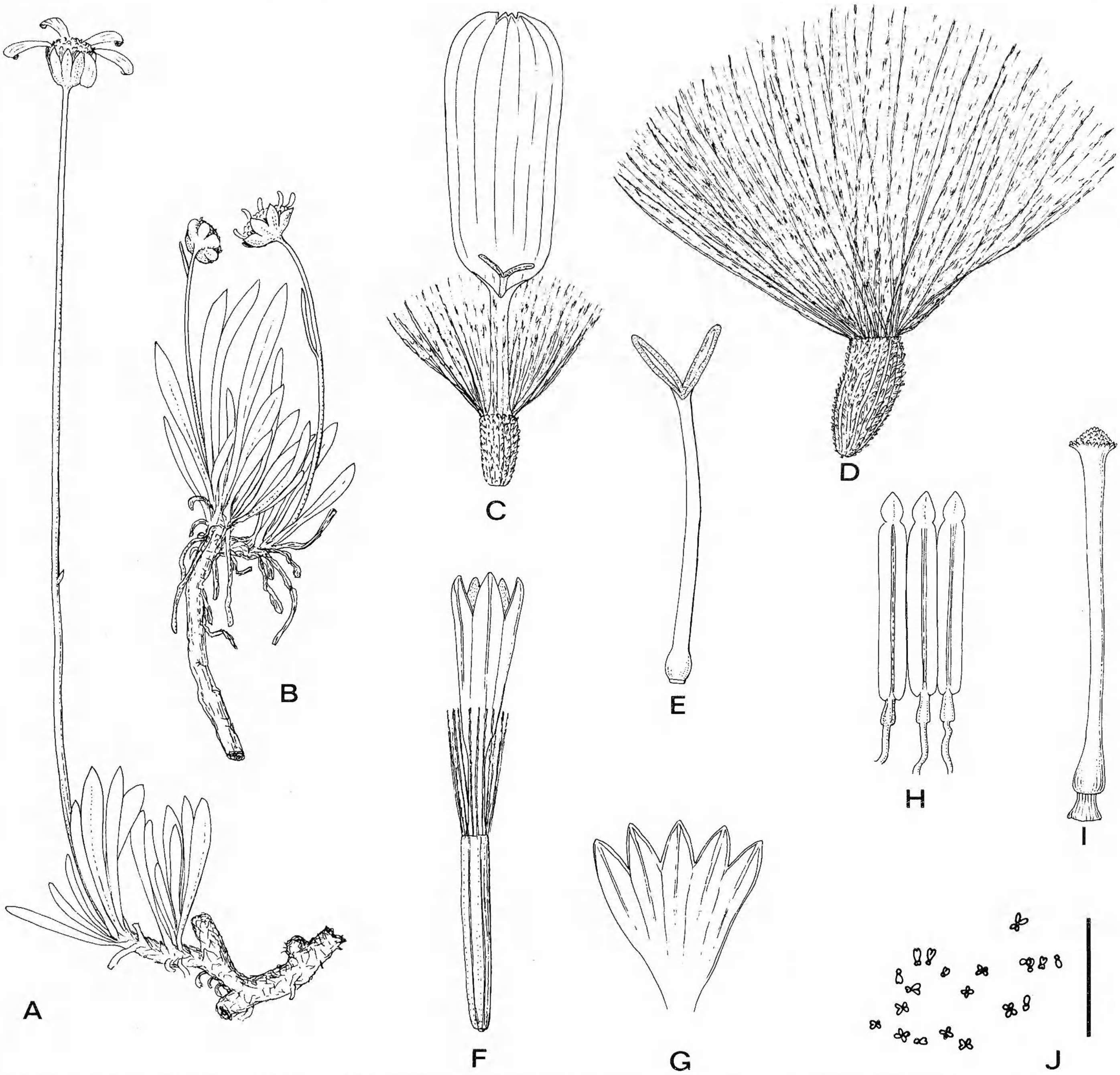

Fig. 1. *Othonna burttii* (Hilliard & Burtt 9389, holotype). — A, B: Habit, × 1/2. — C: Ray-floret, × 3. — D: Achene, × 3. — E: Style of ray-floret, × 6. — F: Disc-floret, × 6. — G: Corolla of disc-floret, laid out, × 6. — H: Stamens, × 12. — I: Style of disc-floret, × 12. — J: Chromosomes of root tip squash, 2n=20. The black line represents 10 μm. — Del. auct.

ly oblong, 1.0–1.5 mm long, with 2 discrete stigmatic lines and an obtuse or rounded glabrous tip. *Achene* oblong-obovate, often slightly curved and compressed, 5.5–6.5 mm long, 2.5–3.5 mm broad, with 12–15 close-lying low ribs (and achene wall with 12–15 corresponding veins), densely and shortly white-villous with duplex obtuse hairs, ca. 0.5 mm long, becoming mucilaginous when wet. Ovary wall crystals numerous, elongate, flattened, hexagonal in outline. *Pappus* bristles copious, pluriseriate, persistent, 4–7 mm long at anthesis, growing to 10–15 mm long in the fruiting stage, whitish or somewhat buff coloured, minutely barbellate.

Disc-florets ca. 50–100. *Corolla* 4.5–5.5 mm long, glabrous; tube cylindrical, 1.5–2.0 mm long; limb narrowly campanulate, 3–4 mm long, 5-lobed; lobes deltoid–ovate, 0.7–1.0 mm long, with lateral veins and a distinct median resin duct. *Anthers* 1.7–2.5 mm long incl. the ovate somewhat keeled apical appendage; anther base obtuse, ecaudate; endothecial tissue radial (i.e., with numerous longitudinal wall thickenings); filament collar somewhat swollen towards the base. *Style* sterile, terete, with swollen base on a distinct stylopodium, apically undivided and dilated to a conical papillate tip. *Ovary* terete, narrow, 2.5–4.5 mm long, 5-veined, glabrous. *Pappus* bristles subuniseriate, ca. 20–30, erect, 2.5–4.0 mm long, minutely barbellate.

Chromosome number. 2n=20.

Flowering period. Nov.–Dec.

Collections. Lesotho: Sehlabathebe National Park, near the Cape border, within 2 km N of Thule Beacon, ca. 2450 m, 1976, F. K. Hoener 1662 (E, NU, S). Sehlabathebe National Park, Lodge Compound, ca. 2400 m, 1977, F. K. Hoener 1900 (NU, S). *South Africa, Natal*: Underberg distr., upper Umzimouti Valley, ca. 2000 m, 1976, Hilliard & Burtt 9389 (NU, S).

Also recorded by B. L. Burtt from the Drakensberg Garden (Hilliard & Burtt, in litt., 1977) and from a remote area midway between Sani Pass and the Rhino near Garden Castle (Hilliard, in litt., 1979).

Habitat and phytogeography. The new species has a characteristic habit, forming mats on rock edges and cliff faces. It has been recorded from dolerite and sandstone rocks at altitudes above 2000 m in the Sani Pass area of the Drakensberg. The plants are said to be grazed avidly by eland (Hilliard, in litt., 1979). Phytogeographically *O. burttii* belongs to the very significant group of Drakensberg endemics (Nordenstam 1969 a, Hilliard 1978).

Cytology. The chromosome number, 2n=20, was counted on Feulgen-aceto-orcein squash preparations of root tips from two collections, viz. Hoener 1900 (grown from seeds) and Hilliard & Burtt 9389 (type collection, live specimens sent by Dr. O. M. Hilliard). The chromosomes are small, only about 1–2 μm long (Fig. 1 J), and did not permit a detailed karyotype analysis. Since the basic number in *Othonna* is invariably x=10 (Nordenstam 1967), the new species is a diploid like the majority of the species counted. Among the previously published numbers (Nordenstam 1966, 1967, 1969 b, 1971 a, b) there are 36 diploids, 9 tetraploids, 5 hexaploids and one octoploid.

Taxonomic position. The closest relative of *O. burttii* is undoubtedly *O. natalensis* Sch. Bip., the chromosome number of which is unknown. Harvey (1865) placed *O. natalensis* in the section *Scapigerae* Harv., but this is an unnatural assemblage of taxa. *O. burttii* does not fit into the section as defined by Harvey, and the sectional limits will be thoroughly revised in a forthcoming monograph of the whole genus (Nordenstam, in prep.).

O. natalensis is a species of lowland to montane grasslands and with a different habit from that of *O. burttii*. It has a short and thick subterranean caudex with distinct tufts of wool at the leaf-bases. The peduncles are usually, but not always, branched, and the leaves are larger, up to 30 cm long and 6 cm wide and provided with a very distinct midrib. In floral details the two species are fairly similar with differences of a mainly quantitative nature. For example, the achenes of *O. natalensis* are about twice as large as those of *O. burttii*, and the grown-out pappus is distinctly longer.

Phytochemistry. The chemistry of i.a. *O. burttii* and *O. natalensis* was investigated by Bohlmann & Knoll (1978) with special reference to the terpene derivatives. The genus is characterized by relatively strongly oxidized furanoeremophilanes. It is interesting to note that the two species contain different but related constituents. The chemical evidence thus supports the taxonomic decision to treat the two taxa as distinct though closely related species.

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Botanical literature

Fosberg, F. R. & Renvoize, S. A. 1980: *The Flora of Aldabra and neighbouring islands*. Kew Bulletin Additional Series VII. 358 pp., c. 500 line drawings (55 figures) and 2 maps. Her Majesty's Stationery Office. Price (paper) £15.

Information available to botanists interested in the island flora of the Indian Ocean is rather scanty. Several papers dealing with parts of the flora of a particular island or island group and a more comprehensive work, the *Flora of Mauritius and the Seychelles* (1877) by J. G. Baker, have appeared. Every new Flora of the area is thus to be greeted with acclaim.

The present work embraces the flora of the Aldabra Atoll, Assumption Island, the Cosmoledo Atoll and the Astove Atoll. These slightly elevated coral islands are situated 320–420 km NNW of the northern tip of Madagascar, and about 640–800 km east of the coast of Africa.

An introductory chapter gives an account of the geology, climate, animal life, vegetation types and botanical collections. It includes maps of the islands and a numerical survey of the flora. There is an interesting discussion on the claim of Braithwaite et al. that Aldabra has been completely submerged several times during its geological history. According to the authors the large number of endemics points to the need for a careful re-examination of this theory. In all the introductory chapter manages to convey much information in its nine pages. A glossary of botanical terms follows.

The main part of the Flora comprises descriptions of the 274 species and varieties of Angiosperms and Pteridophytes found in the area. There is also a very brief treatment of the Mosses. Among the Angiosperms 185 are indigenous 42 being endemic to the island group.

A positive feature of the Flora is that it is well supplied with keys. Every plant can be keyed out, first to family level and then to generic and species level. It is somewhat surprising that in this otherwise admirable Flora the families are arranged according to the Bentham and Hooker system (1862–83). The descriptions of families, genera and species are comprehensive and detailed. Owing to paucity of material description at species level has not been possible for a few of the taxa. There are also notes on flowering period, habitat and world distribution as well as domestic uses and other interesting details. Vernacular names are given for all species.

Most of the species described are illustrated, both habit and details of flowers and/or fruits generally being portrayed.

This work by Fosberg and Renvoize is a most welcome contribution to our knowledge of the complex and fascinating island flora of the Indian Ocean.

Susanna Riebe

Dimorphotheca venusta (T. Norl.) T. Norl. stat. nov. and additional notes on D. montana T. Norl. (Compositae)

TYCHO NORLINDH

Norlindh, T. 1980 12 05: Dimorphotheca venusta (T. Norl.) T. Norl. stat. nov. and additional notes on D. montana T. Norl. (Compositae). *Bot. Notiser 133:* 559–563. Stockholm. ISSN 0006-8195.

Dimorphotheca montana T. Norl. var. *venusta* T. Norl. has now to be considered a species of its own, *D. venusta* (T. Norl.) T. Norl. A supplementary description is given. Like *D. montana* it is a mesophyte growing in the highest levels of the Cape mountains. The variation in flower colour in these two species and the morphological differences between them, including palynological, are discussed. A key to these taxa is given.

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In a previous paper (Norlindh 1957) two new varieties of *Dimorphotheca montana* were described, viz. var. *amoena* and var. *venusta*. At that time I had at my disposal only a scanty and fairly incomplete material of these taxa. Since then I have been able to study numerous specimens of *D. montana* var. *montana* in their natural habitat, and besides several complete herbarium specimens as well as cultivated specimens of the other two taxa.

Key to the taxa

1. Occurring as single scattered plants; ligulae of ray florets yellow, at least on upper surface; ray achenes 3-winged, wings with entire margins .... 1. *D. montana*
– Plants rooting at nodes and forming mat-like clones; ligulae of ray florets non-yellow 2
2. Achenes 3-angular, angles crenate or cristate or irregularly incised ... 2a. *D. venusta* var. *venusta*
– Achenes 3-angular or 3-winged, angles as well as the rigid wings entire or subentire .... 2b. *D. venusta* var. *amoena*

Further distinguishing characters are exhibited by the pollen morphological differences between *D. montana* and *D. venusta*. According to Praglowski & Grafström (1980 pp. 178, 179) these differences are considerable, viz. the size of pollen grains (*D. montana* 31 μm, *D. venusta* 37 μm); the shape and the breadth of lalongate ora (narrow and distinctly constricted in *D. montana,* broad, often rhomboidal, not constricted in *D. venusta*); and the character of the caveae (more elevated in *D. venusta* than in *D. montana*).

1. **D. montana** T. Norl.

Norlindh (1943 p. 73, 1957 p. 145); Praglowski & Grafström (1980 pp. 178, 187).

Holotype. Andreae n. 1193, Cape Province, Laingsburg Div., Seven Weeks Poort Mt., open places among rocks, frequent, 2300 m, 1928 (PR).

Icon. Norlindh (1943 p. 67, Fig. 4 j, k; hoc op. Figs 1 A, B, 2).

When describing *D. montana* in 1943 I had in fact only seen one single specimen with fully developed ray and disc achenes, viz. the above-mentioned type from an altitude of 2300 m in the Seven Weeks Poort Mt. The ray achenes of this plant are 3-winged with entire wings and are similar to those of certain *Osteospermum* species.

First in 1963 after the Kirstenbosch Golden Jubilee celebrations I had an opportunity of making a close investigation of *D. montana* var. *montana*. This occurred when I took part in a private collecting trip to the Karoo mountain Witteberg in the Laingsburg division together with Miss Elsie Esterhuysen and Dr Bertil Nordenstam. On the upper part of the steep southern rocky slopes and on the summit of this mountain this plant grew frequently as single scattered specimens. The open flower heads appeared to be exclusively golden yellow, because the exposed upper surface of the ligules of the ray florets have that colour. However, the flower heads when closed, expose the lower surface of the ligules which usually is not merely yellow but has a more or less strong admixture of a coppery colour. It is notable that the yellow colour of the ray florets does not remain when dried or at least it is then not distinctly visible. Obviously there occurs some chemical change in the cell-sap of the ligules, usually turning whitish above and blue or blue-lilac striped on the reverse side. This is known from my own experience when I collected and pressed a rich material of this species on the Witteberg. The original yellow colour of the ray florets of *D. montana* sens. str. is thus impossible or very difficult to judge, when it is the matter of herbarium specimens. Those determination keys of the genus *Dimorphotheca* which primarily are based on flower colour are in fact only applicable when it is the matter of fresh material. Fortunately there is a statement of the flower colour on the herbarium label of most collections of *D. montana*.

Distribution. The localities quoted below are selected to illustrate the main distribution.

Laingsburg: Seven Weeks Poort Mt., 2300 m, see the above quotation of the holotype. Top of Witteberg (Whitehill), 1500 m, 1926, Compton n. 3161 (BM, K). Witteberg on the summit, in rock crevices, at almost 1800 m, 4.XI. 1963, Norlindh n. 5925 (C, LD, S). Eod. loco, Esterhuysen et Norlindh n. 5924 (S).

Worcester: Brandwacht Pk, amongst rocks near summit, 1800 m, 1944, Esterhuysen n. 10994 (BOL).

Oudtshoorn: In summo monte saxoso Zwartebergen prope Zwartberg Pass, 1800 m, 1905, H. Bolus n. 12042 (BOL, K).

Uniondale: Mannetjieberg, S. slopes, 1500 m, 1941, Esterhuysen n. 6483 (BOL). Hoopsberg, S. slopes, 1500–1800 m, 1941, Esterhuysen n. 6566 (BOL).

2a. **D. venusta** (T. Norl.) T. Norl. stat. nov. var. **venusta**

D. montana T. Norl. var. *venusta* T. Norl. (Norlindh 1957 p. 147); Ahlstrand (1979 pp. 1, 6, 8, 11, 12, 22, 27, Figs. 1 J, 12, 13); Praglowski & Grafström (1980 pp. 178, 179, 187).

Type. Esterhuysen n. 11340, Cape Province, Paarl Div., Wemmershoek Pk, ledges in gully on W. side, 1200–1500 m, 31.XII. 1944 (hol. BOL; iso. LD, S).

Icon. Norlindh (1957 p. 143, Fig. 1, p. 146, Fig. 2 c, d, p. 149, Fig. 3 (map); present paper Fig. 1 C–E).

Perennial herb with weak trailing stems, spreading from the root-stock and forming mats. Stem decumbent or prostrate (or upright in the youngest specimens), about 1 m long, 2–4 mm thick, ± lignified and sparsely rooting at nodes, exceedingly branched in old specimens. Flowering branches erect or ascendent, 10–35 cm high, densely foliate at base, ending in a naked, glandular-puberulous, up to 20 cm long peduncle, bearing a single head. Leaves alternate, glandular-puberulous or subglabrous, obovate–spathulate–oblanceolate–linear, sessile or tapering into a petiole, including petiole up to 7 cm long and 2 cm broad, with margins coarsely dentate to scattered denticulate or entire; midrib prominent beneath, lateral nerves inconspicuous; basal parts of stem provided with hard, tightly-packed remnants of leaf sheaths, from which the lower part of the tough midrib often stands out as a thick, irregularly curved bristle-shaped body. Involucre broadly campanulate, c. 10–15 mm high, bracts uniseriate, or nearly so, lanceolate-linear, acuminate, glandular-puberulous on back, margins whitish-scarious and ciliate. Ray florets equal in number to the involucral bracts; ligule pink or purple above, or rarely white, usually with the same colour beneath, or besides violet or metallic, exceeding the involucre 2(–3) times; disc florets yellow. Ray achenes glabrous, triangular (in immature stage seemingly trialate), with angles irregularly crenate or incised, tuberculate or cristate, 6–10 mm long. Disc achenes glabrous, applanate, elliptic or obovate-elliptic, margins semipellucid, with a slightly thickened rim, usually somewhat emarginate at the tip, 8–12 mm long and 6–8 mm broad.

Distribution. See Norlindh (1957 p. 147, p. 149 Fig. 3 (map)). Additional distributional statements:

Worcester: Kloof between Witteberg and Molenaarsberg, 600–900 m, 16.I. 1955, Esterhuysen n. 24149 (BOL, LD). Buffelshoek Pk. Shallow ledges, S slope, 1800 m, 1958, Esterhuysen n. 1282 (LD, cult.).

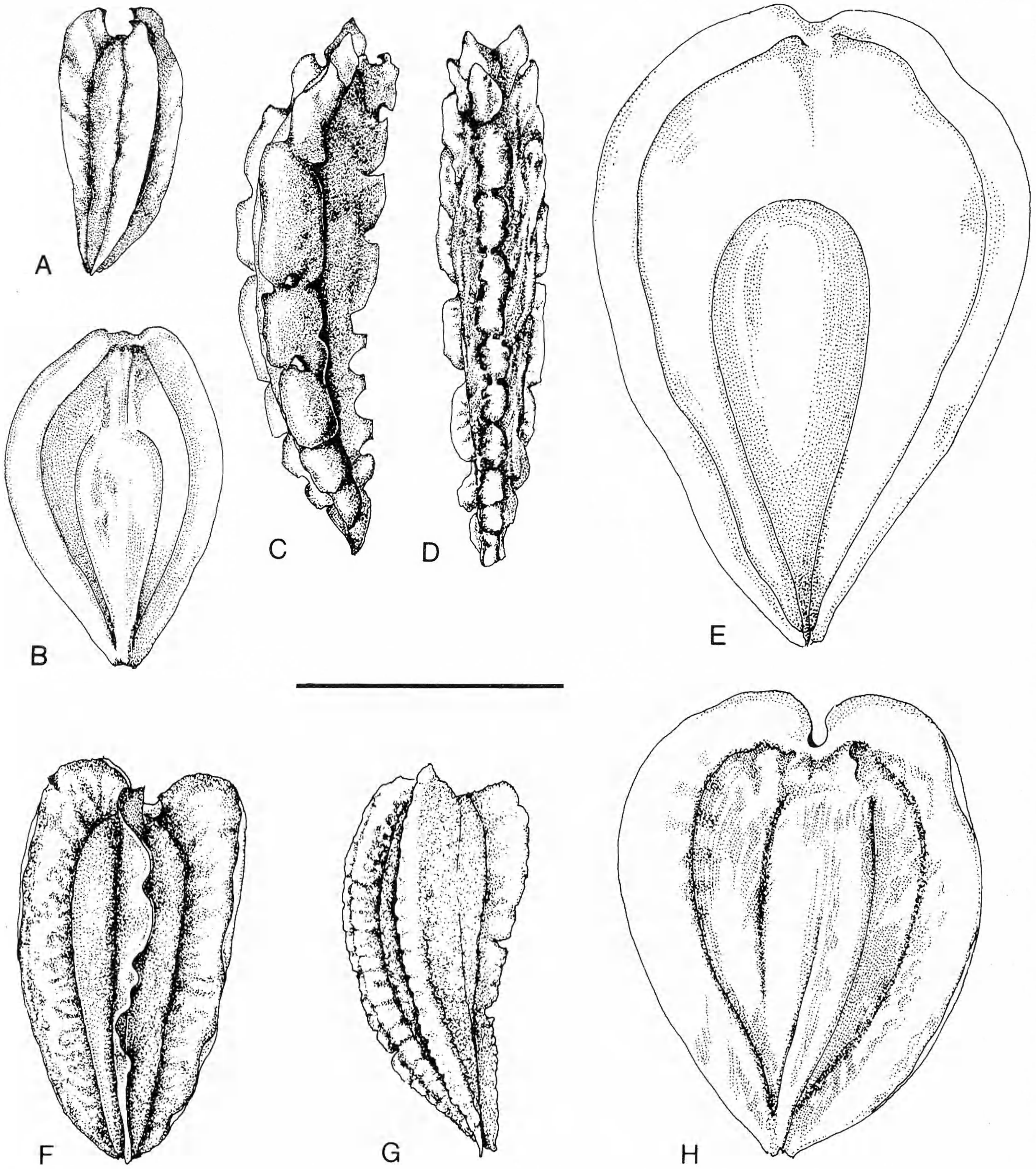

Fig. 1. Achenes of *Dimorphotheca*. A, B: *D. montana*; A ray, B disc achene. — C–E: *D. venusta* var. *venusta*; C radial, D ventral side of ray achene, E disc achene. — F–H: *D. venusta* var. *amoena*; F normal, G somewhat deviating ray achene, H disc achene. — A, B Norlindh n. 5925; C–E Esterhuysen n. 24149; F–H Esterhuysen n. 27424. — Scale = 5 mm. Del. I. Wikander.

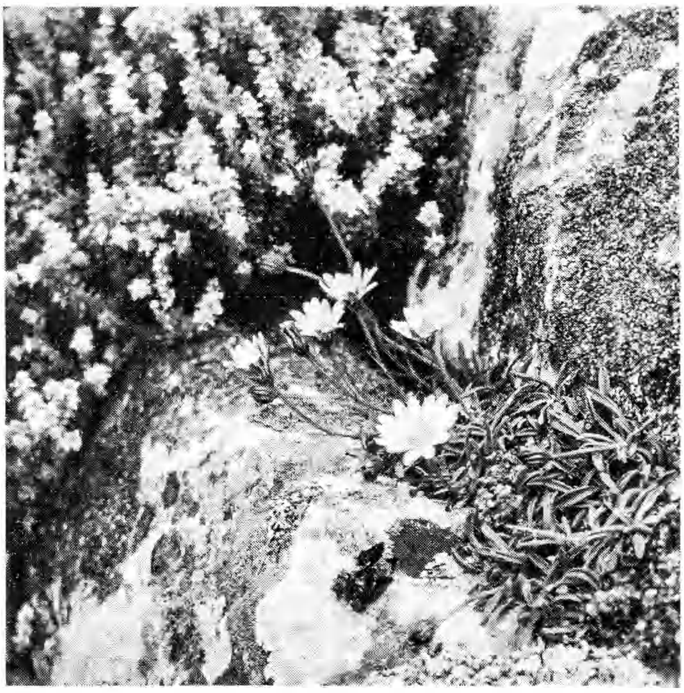

Fig. 2. *Dimorphotheca montana*. In rock crevices on the summit of Witteberg, Laingsburg district, Cape province, at almost 1800 m s. m. Rays golden yellow above and ± coppery beneath. Norlindh n. 5925. In upper left corner *Penaea mucronata* L. — Photo: T. Norlindh, Nov. 4th, 1963.

Worcester-Paarl: Steep on kloof between Witteberg and Molenaarsberg, off Du Toits Kloof, 1200 m, 27.XII. 1960, Esterhuysen n. 28694 (BOL, LD, S).

Dimorphotheca venusta is a perennial herb, decumbent with stems rooting at nodes and widely spreading from root-stock, forming ± circular prostrate mats with a diameter of about 1 m. The flowering branches are erect or ascendent, 10–35 cm high and unbranched.

Baagøe (1978) points out that it has a ligule epidermis similar to that in *Osteospermum ecklonis*.

Baagøe has made a regrettable mistake in the following sentences: "*D. montana* var. *venusta* and *O. ecklonis* are further similar in habit and achenes as admitted by Norlindh (1957). The only character to separate the two taxa seems to be the fertility conditions in their heads, and probably *D. montana* var. *venusta* and *O. ecklonis* are synonymous". Owing to this assertion I feel myself obliged to make the following corrections. *Osteospermum ecklonis* has not at all been mentioned in my paper (Norlindh 1957) and thus I have not there given my opinion on its relation to *Dimorphotheca venusta* (syn. *D. montana* var. *venusta*). As to the habit *O. ecklonis* is widely different from *D. venusta*. The former is a shrub or undershrub, normally erect and about 1 m high, while the latter is a herb with weak, trailing stems and branches, usually spreading over rocks. Their ray achenes are very different in shape; as to *O. ecklonis* see Norlindh (1943 p. 239 Fig. 23 c), as to *D. venusta* see Norlindh (1957 p. 146 Fig. 2 c and present paper Fig. 1). Further they have different areas of distribution. *O. ecklonis* is contrary to *D. venusta* a lowland species occurring in the river valleys of the Humansdorp and Uitenhage districts in the south-eastern Cape Province. The disc florets of *O. ecklonis* are always ♀-sterile. The flowers of this species are very beautiful as the name '*venusta*' indicates, the open head being up to 8 cm in diam. The rays are pink or bright purple above and metallic beneath. However, a rare white-flowered form is also known, probably a loss mutation.

2b. **D. venusta** (T. Norl.) T. Norl. var. **amoena** (T. Norl.) T. Norl. comb. nov.

D. montana T. Norl. var. *amoena* T. Norl. (Norlindh 1957 p. 145); Ahlstrand (1979 pp. 1, 6, 8, 11, 27, Figs. 1 G, I, 11).

Type. Esterhuysen n. 22210, Cape Province, Worcester Div., Hex River Mts. Fonteintjiesberg–Sentinel. Ledges, usually on S side, 1700 m, 1.XI. 1953 (hol. BOL; iso. LD, S).

Icon. Norlindh (1957 p. 146 Fig. 2 a, b, p. 149 Fig. 3 (map); present paper Fig. 1 F–H).

In *D. venusta* var. *amoena* the angles or wings of the ray achenes are entire. Only very occasionally they may have one or two incisions, perhaps caused by outer agencies. The wings are often more or less wrinkled or undulated. As to other characters var. *amoena* agrees quite well with var. *venusta*. They grow under similar ecological conditions in the highest levels of the Cape mountains. A few specimens with intermediate achene forms suggests that these taxa are capable of forming hybrids with each other.

Distribution. See Norlindh (1957 pp. 145, 146, p. 149 Fig. 3 (map)). Additional distributional statements:

Worcester: Hex River Mts. Ledges on S. side of Sentinel and Buffelshoek Peaks, 1700–2000 m, 16.XII. 1957, Esterhuysen n. 27424 (S, LD, also cult.). Hex

River Mts, Milner Pk. Ledges and steep rocky slopes, S. aspect ± 1800 m, 2.I. 1959, Esterhuysen s.n. (BOL, LD, only seed). Sonklip, few miles N. of Matroosberg, 2000 m, 16.I. 1959, Esterhuysen, s.n. (BOL, S, only seed).

Prince Albert: Swartberg Pass, 1500 m, 25.I. 1941, Esterhuysen n. 4550 (BOL).

Acknowledgements. I am very grateful to Dr J. Praglowski at the Palynological Laboratory of the Swedish Museum of Natural History, Stockholm, for his contribution to the Palynological section of this paper. I also wish to thank Mrs Ingrid Wikander, Stockholm, for drawings of achenes of the species. Further I beg to tender my sincerest thanks to Miss Elsie Esterhuysen of the Bolus Herbarium, Cape Town, who has sent me valuable material.

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Praglowski, J. & Grafström, E. 1980. The pollen morphology of the tribe Calenduleae with reference to taxonomy. *Bot. Notiser 133:* 177–188.

Botanical literature

Köhlein, F. 1980: *Saxifragen und andere Steinbrechgewächse.* 289 S., 100 Farbfotos, 50 Zeichnungen. Verlag Eugen Ulmer, Stuttgart. ISBN 3-8001-6107-9. Preis DM 88:–.

Es handelt sich hier in erster Linie um ein Gartenbuch nicht um eine reine botanische Monographie. Damit ist schon angedeutet, dass ein Schwerpunkt dieses Buches in der gärtnerischen Kultur und Verwendung dieser Pflanzengattung liegt. Die Gattung Saxifraga ist mit ihrer grossen Anzahl Arten, Naturhybriden und Gartensorten sehr umfangreich und schwer überschaubar, dazu ist sie auf Grund ihrer grossen geographischen Verbreitung sehr unterschiedlich in ihren Lebensansprüchen. Dieses bringt naturgemäss Probleme für den Gärtner und Liebhaber in der Pflege und Kultur dieser Pflanzen mit sich. Hier ist nun an Hand vieler Beispiele aufgezeigt wie man unter Beachtung einer Reihe von Gesichtspunkten, der Auswahl geeigneter Arten, Ausnutzung vorhandener Geländeverhältnisse und Verwendung von Hilfsmitteln eine erfolgreiche Kultur betreiben kann. Eingehend wird neben der Beschreibung des zu verwendenden Steinmaterials auch das Thema der gegenwärtig so populären Minipflanzungen in Schalen, Steintrögen oder Steintischen behandelt. Hier gibt es eine Vielzahl von Möglichkeiten, die Beispiele oft mit Zeichnungen vervollständigt, können jedem Liebhaber Anregung und Inspiration geben. Da der Steingartenfreund gemeinhin nicht nur Saxifragen in seiner Anlage pflegt sondern sie mit anderen Alpinen kombiniert ist auch die Wahl der Nachbar- oder Begleitpflanzen von einiger Bedeutung. Hier hält der Verfasser eine reichhaltige Auswahl bereit, die sowohl dem Laien als auch dem Fachmann voll zufrieden stellen wird.

Neben einer kurzen Übersicht über Gartenhistorie und Züchtung befasst der andere Hauptteil des Buches sich mit der Beschreibung der Arten und Hybriden. Bei der in 15 Sektionen eingeteilten Gattung sind die Euaizoonia, Porophyllum und Dactyloides ihrer zahlreichen Gartenhybriden und ihrer Attraktivität wegen für den Liebhaber und Gärtner am bedeutungsvollsten. Es ist hier eine Fülle an Material zusammengetragen, und der interessierte Leser findet hier Auskunft über die heimatlichen Standortverhältnisse, die Kulturansprüche, bei Hybriden über Kreuzungsverhältnisse und dergleichen mehr. Eine grosse Anzahl ausgezeichneter Farbaufnahmen veranschaulicht die Vielgestaltigheit und Schönheit dieser beliebten Pflanzen. Zahlreiche Zeichnungen verdeutlichen technische Details im Aufbau der Anlagen oder die morphologischen Unterschiede in den einzelnen Sektionen. Zur Erleichterung bei der Auswahl geeigneter Arten und Sorten geben die Tabellen und Zusammenstellungen über Kulturansprüche, Wuchseigenschaften, Blütezeit usw. wertvolle Hilfen. Einige andere Gattungen mit ihren Arten aus der Saxifraga-Familie werden ebenfalls näher beschrieben. Hier handelt es sich um Pflanzen wie Astilben, Bergenien u. a. die für eine Kultur im Steingarten in Frage kommen können. Ein Bezugsquellennachweis gibt abschliessend Auskunft über Firmen die Pflanzen und Samen liefern können, was der Liebhaber sicher dankbar registrieren wird.

Karl Stünkel

Kashmiria (Scrophulariaceae, Veroniceae), a new name for Falconeria Hook. fil. from the western Himalayas

HONG DE-YUAN

Hong, D. 1980 12 15: Kashmiria (Scrophulariaceae, Veroniceae), a new name for Falconeria Hook. fil. from the western Himalayas. *Bot. Notiser 133:* 565–567. Stockholm. ISSN 0006-8195.

A new name, *Kashmiria* Hong, is proposed for the monotypic genus *Falconeria* Hook. fil. (non Royle) and a new combination, *K. himalaica* (Hook. fil.) Hong, is correspondingly made. A description is given and essential details are illustrated. Differences between *Kashmiria, Wulfenia* Jacq. and *Wulfeniopsis* Hong are discussed. *Wulfenia nepalensis* Yamazaki is transferred to *Wulfeniopsis: W. nepalensis* (Yamazaki) Hong.

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Falconeria Hook. fil. (1883) is a later homonym of *Falconeria* Royle (1839), a genus in Euphorbiaceae. Pennell (1943) transferred the single species, *Falconeria himalaica* Hook. fil., to *Wulfenia* Jacq., an unnatural genus, in its old circumscription distributed in Europe, Anatolia, the Himalayas and adjacent areas.

The genus is said by Hooker to be ''apparently near *Wulfenia,* but differing in the 2-lipped corolla''. He seems only to have compared his new genus with *Wulfenia amherstiana* Benth. (from W Himalayas and S Asia), as *Wulfenia* species from Europe and Anatolia also have a 2-lipped corolla. When Pennell (1943) included the plant in Wulfenia he added no new information on morphology.

From good herbarium material of *Falconeria himalaica* it can be seen that Hooker's description is incomplete (he had no fruiting material) and in some respects not wholly correct. Thus the stigma is 2-parted with spreading lobes, not capitellate. A number of differences between *Falconeria* and *Wulfenia* in fruit, seed and stigma characters were found, so that *Falconeria* merits generic status. A new name, *Kashmiria,* is proposed for the genus.

Kashmiria Hong, nomen novum

Falconeria Hook. fil. (1883 t. 1483; 1884 p. 319), non Royle (1839).
Wulfenia auct. non Jacq.: Pennell (1943 p. 67).

Perennial herb. Leaves all radical, petiolate and crenate. *Inflorescence* a terminal raceme. *Flowers* bracteate, ebracteolate. *Calyx* 5-partite; lobes subequal, narrowly oblong, 3-ribbed, sparsely ciliate. *Corolla* 2-labiate; tube almost as long as limb; upper lip shorter than lower lip, 2-lobed; lower lip spreading, 3-lobed, sparsely hirsute at the base, lobes shallowly 2-lobed (Fig. 1 A, B). *Stamens* 2, included; inserted immediately below the juncture of the lips; anthers 2celled, cells diverging, united at the top. *Stigma* relatively large, 2-parted, lobes spreading to form a flat receptive area (Fig. 1 C). Fruit ellipsoid, dry, with a very thin soft wall, berry-like and indehiscent (Fig. 1 D). Seeds hemispherical; seed coat alveolate (Fig. 2).

Kashmiria himalaica (Hook. fil.) Hong, comb. nov.

Falconeria himalaica Hook. fil. (1883 t. 1438). *Wulfenia himalaica* (Hook. fil.) Pennell (1943 p. 67).

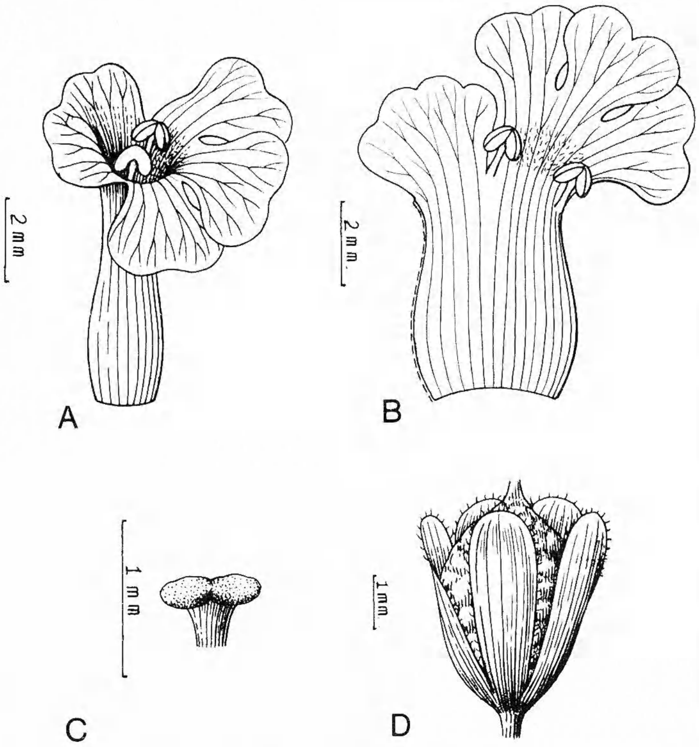

Fig. 1. *Kashmiria himalaica*. — A: Corolla. — B: The same, but opened up. — C: Stigma. — D: Fruit with persistent calyx.

Herbarium material seen. Kashmir: Kumaon, Madhari, 8000 ft., R. Strachey and J. E. Winterbottom 4 (BM); Kumaon, Kalamuni Pars, 3000 m, T. A. Rao 6701 (K).

The author (Hong 1980) has found important gross morphological and pollen differences between *Wulfenia amherstiana* Benth. and the *Wulfenia* species from Europe and Anatolia. A new genus, *Wulfeniopsis* Hong, was proposed for *W. amherstiana*. A second species from Nepal has to be added to the genus (see Appendix).

The genera *Wulfenia* (Europe, Anatolia), *Wulfeniopsis* (Himalayas, S Asia) and *Kashmiria* (Kashmir) all share two prominent characters unique in the tribe Veroniceae, i.e. stamens inserted in the throat of the corolla and leaves which are all radical.

Kashmiria is a monotypic genus apparently close to *Wulfenia*. It is distinguished from *Wulfenia* and *Wulfeniopsis* on the 2-lobed spreading stigma and the berry-like indehiscent fruit. It is also distinguished from *Wulfenia* on alveolate seeds and shallowly 2-lobed corolla lobes and from *Wulfeniopsis* on the 2-lipped, 5-lobed corolla.

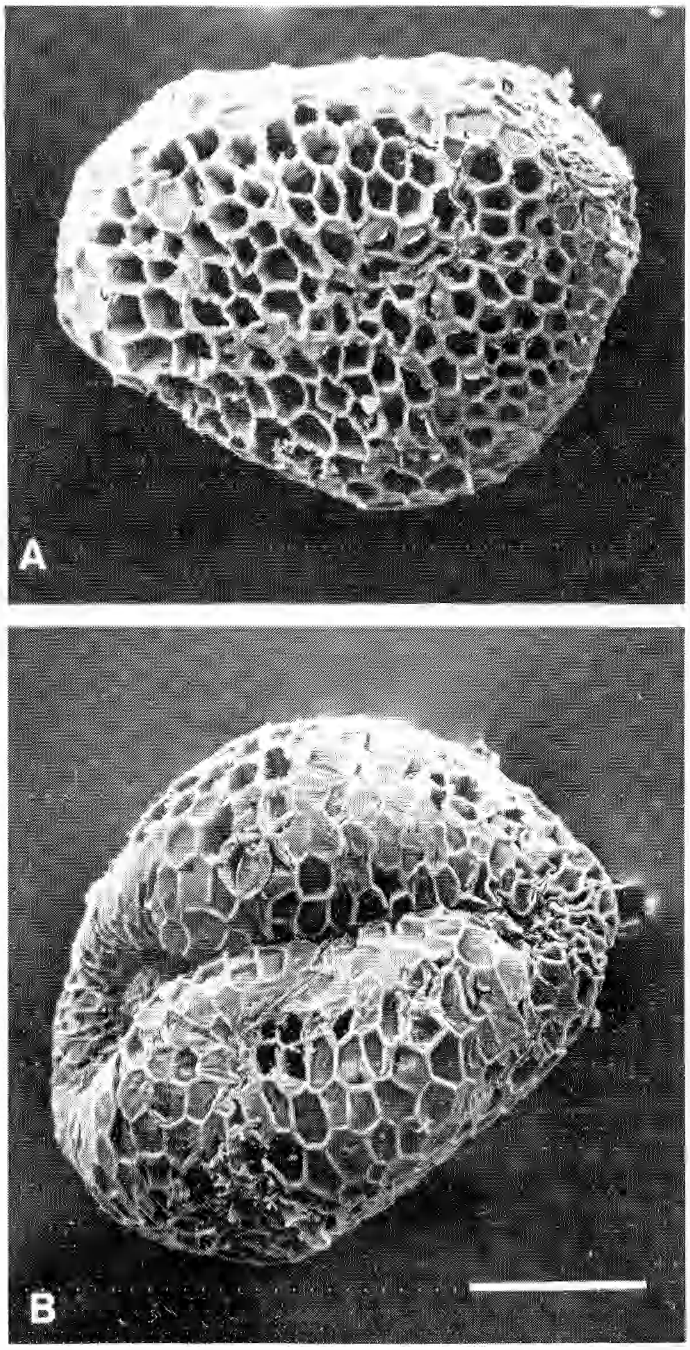

Fig. 2. Scanning electron micrographs of a seed of *Kashmiria himalaica*. — A: Dorsal face. B: Ventral face. — Scale = 0.2 mm.

Appendix

Wulfeniopsis nepalensis (Yamazaki) Hong, comb. nov.

Wulfenia nepalensis Yamazaki (1970 pp. 177, 178, Figs. 23, 24, Pl. IX).

Acknowledgements. I am grateful to Professor Hans Runemark for help with the manuscript, to Dr Ove Almborn for help in borrowing the material and to Miss Wang Jin-feng for drawing Fig. 1. I also thank Kew Gardens and British Museum for lending me the valuable material.

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Botanical literature

Hui-Lin Li 1979: *Nan-fang tsáo-mu chuang. A Fourth Century Flora of Southeast Asia.* The Chinese University Press, Hong Kong. ISBN 962-201-163-2. X + 168 pp., 39 figs. Price US $18.75.

The book is the first English translation of Chi Han's *Nan-fang tsáo-mu chuang* with an introduction and commentary. The Flora, which appeared in A.D. 304, deals with some 80 species and their products in the area covering approximately the present Kwangtung and Kwangsi provinces in southern China and the central and northern parts of Vietnam. As a poet, the author gives us refined descriptions of the species and of their uses and mode of cultivation, as well as of customs of the local inhabitants and interesting stories about the plants. Many of the species in the work were recorded for the first time in Chinese literature. Chi Han's work, that has been well known for many centuries in China for its interesting accounts and elegant style, is an important early treatise on species of southeast Asia, and is reputed to be the oldest work in the world on subtropical and tropical botany. In modern times its significance has also been noted by many western writers. Goodrich, for instance, says in 1959 that "this book is a mine of information for historians of cultivated plants".

As many botanists know China has made great use of plants from ancient times (particularly for medical purposes). China has a great deal of ancient botanical literature, but unfortunately very little of it is available to western botanists and works such as Li's present one are badly needed. The task, however, is a challenging one because of a twofold difficulty: one involving identification of species occurring in literature and the other involving familiarity with both classical Chinese and a western language.

In the first part of the introduction Li briefly surveys the history of the unification of the area with which Chi Han's work deals with China proper. He also surveys the history of the communication of culture and trade over the area, between China and India, Western Asia, Egypt and even Europe, during the period from the end of the 3rd century B.C. to the beginning of the 4th century A.D. We are thus given the historical and geographical background of Chi Han's work. In the second part he gives us a brief biography of Chi Han and mentions his botanical interest and his essays on plants, many of them poetical. The third part is ethnobotanical. He divides the species discussed by Chi Han into 12 categories according to their use by the so-called Yüan people. In addition, he briefly reviews the opinions of modern botanists concerning the regions of origin of cultivated plants in the world. As in an earlier work he maintains that De Candolle's and Vavilov's single region "China" or "southeast Asia" should be divided into four. The area treated by Chi Han lies in two of them, i.e. southern China and southern Asia. Finally, in a brief review of the literature on Chi Han's Flora, Li includes the opinions of western and Chinese authors on its authenticity.

The translation and commentary comprise the major part of the book. Apart from a complete translation of Chi Han's Flora, the botanical identity of all species and products is given and also a commentary on their botanical, bibliographical, historical and ethnological or ethnobotanical significance. While most of Li's identifications of species follow earlier writers some are new and, what is more, several previous misidentifications are pointed out and corrected on the basis of geographical distribution, usage, etc. Although I am not able to check them at the time of writing it seems to me that most of the changes are reasonable.

Thirty-nine figures from a work from the 11th century are included in this book. We find commentaries on customs, religions, superstitions, interesting events connected with some of the plants and, of course, botanical information not only in Chi Han's original text, but also in Li's introduction and commentary. Therefore this book, though botanical literature, is readable, not dreary.

Hong De-yuan

Lichens of western North America with disjunctions in Macaronesia and West Mediterranean region

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Kärnefelt, I. 1980 12 15: Lichens of western North America with disjunctions in Macaronesia and West Mediterranean region. *Bot. Notiser 133:* 569–577. Stockholm. ISSN 0006-8195.

Six unrelated lichens, *Alectoria imshaugii* Brodo & D. Hawksw., *Cetraria merrillii* Du Rietz, *Dimelaena radiata* (Tuck.) Hale & W. Culb., *Parmelia pustulosa* Essl., *Parmelia subolivacea* Nyl. and *Thelomma mammosum* (Hepp) Massal. have their distributional centre in temperate to subtropical W North America. Five were already known from disjunct ranges in Macaronesia, NW Africa, Portugal and Spain. *Cetraria merrillii* recently discovered in the central highlands of Spain, is here included in the same group. Possible modern and historical causes of the discontinuous ranges are discussed. Distribution maps are included.

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A W North American lichen, *Alectoria imshaugii* Brodo & D. Hawksw., has recently been found locally abundant in the Canary Islands (Østhagen & Krog 1979). Four other lichens were earlier known to have the same type of discontinouous distribution, viz. *Dimelaena radiata* (Tuck.) Hale & W. Culb. (Llimona & Werner 1975, Sheard 1974), *Parmelia pustulosa* Essl. (Esslinger 1977), *Parmelia subolivacea* Nyl. (Esslinger 1977) and *Thelomma mammosum* (Hepp) Massal. (Tibell 1976). *D. radiata* and *T. mammosum* are known from Morocco, Portugal and Spain apart from the discontinuous range in Macaronesia.

Last autumn a specimen of an unknown lichen from the central highlands of Spain was sent to me. It proved to be *Cetraria merrillii* Du Rietz, previously only known from coniferous habitats in W North America (Esslinger 1973), making it the sixth species in this strange discontinuous group. The Eurasian disjunct ranges occur in Mediterranean or semi-arid types of climate and vegetation. In the W North American distributional centre *D. radiata* and *T. mammosum* partly occur in lowland localities in California characterized by a Mediterranean climate. *P. pustulosa* occurs in semi-arid inland localities in Utah and Colorado, whereas *A. imshaugii, C. merrillii* and *P. subolivacea* also seem to be more abundant in semi-arid regions rather than humid ones. However, in addition all three species occur at lower altitudes in California with a warmer and drier climate.

There are also a few bryophytes known with a similar W North American-Macaronesian-Mediterranean distribution (see Irmscher 1929, Størmer 1959). However, there are only very few angiosperm species known with a similar disjunct distribution (Raven 1971, Raven & Axelrod 1978). In angiosperm genera there are a few more examples of relationship between the Californian and Mediterranean floras. Otherwise there are floristic relationships between families in the regions with a Mediterranean climate (Axelrod 1975, Raven 1971, Raven & Axelrod 1978).

Material and methods

I have examined all collections of *C. merrillii* in CANL, FH, H, LAM, LD, MIN and US. The Spanish specimen was examined and compared with numerous North American collections for both chemical content and anatomical structure with TLC and light microscopy.

Alectoria imshaugii Brodo & D. Hawksw.

Distribution. A. imshaugii appears to have a distributional centre in the mountain regions of S Alberta, SE British Columbia, NW Montana, N Idaho and E Washington with an extension over the mountain regions of Oregon to NE California. Further there is an isolated locality in the Queen Charlotte Islands which according to Brodo & Hawksworth (1977) is somewhat doubtful (Fig. 1 A). Brodo & Hawksworth (1977) also reported a specimen from the Venezuelan Andes. This has now been re-examined together with additional Venezuelan material and is claimed not to be identical with *A. imshaugii* (Østhagen & Krog 1979).

In the Canary Islands *A. imshaugii* is reported from Gomera and Hierro (Østhagen & Krog 1979).

Habitat and dispersal. A. imshaugii grows primarily on conifers or on lignum in mountainous regions from 750–1750 m or near sea level at 2–85 m. It has been found on *Pinus contorta, P. ponderosa, Pseudotsuga menziesii*, etc. The species seems to prefer open coniferous stands. Secondarily it has been found growing on rocks.

In the Canary Islands *A. imshaugii* was found in laurel forest where mists are prevalent at 1100–1350 m on *Erica* spp., *Laurus* spp. and *Myrica faya* (Østhagen & Krog 1979). Here too, the species seemed to prefer open and humid sites.

The most important mode of propagation is probably dispersal by means of small isidiform spinules. In addition pseudocyphellae sometimes becomes sparsely sorediate which may be a potential mode of vegetative propagation. Apothecia are rare and no mature asci or ascospores have been seen. Sexual reproduction is probably very limited. Pycnidia are not known.

Cetraria merrillii Du Rietz

C. merrillii has long been poorly known mainly because of confusion with *Cornicularia californica* (Tuck.) Du Rietz (see Du Rietz 1926, Howe Jr 1911). The taxonomic position and affinity of these units is to be discussed in a coming paper (Kärnefelt in prep.).

Distribution. C. merrillii is distributed from the mountain regions of SW Alberta, NW Montana and Idaho over S British Columbia and Washington towards the Pacific coast which appears to be a distributional centre. From here *C. merrillii* extends southwards over the coastal mountain ranges in Oregon and California down to the Mexican border (Fig. 1 B).

In the Mediterranean region *C. merrillii* is only known from one locality in the central highlands of Spain.

Habitat and dispersal. C. merrillii grows mainly on twigs and branches of conifers and shrubs or on lignum in subalpine areas or in open forests. It has been found on various conifers, e.g. *Larix lyallii, Pinus albicaulis, P. contorta, P. ponderosa, P. cuolteri, P. lambertiana, Pseudotsuga menziesii* and *Tsuga mertensiana* at 150–2200 m. It has also been found on twigs of *Arctostaphylos myrtifolia* and *A. patula*.

In Spain *C. merrillii* has been found on twigs of *Cistus ladanifer* at c. 1050 m.

No surface structures for vegetative dispersal such as isidia, spinules or soralia are present. However, apothecia are usually abundant and sexual reproduction and dispersal by ascospores is presumably the most important mode of propagation. Pycnidia are occasionally present on the margins.

Selected specimens. U.S.A. California. Amador Co., Lancha Plana, 1895 Hansen 1016 (FH, MIN). Alameda Co., Oakland Hills, 1930 Herre 1800 (LAM). Contra Costa Co., Las Tampas Ridge, 1932 Herre 1801 (LAM). Lassen Co., Lassen Volcanic National Park, 1965 Thiers (CANL). Montorey Co., Santa Lucia Mts., 1955 Howell 5319 (CANL). San Antonia Mts., Brown Flats, 1966 Johnston (3083 FH). San Gabriel Mts., Mt. Lowe, 1911 Kingman 1365 (FH). San Jacinto Mountains, Hasse (Krypt. Exs. Vind 1047, FH, H, LD, US). Santa Monica Range, 1910 Hasse (Hasse, Lich. Exs. 210, FH). San Mateo Co., 5 miles W of Stanford university, 1943 Herre (1885 LAM). San Diego Co., 1 mile NW of Descanso, 1967 Wetmore 16995 (CANL, MIN). Sierra Nevada, Pringle (FH, US). Siskiyon Co., Mt. Shasta, 1956 Cooke 10209 (LAM). Trinity Co., 4 miles W of Weavesville, 1939 Wing (LAM). Wawona, 1896 Cummings (Cummings, Dec. North Amer. Lich. 212, CANL, Cummings Lich, Bor. Amer. 142, (FH, H). *Idaho.* Idaho Co., Selway Bitterroot Wilderness Area, 1972 Anderegg 756 (LD). Lalah Co., Moscov Mts., 1954 Herre 7439 (LAM). *Montana.* Flathead Co., Maria Pass, 1977 Hale (Hale, Lich., Amer. Exs. 205, LD). Glacier National Park, Ptarmigan Creek, 1950 Imshaug 6058 (LAM). Yaak River, Hwy 2, 1969 Thomson 16303 (CANL). *Oregon.* Josephine Co., NE edge of Grants Pass, 1975 Wetmore 24497 (MIN). Lake Co., Booth State Park, 1956 Tavares 235 a & Chisaki (CANL). Umatilla Co., Emigrant

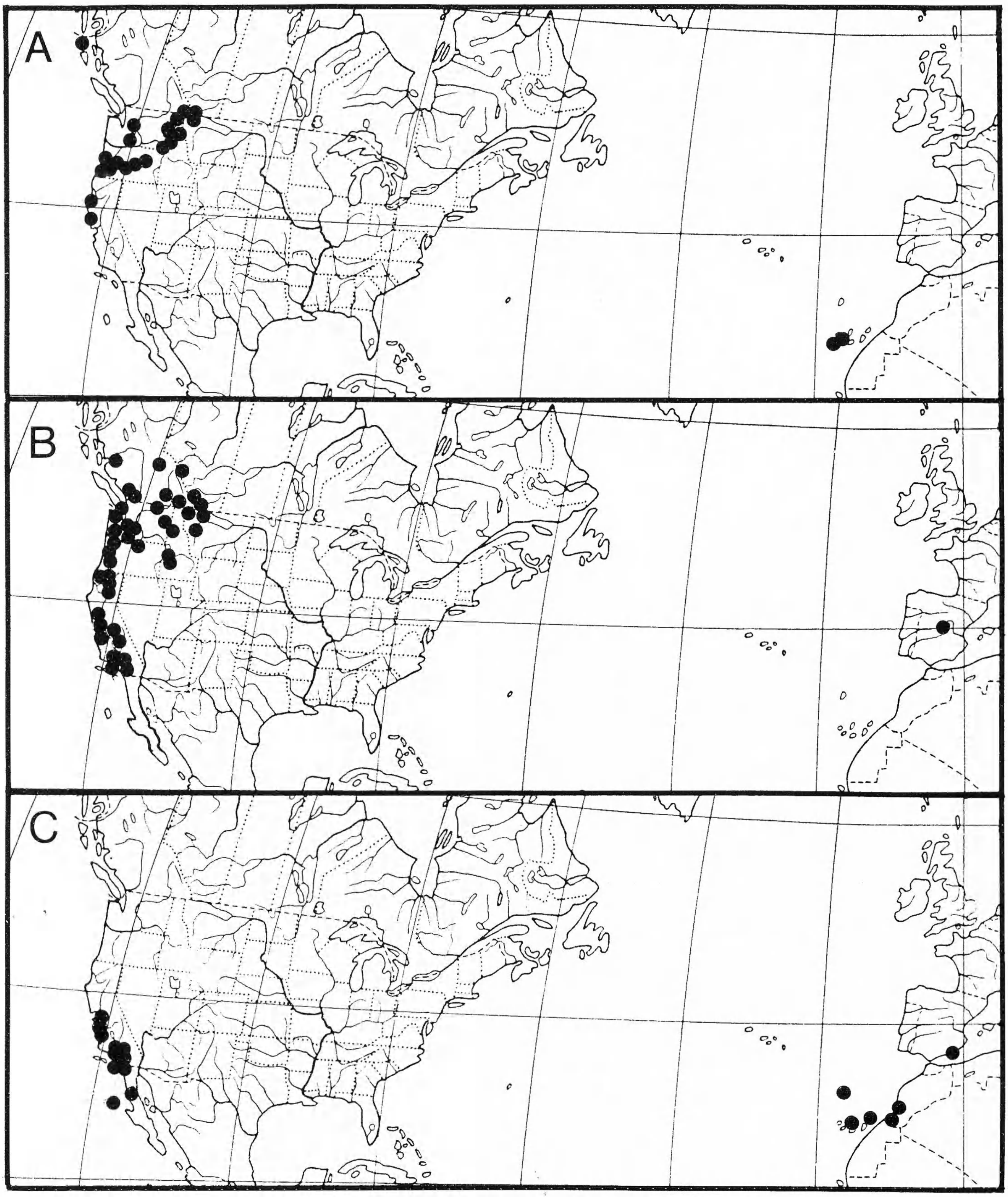

Fig. 1. Distribution of western North American-Macaronesian-northern African-Mediterranean element. — A: *Alectoria imshaugii*, from Brodo & Hawksworth (1977) and Østhagen & Krog (1979). — B: *Cetraria merrillii*. — C: *Dimelaena radiata*, from Llimona & Werner (1975) and Sheard (1974).

Springs State Park, 1952 Weber 1775 (US). On Hwy 97, near Reaver Marsh, 1951 Herre 1790 (LAM). *Washington*. Clallam Co., Olympic National Park, Hurricane Ridge, 1969 Wetmore 19057 (MIN). Goldendake, 1909 Foster 1158 (FH, MIN, US). Mount Rainier National Park, Naches Peak, 1950 Imshaug 361 (CANL, FH, LAM). Republic, 1912 Foster 2282 (FH). Spokane Co., N of Spangle, 1948 Cooke & Cooke 23187 (LAM). Yakima Co., Rattlesnake Canyon, 1931 Howard 1544 (FH).

Canada. Alberta. Banff National Park, E side of Lower Consolation Lake, 1970 Bird 24886 (CANL). Oldman River Watershed, 1 mile SW of summit of Prairie Bluff Mountain, 1966 Bird & Lakusta 14922 (CANL, H). do., Waterton Lakes National Park, Sage Pass, 1966 Bird & Lakusta 16702 (CANL). Plateau Mountain, 50 miles N of Coleman, 1969 Wetmore 18705 (MIN). *British Columbia*. Blackwell Mountain, Manning Provincial Park, 1967 Bird 19121 (H). Hwy 20 out of Bella Coola valley, 1970 Ohlsson 2345 (CANL). 5.4 miles E of Creston on Hwy 3, 1969 Wetmore 18776 (MIN); shoulder of Four Mile Mountain W of Hagensborg, 1970 Ohlsson 2306 (CANL, H). Saltspring Island, Mt. Erskine, 1971 Bird & Bird 25772 (CANL); shoulder of Mt. Walker about 40 miles E of Bella Coola, 1970 Ohlsson 2236 (CANL).

Spain. Guadalajara, Tamajón, 1977 Crespo & Costa (LD).

Dimelaena radiata (Tuck.) Hale & W. Culb.

Distribution. *D. radiata* is distributed along the coast of California from near San Francisco to the Los Angeles region, reaching Baja California in Mexico (Sheard 1974) (Fig. 1 C).

In the Old World *D. radiata* is known from coastal areas in SE Spain, W Morocco, the Canary Islands and Madeira (Llimona & Werner 1975). In the Canary Islands it has been reported from Tenerife and the small islands north of Lanzarote (Llimona & Werner 1975).

Habitat and dispersal. *D. radiata* grows mainly on rocks in maritime localities or on rocks in coastal areas. In the localities in SE Spain it has been reported from acid rocks from the spray zone to c. 300 m (Llimona & Werner 1975).

Surface structures for vegetative dispersal are lacking, whereas apothecia and pycnidia are common. The main mode of propagation is presumably by ascospores or pycnoconidia.

Parmelia pustulosa Essl.

Distribution. This species is so far only known from a few localities in N Colorado and NE Utah (Esslinger 1977) (Fig. 2 A).

In the Canary Islands it has been reported from Gran Canaria (Esslinger 1977).

Habitat and dispersal. *P. pustulosa* has only been found growing on rocks.

The only mode of propagation is presumably by isidia. Apothecia and pycnidia have not been seen on the limited material studied (Esslinger 1977).

Parmelia subolivacea Nyl.

Distribution. *P. subolivacea* has a wide mainly W North American distribution. It is distributed along the Rocky Mountains from S Alberta to New Mexico reaching the Rio Grande. Further *P. subolivacea* has been reported from the coastal mountain system from British Columbia to Baja California (Ahti 1966, Esslinger 1977). A few apparently isolated localities have been found in N Michigan (Esslinger 1977) (Fig. 2 B).

In the Canary Islands *P. subolivacea* is reported from Gomera, Hierro and Tenerife (Esslinger 1977, Østhagen & Krog 1976).

Habitat and dispersal. *P. subolivacea* grows mainly on small twigs, branches or trunks of a great variety of trees from 450 to 3200 m (Ahti 1966). It is common on conifers, e.g. *Abies concolor, Pinus edulis, P. ponderosa, P. strobiformis* and *Psedotsuga menziesii*. *P. subolivacea* has also been reported growing on deciduous trees such as *Alnus, Cerocarpus, Prunus, Quercus* and *Salix*. According to Ahti (1966) the species prefers warm and dry open forest such as oak woodland and *Pinus ponderosa-Pseudotsuga* woodland.

In the Canary Islands *P. subolivacea* has been found from 600 to 1000 m on *Euphorbia* spp. and *Ficus carica* (Østhagen & Krog 1976). The associated vegetation was dominated by scrubby and succulent species of *Euphorbia*.

There are usually no surface structures for vegetative dispersal. On older lichens, however, isidoid papillae sometimes develop. Apothecia and pycnidia are often abundant. The main mode of propagation is presumably dispersal by ascospores and pycnoconidia.

Thelomma mammosum (Hepp) Massal.

Distribution. *Thelomma mammosum* is known from scattered localities along the W North

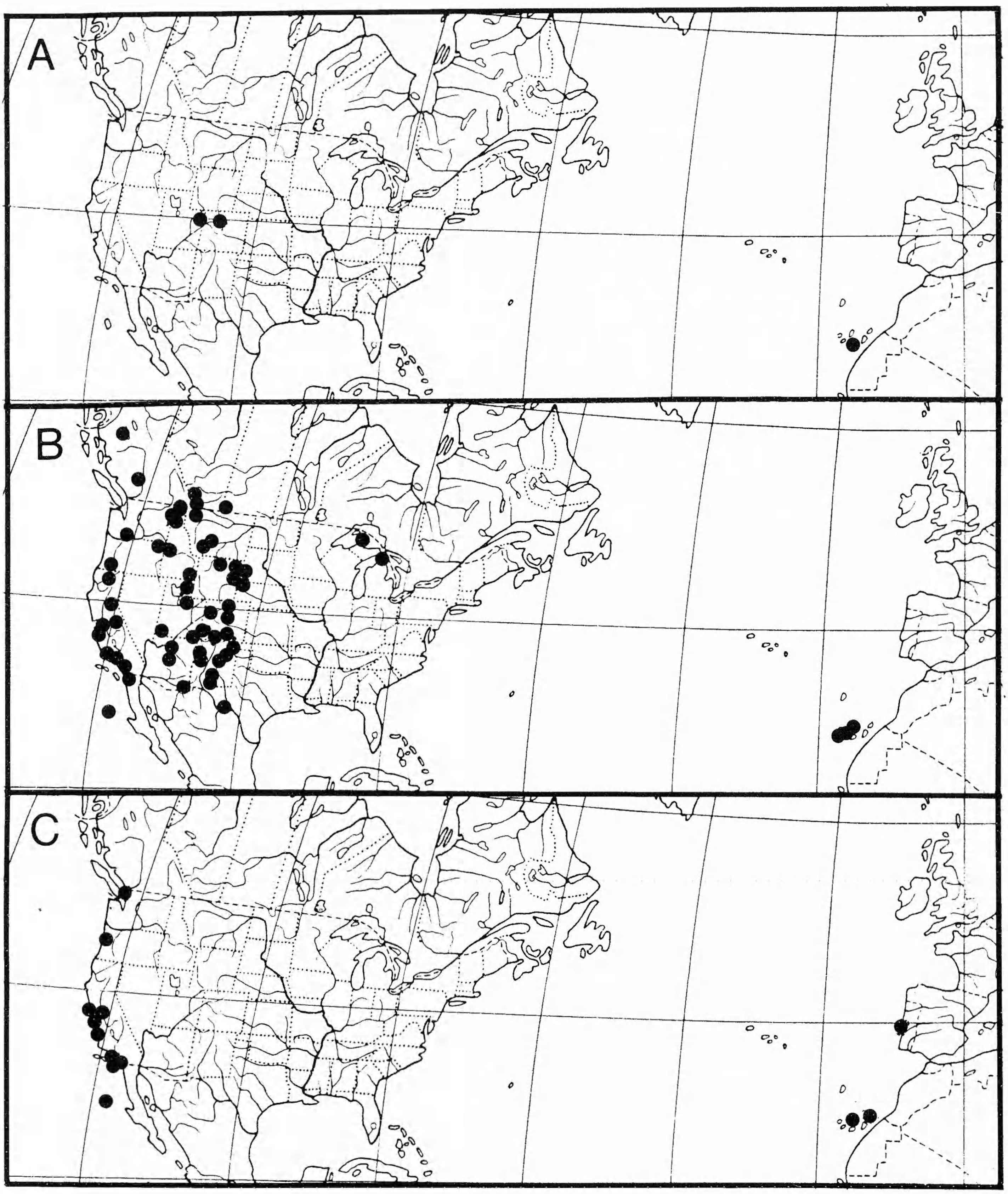

Fig. 2. Distribution of western North American-Macaronesian-northern African-Mediterranean element. — A: *Parmelia pustulosa*, from Esslinger (1977). — B: *P. subolivacea*, from Esslinger (1977) and Østhagen & Krog (1976). — C: *Thelomma mammosum*, from Tibell (1976).

American coast from S British Columbia to S California and Guadalupe Island in Mexico (Tibell 1976) (Fig. 2 C).

In the Old World disjunct range the species is known from Portugal and the Canary Islands from Lanzarote and Tenerife (Tibell 1976).

Habitat and dispersal. T. mammosum grows primarily on siliceous rocks in coastal areas. It appears to prefer open situations from the spray zone to c. 700 m.

Secondarily *T. mammosum* has been found growing on *Juniperus sabina* at c. 800 m in the Canary Islands.

No soralia, isidia and pycnidia have been seen and reproduction is presumably by ascospores.

Comments on phytogeography

The western North American range

Within the area of distribution in W North America the species occur in both the temperate to subtropical climatic zones. The three corticolous species, *Alectoria imshaugii, Cetraria merrillii* and *Parmelia subolivacea*, are mainly distributed within the temperate region which in W North America is characterized by moderate humidity and precipitation. In addition these species appear to prefer mountainous habitats with colder conditions.

Parmelia pustulosa occurs in the southernmost part of the temperate zone in the inland Rocky Mountain region. The regional climate there is less influenced by the humid Pacific winds, is more continental in character and the vegetation at lower altitudes at least is characterized by steppes.

Further *A. imshaugii, C. merrillii* and *P. subolivacea* extend southwards to California and the subtropical zone with a Mediterranean climate characterized by humid winters and long dry summers. Walter (1968) described the Mediterranean climate as prevailing in limited regions at the edge of the subtropics in regions between deserts and truly temperate zones.

Dimelaena radiata and *Thelomma mammosum* occupy habitats with a Mediterranean climate. However, the three corticolous species are not associated exclusively with a Mediterranean climate but also inhabit higher altitudes in this region.

Good (1974) classified the North American region where the species occur as the Pacific North American region of the Boreal Kingdom. Takhtajan (1969) divided the same region into a northern Rocky Mountain region of the Holarctic Boreal Subkingdom and a southern Madrean (Sonoran) region of the Holarctic Madrean Subkingdom. The Madrean or Sonoran region comprises most of the drier regions of W United States and Mexico. The two regions include the lichens treated here with a group of three, *A. imshaugii, C. merrillii* and *P. subolivacea*, being mainly western temperate species and two, *D. radiata* and *T. mammosum*, western subtropical species. *P. pustulosa* represents an intermediate to these elements, or may be included in the western temperate species group as a temperate semi-desert element.

The Macaronesian-northern African-Mediterranean range

Macaronesia includes the oceanic islands to the west and northwest of Africa here represented by the Canary Islands and Madeira. The climate of the Canary Islands is defined as subtropical semi-arid (Fernandopullé 1976). Madeira, however, has a milder, more oceanic climate.

The coastal localities for one of the species in Morocco are semi-arid in character, influenced mainly by the extensive northern African desert-steppe region. The localities in Spain and Portugal are within the subtropical zone with a Mediterranean climate.

The corticolous species *A. imshaugii* and *P. subolivacea* in the Canary Islands were found growing in the sclerophyllous type of vegetation that characterizes the Mediterranean region (see Østhagen & Krog 1976, 1979) where *C. merrillii* was also found in C Spain. The saxicolous species *D. radiata, P. pustulosa* and *T. mammosum* are locally found in this semi-arid Mediterranean type of habitat.

The disjunctive distribution

Major discontinuities are generally accepted as being the result of the extinction of units now forming a discontinuous group. The present disjunction could have various reasons such as major climatic changes (Bramwell 1976, Cain 1944). Cain (1944) also suggested that minor discontinuities could be the result of recent migrations.

The disjunction between W North America and Macaronesia-NW Africa-Iberian peninsula is certainly a major discontinuity. A more natural region for disjunctions for western North American elements with more or less corresponding climatic and physio-geographical features is East Asia, in a region comprising Sakhalin, parts of Manchuria, Korea and Japan. Elements with this discontinuous distribution have been discussed by Hultén (1937). For example *Rubus spectabilis* and *Steptopus streptopoides* are elements in a group of plants now restricted to the southernmost parts of Beringia (Hultén 1968). This element, defined as southern Beringian radiants by Hultén (1937) today occupies habitats with a temperate climate. However, this element was presumably present in the Bering Strait region during the warmer interglacials of the Pleistocene, the glacials annihilating the element there so that at present only the two southern extremities of the long and narrow range of the species remain.

As regards the southern part of the W North American distributional area with a Mediterranean type of vegetation disjunctions and relationships with other Mediterranean floras have been previously discussed (Axelrod 1975, Raven 1971, Raven & Axelrod 1978). The similarities between the floras of California and of the Mediterranean region lie mainly within characteristic families and tribes such as Asteraceae-Inuleae, Ericaceae-Arbuteae or Pteridaceae (Raven & Axelrod 1978).

Among the genera represented here there are in particular many woody members common to California and the Mediterranean region such as *Arbutus, Cercis, Clematis, Crataegus, Juniperus, Lonicera, Prunus, Rhamnus, Rhus, Smilax, Staphylea, Styrax* and *Vitis*. Many of these genera are also distributed continuously through the temperate regions of North America and Eurasia. The populations on the different continents have been isolated since the Cretaceous at least, and endemic species have evolved in the two areas (Raven 1971). Therefore very few species or closely related species exist today in California and in the Mediterranean region (Raven 1971, 1973, Raven & Axelrod 1978). Only two possible examples, *Plantago ovata* and *Oligomeris linifolia*, have been mentioned. Other examples include species of *Aphanes, Caucalis* and *Valerianella*. Raven & Axelrod (1978) stated that this species link between California and the Mediterranean region probably originates from human introduction.

A few bryophytes with a similar W North American-mainly Mediterranean disjunction are known (Irmscher 1929). Examples are *Antitrichia californica, Crossidium squamigerum* and *Clapodium whippleanum*. *A. californica* has a wide distribution in the Mediterranean region westwards to Spain and Morocco and *C. whippleanum* is found in Spain and Portugal (Størmer 1959). Other species, such as *Tortula bolanderi* and *Trichostomopsis brevifolia*, are mainly distributed in Washington, Oregon, California and Arizona. In addition both species have discontinuous areas in the Canary Islands (Størmer 1959).

Possible causes of the disjunction

Long-distance dispersal mainly by wind or water has been suggested as a possible cause of major discontinuous ranges such as those of amphi-Atlantic elements (Dahl 1963). Lems (1960) also suggested that the presence of some mainly South American elements occurring in the Canary Islands is due to dispersal by water. However, as most species of this group of lichens have a mainly W North American distribution not near the coast, and produce very small diaspores, it is scarcely likely that they have spread by water to the Old World. Only *Dimelaena radiata* and *Thelomma mammosum* are coastal species both mainly reproducing by ascospores. The dispersal of small diaspores by wind from W North America across the Atlantic Ocean is no more likely. The prevailing winds in W North America during summer are southerly, and during winter northerly and southerly. Over the central Atlantic sector the prevailing winds are southwesterly (see Bartholomew 1975).

Dispersal by birds is not a probable cause of the discontinuous distribution. There are no ordinary migratory pathways between W North America and S Europe-N Africa. Nor are there any migratory pathways from E North America to Europe or vice versa.

Raven (1971, 1973) suggested that the few W North American species known from the Mediterranean region are a probable result of human introduction. The Canary Islands flora, comprising over 3000 species of angiosperms, has some

700 species registered as involuntarily introduced weeds or plants escaped from gardens (Kunkel 1976). Much of the introduction of American plants presumably took place during the Portuguese and Spanish colonization of South and Central America including SW North America in the 15th and 16th centuries. Well-known examples of introduced plants are *Agave* and *Opuntia*, W and C American elements, now locally abundant in the Canary Islands and the Mediterranean region.

In the lichen group discussed here presumably only the coastal species could have been introduced to the Old World by expeditions returning home. However, as both *D. radiata* and *T. mammosum* are inconspicuous saxicolous lichens it is not likely that they have been introduced voluntarily by man. In my opinion it is still less likely that the corticolous species that prefer coniferous forests at higher altitudes have been introduced by man. The question may now be raised as to whether there is another quite different palaeogeographic cause of the disjunction.

With regard to Mediterranean floras Axelrod (1975) suggested that an ancient sclerophyllous flora had evolved and adapted to the sub-humid climate along the shores of the Tethyan Sea and across S North America. Axelrod termed these links Madrean-Tethyan, and a migratory pathway presumably existed across the middle Atlantic which was narrower during the Paleogene. Dispersal was also favoured by the presence of volcanic islands along the mid-Atlantic ridge.

It is possible that this lichen group and the bryophytes mentioned above are part of an older and much larger continuously distributed Madrean-Tethyan element. The more primitively organized lichens and bryophytes have evolved much more slowly and units may have remained unchanged through the ages. A corresponding Madrean-Tethyan element in the angiosperms has developed more rapidly and selected new forms. Distinct genera and species are now found in the discontinuous areas.

The disjunct localities isolated from the nearby Mediterranean region, however, can be explained only with difficulty. The present lichen flora of the Canary Islands comprises over 600 species (see Klement 1965, Tavares 1952). Follmann (1976) estimated that c. 49 % of the species were of Mediterranean origin.

The archipelago is volcanic in origin, the seven largest islands differing somewhat in age (Schmincke 1976). The easternmost islands of Lanzarote and Fuerteventura were originally part of the African continental mass (see Bramwell 1976, Schmincke 1976). Cretaceous sedimentary rocks have been found on Fuerteventura, similar to rock formations in Morocco. The laurel forest of the Canary Islands is presumably a relict from this time. Fossil evidence from S Europe and N Africa supports this view (Bramwell 1972, Raven & Axelrod 1974, Takhtajan 1969).

Alectoria imshaugii, Parmelia pustulosa and *P. subolivacea*, today represented only in the Canary Islands in the Old World, probably spread from nearby African and Mediterranean areas where the other disjunct species now occur.

Sheard (1977) has discussed the possible evolution and radiation of the genus *Dimelaena*, mainly reflecting the chemical evolution in *D. oreina*. Sheard adopted modern paleogeographic theories and suggested that the evolution of *Dimelaena* has presumably been similar to that of many fossil conifers (Sheard 1977). A centre of the evolution and radiation of the genus could have been located in the N-C sector of the ancient supercontinent. The ancient predecessor of *D. radiata* presumably evolved there, extending westwards to the future North America. The minor distributional area in S Europe, N Africa and Macaronesia is today all that remains of the ancient more continuous Madrean-Tethyan distribution. However, *D. radiata* and the other five species discussed here appear to have their distributional centre in W North America. During the Tertiary climatic changes in Europe and N Africa reduced the habitats of many plant groups. Conifers such as *Pseudotsuga* and *Sequoiadendron* were then present in Europa (see Florin 1963, Walter & Straka 1970). The corticolous species *A. imshaugii, C. merrillii* and *P. subolivacea* could well have been commoner in these warmer Tertiary European forests, surviving only on a narrow platform in the south.

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Botanical literature

Kornmann, P. & Sahling, P.-H. 1978: *Meeresalgen von Helgoland.* 289 pp. Biologische Anstalt Helgoland, Hamburg.

Up-to-date Floras of marine macroalgae are in scant supply in NW Europe. During recent years Volume 1 of P. F. Dixon and L. M. Irvine, *Seaweeds of the British Isles* has appeared followed by Rueness's *Norsk Algeflora* in Norwegian only. In 1978 the work by P. Kornmann and P.-H Sahling, *Meeresalgen von Helgoland, appeared.* As early as 1892 Kuckuck had planned to publish a Flora from Helgoland which, however, did not materialize. Later O. C. Schmidt carried on Kuckuck's work but unhappily both Kuckuck's notes and a completed manuscript of Schmidt's were destroyed during the Second World War.

Kornmann and his assistant Sahling began work on the Flora in 1959. They have identified c. 150 species in this phytogeographically interesting area of the North Sea. However, little or no information on distribution is included. A new approach is that all species are illustrated by excellent photos, for each species at least two photos showing detail, and for most species one showing the habit. All the customary illustrations of varying quality normally found in Floras have been abandoned. Photos of algae are often not so good as drawings but in *Meeresalgen von Helgoland* most of the photos are better than drawings. The descriptions of the species are generally very good, though for many species the size, while indicated by a scale mark in the figures, is not mentioned in the text so that the reader is not given any idea of the morphological variation.

For the systematics of the red and brown algae the authors follow in the main the check-list of Parke and Dixon, but for some species (e.g. Acrochaetium) they deviate, and in this I fully agree. For the green algae they use a modified system proposed by Round. They consider that Chlorophyta should be divided into three classes (Codiolophyceae, Bryopsidophyceae and Chlorophyceae). The interesting idea to combine all species that have a codiolum stage, for instance *Ulothrix, Urospora, Monostroma* and *Acrosiphonia*, was suggested by Kornmann in 1973. This requires the establishment of two new orders: Codiales which includes the genus *Urospora* and Monostromales with *Monostroma*.

The Flora includes a short key to the genera. It is easy to follow, but one must bear in mind that it is based on a restricted number of species. Though relatively few species are described and the distribution is local, this new algal Flora will be of great value to all those interested in Phycology. The authors are to be congratulated on the results of their efforts.

Torgny von Wachenfeldt

Rhizosolenia phuketensis sp. nov. and Rhizosolenia stolterfothii H. Peragallo (Bacillariophyceae)

BO G. SUNDSTRÖM

Sundström, B. G. 1980 12 15: Rhizosolenia phuketensis sp. nov. and Rhizosolenia stolterfothii H. Peragallo (Bacillariophyceae). *Bot. Notiser 133:* 579–583. Stockholm. ISSN 0006-8195.

Rhizosolenia phuketensis sp. nov. and *R. stolterfothii* H. Peragallo are compared in the light microscope. Distinctive differences in pleurae and process are noted. Distribution patterns, older descriptions and illustrations and phylogenetic relationship are commented upon.

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This paper draws attention to two marine planktonic species of Bacillariophyceae with a superficial similarity: *Rhizosolenia phuketensis* sp. nov. and *R. stolterfothii* H. Peragallo.

Both species are colonial and have elongated cylindrical cells that are curved. They thus form circular or spiralling chains. They both have weakly convex valves with one eccentrically located process. Both species lie within the same size range.

Dissimilarities in shape and arrangement of the girdle elements and in other morphological features separate the two species quite clearly.

The papers consulted and material examined together suggest partly different distribution patterns for the two species.

Material and methods

The material examined consists essentially of net samples taken on the eastern coast of Phuket Island, Thailand, from February to April 1980. The samples were fixed in formaldehyde before being examined. Older samples from other parts of the world were examined for referential purposes. Sources consulted for the distribution of *R. stolterfothii* are listed in the reference list. Terminology is adopted from von Stosch (1975). The drawings and micrographs were made from Phuket material. Micrographs were made in a Dialux 20 EB microscope with phase-interference and phase-contrast equipment.

Rhizosolenia phuketensis sp. nov., Figs. 1, 3

Frustula tubiformia, curvata. 4,5–48 µm diametro. Taeniae dimidiae. Imbricationes laterales et dorsales. Cellulae in catenas curvatas conjunctae. Valvae inaequales leviter convexae, processu brevissimo excentrico munitae. Chloroplasti multi.

Habitat of the type. Plankton, marine. Collected in surface water near Ko Hung Island on the east coast of Phuket Island, Thailand.

Holotype. Marked specimen on slide labelled "Rhizosolenia phuketensis SUNDSTRÖM, Ko Hung, Phuket, Thailand, 800313. Nr. 1." Botanical Museum, Univ. of Lund (LD). Isotypes will be placed in the Department of Marine Biology and Limnology, Section of Marine Botany, University of Oslo, Norway and at Phuket Marine Biological Research Center, Phuket, Thailand.

Observations in the light microscope show elongated cylindrical cells that are always more or less sharply curved. The valves are weakly convex and adjoined to a mantle like band (*valvocopula*).

Each valve has one process with a length less than 10 % of the diameter of the cell and one adjoining indentation, both eccentrically situated towards the convex profile of the cell. The valves of adjacent cells are pressed together with the processes fitted into adjacent indentations. The girdle elements are half-bands (*taenia dimidia*) (Fig. 1 B). The ends of the bands meet in

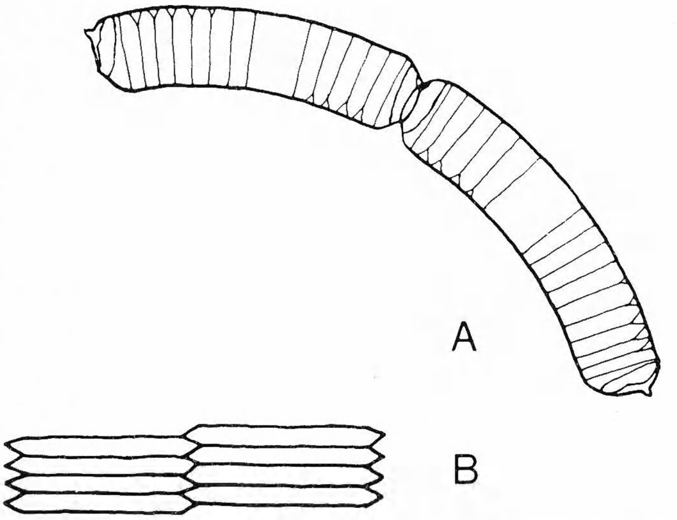

Fig. 1. *Rhizosolenia phuketensis*. — A: Two individuals. — P: Unfolded half-bands.

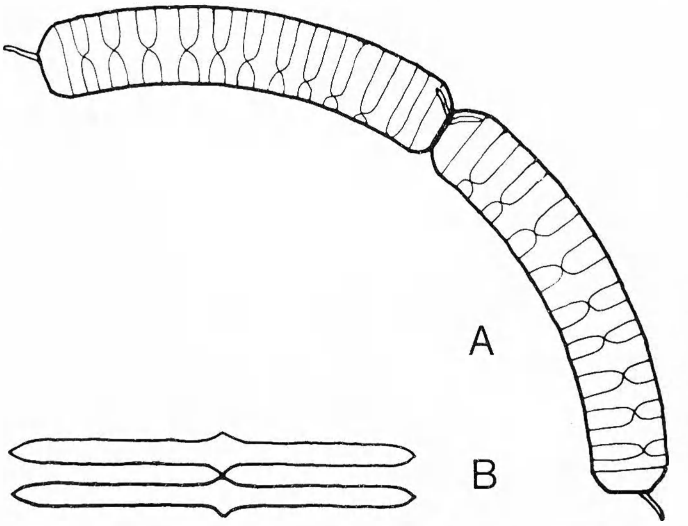

Fig. 2. *Rhizosolenia stolterfothii*. — A: Two individuals. — B: Unfolded bands.

two straight zigzag lines that are always situated in the middle of the convex and concave surfaces respectively of the girdle. As a consequence these lines are not seen when the cells are normally oriented in water mounts (Figs. 1 A, 3). The valve and girdle are usually quite heavily silicified with the bands observable in water mounts without the aid of phase-contrast. Cell diameter varies between 4.5 and 48 μm in the observed material. The variation in diameter-to-length ratio is considerble within all size fractions but the ratio has a tendency to increase with increasing cell diameter. A varying number of cells are tightly joined into curved or spiralling chains. Single cells are often found. Chloroplasts are numerous and small but were not well preserved in the observed samples. *R. phuketensis* was about equal in number to *R. stolterfothii* in the Phuket samples and was also found in older samples from the Thai coast of the Gulf of Siam.

Rhizosolenia stolterfothii H. Peragallo, Figs. 2, 4

Peragallo (1888 p. 82, Fig. 44).

Eucampia striata Stolterfoth (1879 p. 385, Figs. a, b).

Descriptions and figures. Peragallo 1892, Karsten 1907, Gran 1908, Meunier 1910, 1915, Okamura 1911, Hustedt 1930, Allen and Cupp 1935, Cupp 1943, Subrahmanyan 1946, Curl 1959, Hendey 1964, Sournia 1968, Drebes 1974, Hasle 1975.

The original description by Stolterfoth (1879) does not give many clues to the finer details of the cells although Figs. a and b quite clearly depicts the species. Figs. c and d probably show *Guinardia flaccida* (Castr.) Peragallo which is sometimes seen in curved chains, according to my observations. Peragallo (1888) transferred *Eucampia striata* to *Rhizosolenia* on the grounds of it having a central (sic!) and solitary process, a feature present in this genus, and renamed it after its original discoverer. In Peragallo (1892) a more thorough description was made, but the shape of the pleurae in Pl. XIII, Figs. 17, 18 are not in accordance with illustrations in Hustedt (1930), Cupp (1943) and Subrahmanyan (1946) which show the type of bands that I have observed in the species.

Observations in the light microscope show elongated cylindrical cells that are always more or less sharply curved. The valves have a flattened valve face and a distinct mantle. Each valve has one process with a length of more than 20 % of the diameter of the cell and one groove, both situated eccentrically towards the convex profile of the cell. The valves of adjacent cells are pressed together with the processes fitted into adjacent grooves. The girdle elements are open bands with ligule and antiligule (*taenia aperta, ligula, antiligula*). These structures and the ends of the bands lie in slightly oblique lines along the 'lateral' surfaces of the girdle and are thus visible when the cells are normally oriented in water mounts (Figs. 2 A, 4). The valve and girdle are usually weakly silicified with the bands usually not observable in water mounts without the aid of phase-contrast. The diameter of the cells varies between 3.5 and 55 μm in the ma-

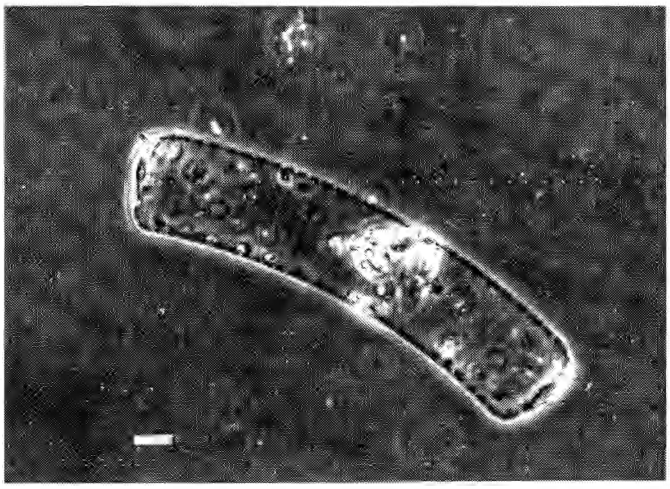

Fig. 3. *Rhizosolenia phuketensis.* Light micrograph. Scale = 10 μm.

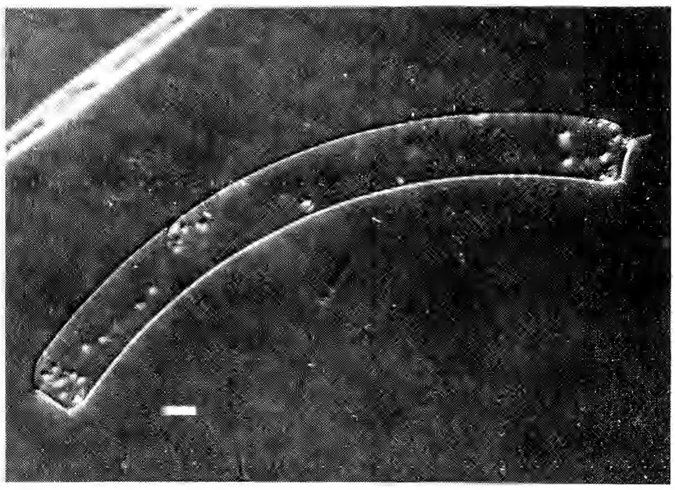

Fig. 4. *Rhizosolenia stolterfothii.* Light micrograph. Scale = 10 μm.

terial observed. The variation in diameter-to-length ratio is considerable within all size fractions, but the ratio has a tendency to increase with increasing cell diameter. A varying number of cells are tightly joined into curved or spiralling chains, but single cells are often found. Chloroplasts are numerous and small.

In descriptive articles and in check-lists consulted no hints were given to any specimen answering to the above description of *R. phuketensis,* except for the illustrations of *R. stolterfothii* in Karsten (1907) and Okamura (1911) which might depict *R. phuketensis,* judging from the short lengths of the processes and from the appearance of the bands. Upon rechecking samples from Europe, West Africa and the Caribbean with records of *R. stolterfothii* no *R. phuketensis* was found.

Some records of the distribution of *R. stolterfothii* together with the Thai localities of *R. phuketensis* are presented in Fig. 5. It shows *R. stolterfothii* as being a cosmopolitan species, perhaps limited to tropical to temperate coastal regions for efficient growth but being transported by currents to other less favourable areas such as the Barents Sea (Meunier 1910).

A comparison between observations in the light microscope shows the following morphological differences:

	R. phuketensis	*R. stolterfothii*
Girdle bands	Halfbands	Open bands with ligula and antiligula
Band ends	Meet on the dorsal and ventral surfaces of the curved cell, forming straight zigzag lines	Meet on the lateral surfaces of the curved cell in slightly oblique lines
Length of process	Less than 10 % of the cell diameter	At least 20 % of the cell diameter

Discussion

As pointed out above, the two species discussed are similar in gross morphology. There is therefore reason to believe that *R. phuketensis* has been recorded as *R. stolterfothii* from time to time. The present material offers only vague evidence for assumptions concerning distribution patterns.

So far *R. phuketensis* has only been observed in the present Thai material but it is probably to be found in the Indian Ocean (Karsten 1907) and in waters around Japan (Okamura 1911), assuming that the illustrations of *R. stolterfothii* mentioned earlier actually represent *R. phuketensis.* Records of *R. stolterfothii* from those areas should therefore be regarded with scepticism, but no material or articles have so far been seen to suggest the presence of *R. phuketensis* in any other areas. It therefore seems logical to assume that *R. phuketensis* has a far more limited distribution than the cosmopolitan *R. stolterfothii.*

From observations in the light microscope not much can be said about relationships between

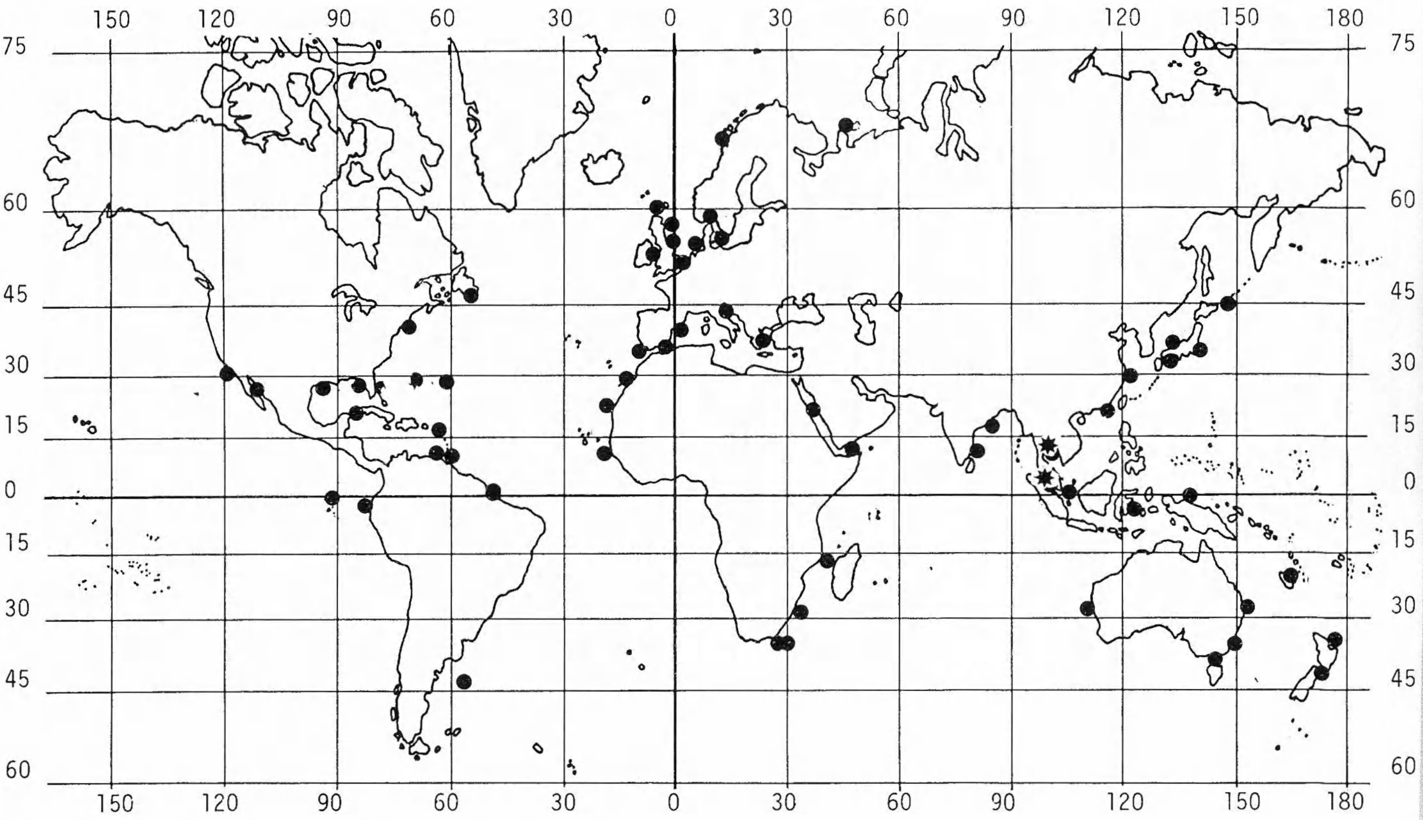

Fig. 5. Known distribution. ● *Rh. stolterfothii*. * *Rh. phuketensis*.

the species discussed or between these and other species. *R. phuketensis* seems, however, to be related to *R. fragilissima* Bergon in that they both have the same type of bands and process, but no conclusive evidence can be given here. As pointed out by Hasle (1975) *R. stolterfothii* shows morphological features that point to a relationship with *Guinardia flaccida* (Castr.) H. Perag. It should also be noted that the genus *Rhizosolenia* is heterogeneous in morphology and that a revision is to be expected which might well exclude the species discussed from the genus.

Acknowledgments. I wish to thank the Director, scientists and other staff of the Phuket Marine Biological Center for the opportunity and facilities to start this investigation. Thanks are also due to Mrs Ladda Wongrat of the Faculty of Fisheries, Kasetsart Univ., Bangkok, for Gulf of Siam samples, to Dr. Ove Almborn of the Botanical Museum, Univ. of Lund for the Latin diagnosis, to Miss Ingrid Magnusson for help with the micrographs and to Roger Stenlund for help with the articles in Russian.

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Wolff, W. J. (ed.): *Flora and vegetation of the Wadden Sea*. A. A. Balkema, Rotterdam, 1979. Price Hfl. 17.50.

The final reports of the Wadden Sea Working Group have now been published. Report 3: *Flora and vegetation of the Wadden Sea* deals with the algae and seagrasses of this shallow area off Denmark, Germany and the Netherlands. These sandy and muddy flats which are partly uncovered during low tide are dominated by microphytobenthos, mostly diatoms but also blue-green algae. As there is no hard substratum, macroalgae are few and are of importance only in the salt-marsh. The sublittoral zone was formerly dominated by sea-grasses, i.e. *Zostera* spp., but these came close to being exterminated by the wasting disease and are now only found on the tidal flats. The composition of phytoplanktic species corresponds mainly to that found in the North Sea but is influenced by fresh water from the large rivers.

The book gives a good description of the vegetation in the whole area and also of recent changes in the flora due mainly to the disappearance of *Zostera* and to large-scale engineering works. The section dealing with microphytobenthos is excellent.

Biomass values and production rates are given for the different groups. The authors have drawn the conclusion that the Wadden Sea is not as productive as expected and that, contrary to an earlier opinion, the shallow area receives organic material from the North Sea.

The reviews and discussions are illustrated with several maps, figures and tables which include results from other investigations.

The report is mainly intended for scientists but the extensive literature reviewed and cited makes it an ideal introduction for students of marine biology and interested laymen.

Ruth-Aimée Kornfeldt

Ein Beitrag zur Revision der Gattungen Rhoicosphenia Grun., Gomphonema C. Ag., Gomphoneis Cl.

HORST LANGE-BERTALOT

Lange-Bertalot, H. 1980 12 15: Ein Beitrag zur Revision der Gattungen Rhoicosphenia Grun., Gomphonema C. Ag., Gomphoneis Cl. *Bot. Notiser 133:* 585–594. Stockholm. ISSN 0006-8195.

Common concepts of *Gomphonema abbreviatum* C. Ag. and *Gomphonema minutum* (C. Ag.) C. Ag. are based on misidentifications by Kützing. Examination of the type material has shown that *G. abbreviatum* C. Ag. 1832 is conspecific with *G. curvatum* Kütz. 1833. Therefore, the correct combination of this taxon is *Rhoicosphenia abbreviata* (C. Ag.) Lange-B. comb. nov. *Licmophora minuta* C. Ag. 1827 syn. *Gomphonema minutum* (C. Ag.) C. Ag. 1831 was misinterpreted by Kützing as a synonym of *G. abbreviatum*. Samples at British Museum (Natural History) referred to *G. abbreviatum* by Kützing represent extremely different taxa, viz. *Licmophora abbreviata* C. Ag., *G. constrictum* Ehrenb., *G. exiguum* Kütz., *G. gracile* Ehrenb., *G. minutum* (C. Ag.) C. Ag. and '*G. abbreviatum* Agardh? Kützing' sensu Hustedt which probably must be described as a new species. The authentic *G. minutum*, on the other hand, is one of the most common species of this genus in European rivers and is conspecific with *G. curtum* Hustedt. *Gomphoneis* Cl. cannot be separated from *Gomphonema* as a distinct genus. This is shown by EM micrographs of various taxa, illustrating the fact that the differential characters used by Cleve and Dawson can vary quite unsystematically, even in one species.

Horst Lange-Bertalot, Botanisches Institut der Johann Wolfgang Goethe-Universität, Frankfurt am Main, B. R. Deutschland.

Die Diatomeensammlung C. A. Agardhs im Botanischen Museum in Lund ist von den Taxonomen bis heute offenbar nur wenig beachtet worden. Schon wenige stichprobenhafte Untersuchungen zeigen nämlich, daß die gegenwärtigen Konzeptionen einiger kosmopolitisch verbreiteter Süßwasserarten überhaupt nicht mit den Typen übereinstimmen. Vielmehr hat man in der Folgezeit die falschen Vorstellungen Kützings von deren Identität allgemein anerkannt. Eine Klarstellung im Sinne der Prioritätsregeln und Aufklärung von Verwechslungen erscheint ganz besonders bei den ökologisch bedeutenden Taxa unverzichtbar, unbeschadet von möglichen Einwänden, daß Korrekturen derzeit gebräuchlicher Kombinationen nur Prinzipienreiterei darstellen.

Ergebnisse und Diskussion

Gomphonema abbreviatum C. Ag. (non Kützing)

Leiblein (1830 p. 324, 325) beschreibt eine Diatomeenpopulation aus der Umgebung von Würzburg und hält sie für nahe verwandt mit *Licmophora minuta*, die C. A. Agardh (1827 p. 628) in der Isar bei München gefunden hat. Er schreibt: ,,Der daselbst angegebene kurze Charakter derselben will übrigens auf die von mir beschriebene Form nicht ganz passen; aber der Gattungs-Charakter paßt gut, es wäre daher möglich, daß es eine andere Art dieser Gattung wäre!'' Leibleins Abbildung (t. 1, fig. 6) zeigt schwach gebogene Frusteln, die auf *Rhoicosphenia* hindeuten. Ein Jahr später (1831 p. 34) veröffentlicht C. A. Agardh diese Form nach

Leibleins Beschreibung unter der Kombination *Gomphonema abbreviatum* als neue Species. Leibleins Material befindet sich noch heute in der Collection C. A. Agardh samt der Originalzeichnung zur Abbildung in der Zeitschrift Flora unter no. 4682, 4683. Die Überprüfung zeigt eindeutig eine Massenpopulation von *Rhoicosphenia curvata* (Fig. 1 A). Das Epithet *abbreviata* besitzt nun aber Priorität. Die bisher gültige Kombination *Rhoicosphenia curvata* (Kützing) Grun. ist danach in die Synonymie zu überführen. Vermutlich werden sich bei weiterer Überprüfung noch weitere Taxa als Synonyme erweisen, die C. A. Agardh gleichzeitig nach dem Material Leibleins aufgestellt hat. Der Grund dafür ist zweifellos darin zu suchen, daß im frühen 19. Jahrhundert die Wuchsform der Gallertstiele höher bewertet wurde als die schwerer erkennbaren Strukturunterschiede der Schalen. Das Epithet *abbreviatum* bezieht sich im Sinne C. A. Agardhs somit sicher nicht auf verkürzte Transapikalstreifen.

Auch das Taxon *G. minutissimum* Greville (1827 p. 224) ist von Ehrenberg und Kützing mit *Rhoicosphenia* in Zusammenhang gebracht worden. *G. minutissimum* sensu Kützing (1833 p. 567), aus dem Rollsdorfer See im ,,Mansfeldischen'', ist tatsächlich ein Synonym. Dagegen wird eine Synonymie von *G. minutissimum* sensu Kützing 1844 (non 1833), p. 84, t. 8, fig. 11 mit *G. exiguum* Kütz. für möglich gehalten (vgl. z. B. Van Landingham 1971 p. 1930). Da das Typenmaterial aber nicht ,,von einem Callithamnion der Englischen Küste'' stammt, sondern Greville mehrere Fundorte aus Süßwasser angibt, bleibt jede Identität ungeklärt, zumal kein authentisches Material auffindbar ist (Sims, persönliche Mitteilung).

Korrekt ist danach folgende Nomenklatur:

Rhoicosphenia abbreviata (C. Ag.) Lange-B. comb. nov. Basionym: *Gomphonema abbreviatum* C. A. Agardh 1831 p. 34; Leiblein 1830 p. 324, 325, fig. 6. Typuslokalität: Bei Würzburg, Deutschland. Lectotypus: Coll. C. A. Agardh in Lund no. 4682 (design. Lange-Bertalot).

(Neue) Synonyme: *Gomphonema curvatum* Kützing 1833 p. 567, t. 16, fig. 51. *Roicosphenia curvata* (Kütz.) Grunow ex Rabenhorst 1864 pp. 112, 342 (vgl. Patrick & Reimer 1966 p. 283).

Zu vermutende Synonyme: *Gomphonema subramosum* C. A. Agardh 1831 p. 34, Leiblein 1830 pp. 323, 324, fig. 5. *Gomphonema septatum* C. A. Agardh 1831 p. 33, Leiblein 1830 pp. 327, 328, fig. 9.

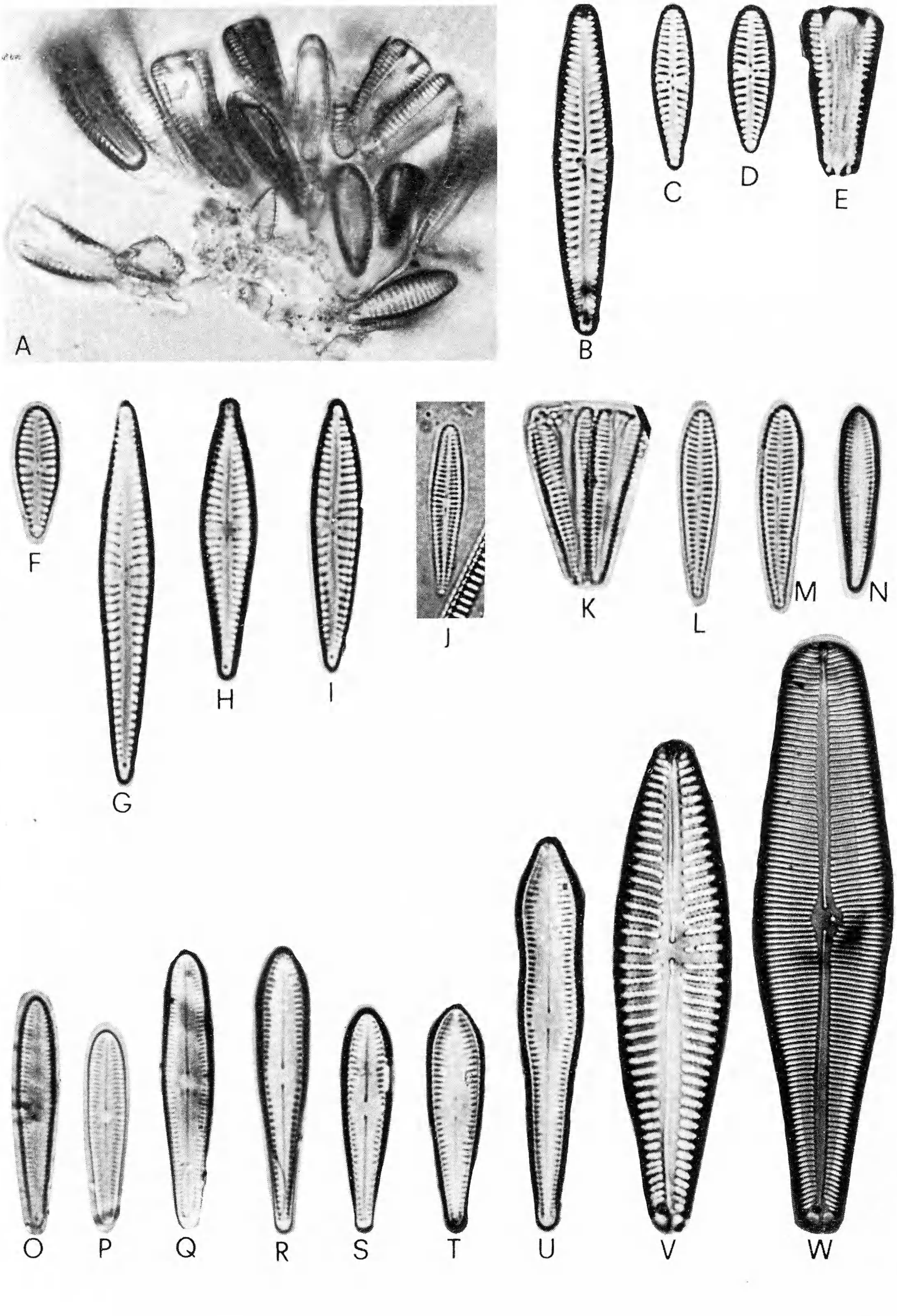
Weitere Synonyme: Vgl. Van Landingham 1978 p. 3606–3608.

Die heterogenen Taxa von Gomphonema abbreviatum sensu Kützing insbesondere Gomphonema minutum C. Ag.

Interessanter als die nur nomenklatorisch bedeutsame Prioritätsfrage für die häufigste Art der Gattung *Rhoicosphenia* ist nun aber die aus systematischer Sicht wichtige Lösung des Problems um *Gomphonema abbreviatum* sensu Kützing. Die Konfusion um dieses Taxon beginnt mit der Verwechslung durch Kützing, der die gekrümmte Form der Frusteln in Gürtelbandansicht in Leibleins Abbildungen sowie Beschreibung nicht beachtete und mit *Gomphonema curvatum* ein anderes, neues Taxon gefunden zu haben glaubte. *Gomphonema abbreviatum* sensu C. A. Agardh bzw. Leiblein identifizierte er deshalb im mehrfachen Irrtum mit völlig andersartigen und untereinander verschiedenen Formengruppen: 1. mit *Licmophora abbreviata* C. Ag., einer marinen Form (Kützing 1833 a p. 572); 2. mit *Licmophora minuta* C. Ag. syn. *Gomphonema minutum* (C. Ag.) C. Ag., einer reinen Süßwasserform; 3. einer Reihe infraspezifischer Taxa und vermeintlicher Synonyme, die aus wiederum anderen Formengruppen stammen. In der Sekundärliteratur sind diese Taxa dann noch weiter verwirrt worden.

Ein Vergleich des heterogenen Herbarmate-

Fig. 1. (A–V × 1500, W × 1000). — A: *Rhoicosphenia abbreviata* nov. comb., Lectotypus. — B–E: *Gomphonema minutum*, Lectotypus. — F: *G. minutum* = ,,*G. abbreviatum α*) *brevipes*'' (Kützing no. 339). — G–I: *Gomphonema gracile* = ,,*G. abbreviatum α*) *brevipes*'' (Kützing no. 1776). — J: *Gomphonema exiguum*, Lectotypus (Kützing no. 391 aus Flensburg). — K–M: *Gomphonema exiguum* = ,,*G. abbreviatum β*) *longipes*'' (Kützing no. 1265). — N: ,,*Gomphonema abbreviatum* syn. *Licmophora minuta* Ag.'' (Kützing Exsikkat Dec. III no. 23 aus Weißenfels). — O–U: *Gomphonema abbreviatum* sensu Kützing pro parte (O–P: Hustedt no. S 2/52 aus dem Vogtland, Q: Hustedt no. 75/32 aus Finnland; R–S: ,,forma *brasiliensis* (Kg.) Grun.'' Hustedt no. 333/13b aus El Salvador; T–U: aus der Saône in Frankreich). — V: *Gomphonema* aff. *herculeanum* aus Israel, mit weiter Streifung, ohne charakteristische Längslinien. — W: *Gomphonema herculeanum* ex Herbar Grunow no. 2592 aus dem Erie See, USA, mit den charakteristischen Längslinien.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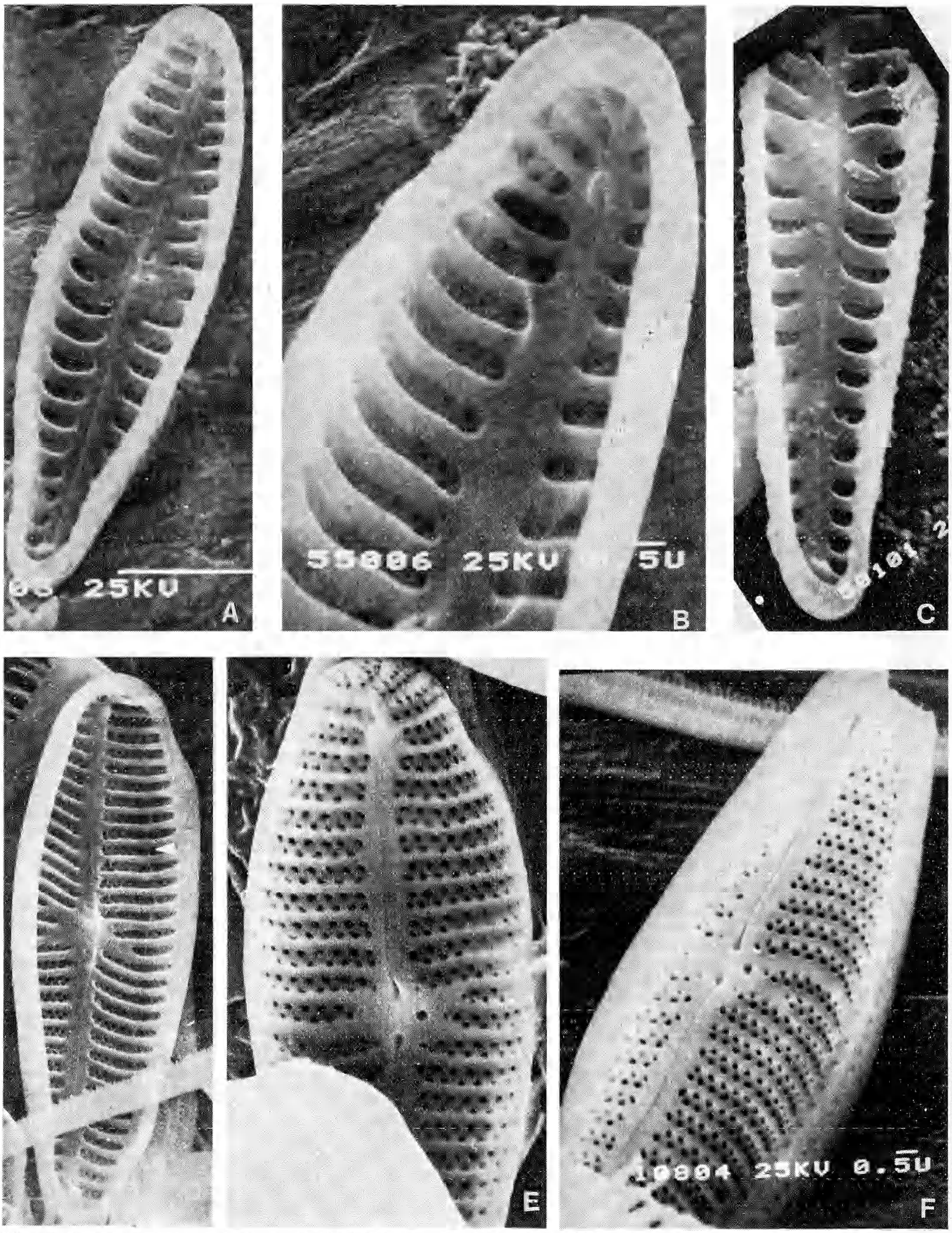

Fig. 2. *Gomphonema minutum*. A–C (SEM, ca. × 5000, × 12000, × 5000): Innenseite von Valven ohne Septenbildung aus Isotypen-Material Agardhs im British Museum London; die gröberen Strukturen sind für alle Populationen in größeren europäischen Flüssen charakteristisch. — D–F (SEM, ca. × 4400, × 7500, × 6000): Valveninnen- und außenseite von Populationen mit den für periglaziale Seen charakteristisch feineren Strukturen, Areolen meist punktförmig, aber auch Übergänge zur Nierenform (E), schwach entwickelte Längssepte (D) rechtsseitig. (D–E: „*Gomphonema curtum*" Hustedt aus dem Ochridsee, Typenmaterial; F: aus dem Genfer See.)

rials von Kützing im British Museum und der Typen aus der Sammlung C. A. Agardh in Lund führt zu folgenden Ergebnissen:

1) Kützing revidierte seinen Irrtum, *Licmophora abbreviata* C. Ag. mit *Gomphonema abbreviatum* C. Ag. zu synonymisieren, bereits 1844 (p. 122) duch Überführung der marinen Form in die Gattung *Rhipidophora*.
2) ,,*G. abbreviatum β) longipes*'' im Herbar Kützing no. 1265 = BM no. 18610 ist in Fig. 1 K–M dargestellt; diese Form gehört zu *G. exiguum* Kütz. (vgl. Fig. 1 J).
3) ,,*G. abbreviatum*'', im Herbar Kützing no. 870 aus der Dreisam in Freiburg, leg. A. Braun = BM no. 18606 enthält *G. constrictum* und *G. acuminatum*.
4) ,,*G. abbreviatum α) brevipes*'' im Herbar Kützing no. 1776 = BM no. 18607 aus Penzance in der englischen Grafschaft Cornwall stammt von Ralfs und enthält die in Fig. 1 G–I gezeigte Form, die zum sehr variablen, schwer abzugrenzenden Formenkreis von *G. gracile* gehört.
5) ,,*G. abbreviatum α) brevipes*'' im Herbar Kützing no. 339 = BM no. 18608 entspricht dem Typus von *G. minutum* (C. Ag.) C. Ag.
6) Das Exsikkat Kützings Alg. aquae dulcis Germ. Decas III no. 23, aus Weißenfels, bezeichnet als ,,*Licmophora minuta* C. Ag.'', enthält nicht C. A. Agardhs Taxon, sondern — soweit erkennbar — eine Population aus dem Formenkreis, der heute von den meisten Autoren (z. B. Hustedt 1930 p. 379, fig. 722) als *G. abbreviatum* verstanden wird. Gemeint ist eine Form mit verkürzten Transapikalstreifen, ohne Stigma (vgl. Fig. 1 N).
7) Das Typenmaterial von *Gomphonema minutum* in der Coll. C. A. Agardh no. 4688 zeigt eine der in Europa häufigsten Arten aus dieser Gattung. Sie ist konspezifisch mit *Gomphonema curtum* Hust. bzw. *Gomphoneis curta* (Hust.) Lange-B.

Taxonomische Revision:

Gomphonema minutum (C. Ag.) C. A. Agardh 1831 p. 34 (Fig. 1 B–E, Fig. 2 A–C, Fig. 3 A, B, Fig. 5 D). Basionym: *Licmophora minuta* C. A. Agardh 1827 p. 629. Typuslokalität: Isar bei München ,,in der Thal''. Lectotypus: Coll. C. A. Agardh in Lund no. 4688 (design. Lange-Bertalot).

Synonyme: *Gomphonema curtum* Hustedt 1945 p. 939, t. 42, figs. 37–43. *Gomphoneis curta* (Hust.) Lange-B. 1978 p. 405, t. 10, figs. 4–10, t. 11, figs. 1–4.

Aus der Synonymie auszuschließen sind: *Licmophora minuta* sensu Kützing 1833 b (Exs. Alg. aquae dulcis Germ. Dec. III no. 23). *Gomphonema abbreviatum* sensu Kützing 1844 p. 84.

Beschreibung: Frusteln in Gürtelbandansicht keilförmig, Grad der Heteropolarität etwa wie bei *G. olivaceum*. Valven von fast oval bis linealisch-keulenförmig ohne jede transapikale Auftreibung in der Mitte, allmählich gegen die stumpf gerundeten Pole verschmälert. Dichte der Transapikalstreifen in unterschiedlichen Biotopen sehr variabel (8–18 in 10 μm), in oligotrophen Gewässern wesentlich dichter als in eutrophen (analog zu *G. olivaceum*). Im Bereich der Zentralarea sind beidseitig ein oder einige Streifen verkürzt, isoliertes Stigma vorhanden. Axialarea variiert von sehr eng bis mäßig weit. Raphen an beiden Polen gleichsinnig in Raphenspalten auslaufend, Polarknoten von den Enden etwas entfernt gestellt.

Im EM: Transapikalstreifen aus Doppelreihen mit alternierenden Areolen gebildet; Gallertporen am Fußpol vorhanden; alle Feinstrukturen sind in Abhängigkeit von der Ökologie der Biotope außerordentlich variabel.

Es erscheint sicher, daß die im Süßwasser sehr verbreitete Art von anderen Autoren mit *G. intricatum* var. *pumilum* oder anderen Taxa verwechselt worden ist.

Zum Problem Gomphonema/Gomphoneis

Die Gattung *Gomphoneis* wird nur von einem Teil der Diatomeentaxonomen anerkannt. Jedoch sind bisher kaum überzeugende Argumente dafür oder dagegen geäußert worden. Cleve (1894 p. 73) trennte sie von *Gomphonema* ab, weil er bei einigen großschaligen Arten die Transapikalstreifen lichtmikroskopisch als Doppelreihen von Punkten auflösen konnte und parallel zu den Schalenrändern je eine apikal verlaufende Linie erkannte. Diese Merkmale konnten nun jedoch elektronenoptisch von Dawson (1974) und Lange-Bertalot (1978) auch bei kleinschaligen Taxa festgestellt werden. Konsequenterweise wurden sie in Analogie zu Cleve deshalb in die Gattung *Gomphoneis* überführt. Inzwischen konnten aber weitere Formen mit solchen Doppelreihen gefunden werden (Lange-Bertalot unveröffentlicht) und vor allem auch Übergangsstadien zwischen Ein- und Doppelreihigkeit (vgl. Figs 4–5). Linienhafte Andeutungen von apikal verlaufenden Septen sind bei

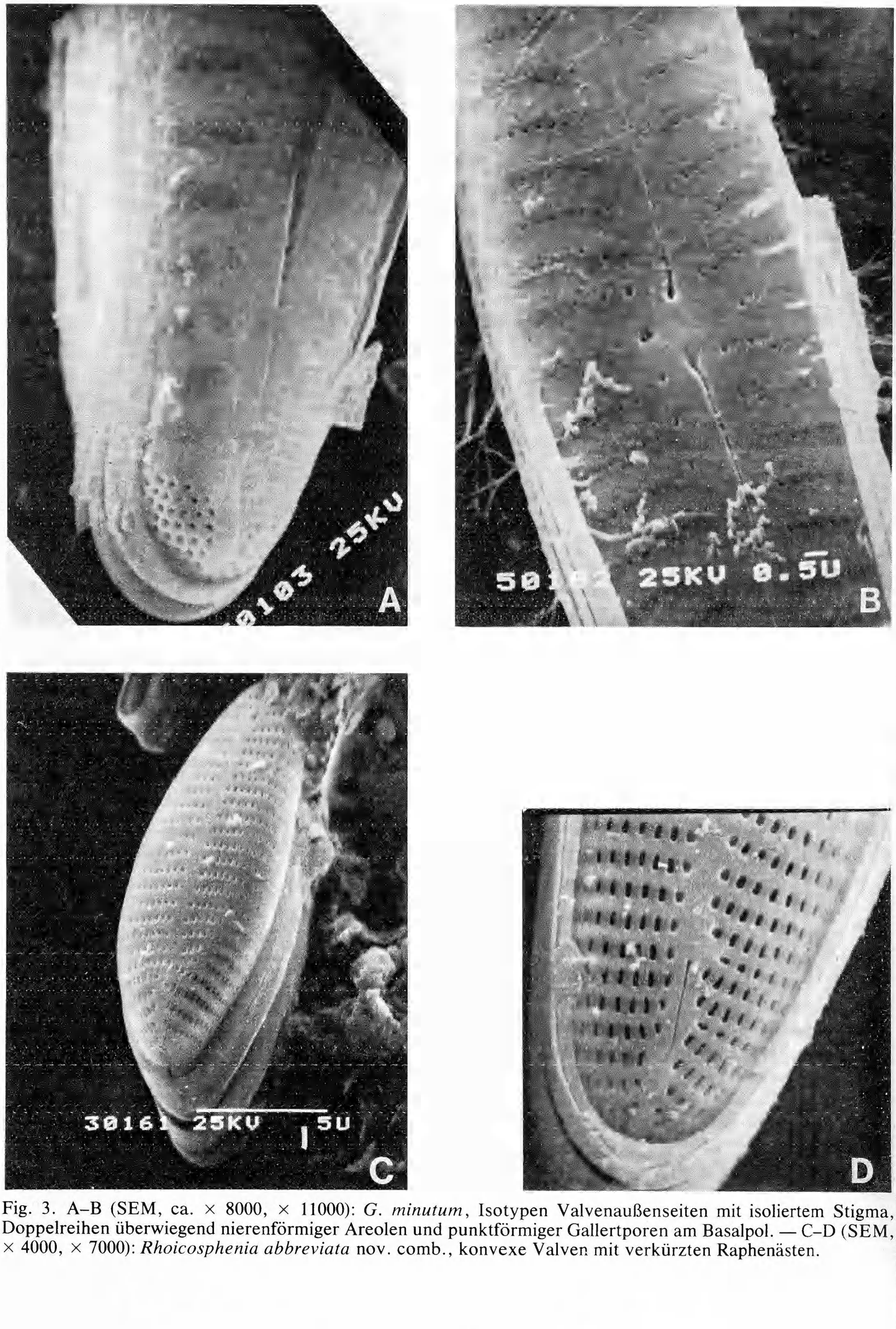

Fig. 3. A–B (SEM, ca. × 8000, × 11000): *G. minutum*, Isotypen Valvenaußenseiten mit isoliertem Stigma, Doppelreihen überwiegend nierenförmiger Areolen und punktförmiger Gallertporen am Basalpol. — C–D (SEM, × 4000, × 7000): *Rhoicosphenia abbreviata* nov. comb., konvexe Valven mit verkürzten Raphenästen.

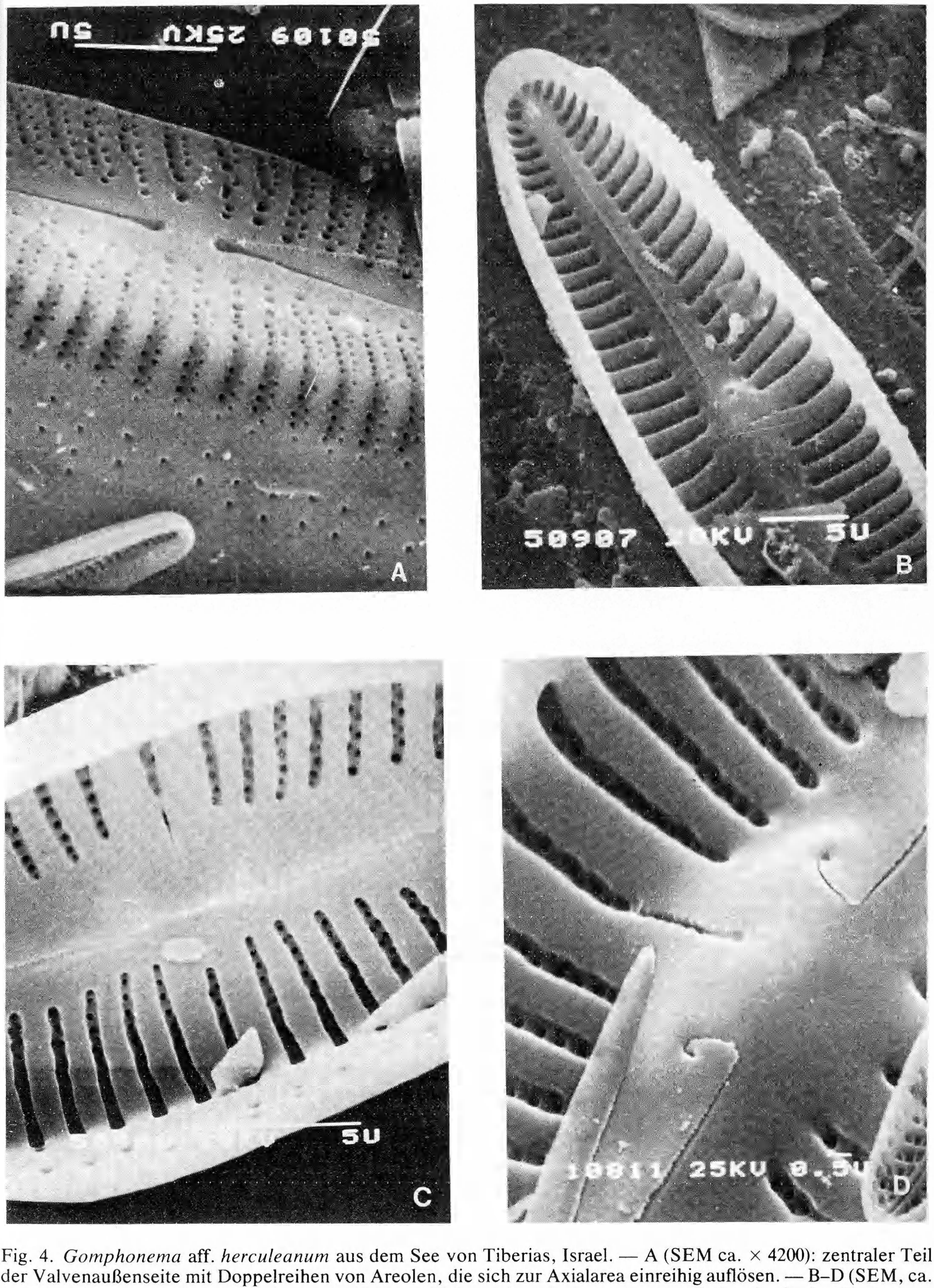

Fig. 4. *Gomphonema* aff. *herculeanum* aus dem See von Tiberias, Israel. — A (SEM ca. × 4200): zentraler Teil der Valvenaußenseite mit Doppelreihen von Areolen, die sich zur Axialarea einreihig auflösen. — B–D (SEM, ca. ×2600, ×4200, × 8000): Innenseiten verschiedener Valven ohne Andeutung von apikal verlaufenden Septen.

G. minutum nur ausnahmsweise, bei *G. olivaceum* bislang nicht gefunden worden (vgl. Dawson 1974 figs 6–8, Lange-B. 1978 t. 11, fig. 2 u. 5). Aber auch bei den „etablierten" großen *Gomphoneis*-Arten können sie fehlen (vgl. auch Patrick & Reimer 1975 t. 21, fig. 5). Fig. 1 V zeigt ein besonders kleines Individuum einer Population aus dem See von Tiberias (Kinneret) in Israel. Die Merkmale, Form des Kopfpols sowie Streifendichte, weichen von den nächstähnlichen Taxa *G. mamillum* und *G. herculeanum* deutlich ab. Wenn man jedoch vergleichsweise die Variabilität bei *G. olivaceum* in Betracht zieht (Lange-Bertalot 1978 t. 10, figs 1–3), dann erscheint die Einführung einer neuen Species nicht gerechtfertigt. Wie *G. minutum* zeigen auch andere *Gomphonema*-Arten in oligotrophen Seen oft eine Tendenz zu feineren und dichteren Strukturen, in größeren Flüssen dagegen zu gröberen Silikatrippen. Hinzu kommt, daß auch in anderen Gattungen, z. B. *Achnanthes, Navicula, Nitzschia* mehrreihige Anordnung der Areolen kein Kriterium zur Abtrennung unabhängiger Gattungen ist. Die Areolen bzw. Foramina sind ebenfalls zwischen den „*Gomphonema*-typisch gebogenen Formen" und „*Gomphoneis*-typisch einfachen Poren" variabel. Bei *G. minutum* sowie *G. angustatum* besitzen manche Populationen einfach lochartige Areolen, andere kontinuierliche Übergänge zu mondsichel- bis nierenförmigen Strukturen (Figs 4–5), so daß diese Möglichkeit der Unterscheidung zwischen *G. angustatum* und *G. parvulum* praktisch entfällt (vgl. Lange-Bertalot 1978). Ein Septum am apikalen Pol kann ebenso wenig als gattungsspezifisch gewertet werden, weil es in ausgeprägter Form auch bei *Rhoicosphenia* auftritt, andererseits bei verschiedenen „*Gomphoneis*"-Populationen, falls überhaupt vorhanden, nur sehr schwach ausgebildet ist, jedenfalls nicht verschieden von unbestrittenen *Gomphonema*--Species. Somit sprechen alle überzeugenden Argumente für die infragenerische, teilweise sogar infraspezifische Variabilität dieser Merkmale und folglich für die Einziehung des Taxons *Gomphoneis*.

Diese Wertung wird noch durch einen weiteren morphologischen Befund gestützt: *G. abbreviatum* sensu Kützing (1833 b) und sensu Hustedt zeigt elektronenmikroskopisch von anderen Gomphonemata so erheblich abweichende Feinstrukturen (u. a. fehlende polare Raphenspalten und Gallertporen, pinnularia-ähnliche Kammerung), daß nochmals eine neue Gattung abgetrennt werden müßte (vgl. Fig. 5 E–G), was im gegenwärtigen Stadium der Diatomeensystematik wenig sinnvoll erscheint. (Eine ausführlichere Darstellung über die Charakteristika dieses Taxons ist in Vorbereitung.)

Dank

Mein besonderer Dank gilt Herrn Ove Almborn vom Botanischen Museum in Lund für die großzügige Hilfe bei der Beschaffung der C. A. Agardh-Typen gleichermaßen den Damen und Herren Patricia Sims, T. B. B. Paddock, R. Ross (London), U. Passauer (Wien) und R. Simonsen (Bremerhaven). Hilfreiche Diskussionsbeiträge lieferte außerdem J. Carter (Hawick). Für ausgezeichnete technische Assistenz danke ich den Damen U. Rumrich und A. Barth. Die EM-Photographien wurden von U. Rumrich (5 B) und M. Ruppel (alle anderen) ausgeführt.

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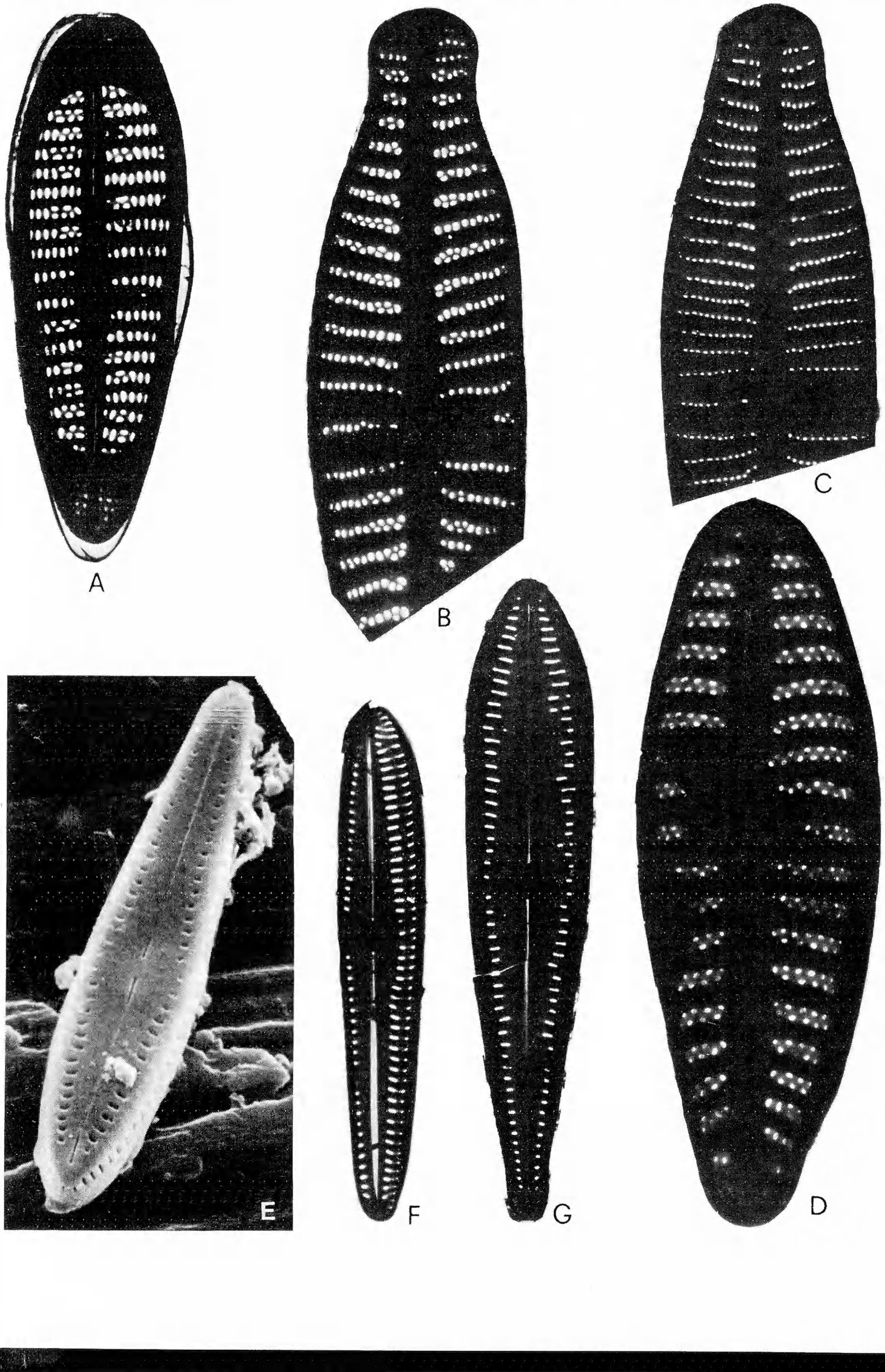
Fig. 5. A (TEM, × 6200): *Rhoicosphenia abbreviata*, übergänge von einfachen zu doppelten Areolenreihen. — B: (TEM, × 8700): *Gomphonema angustatum* mit Übergängen zur Doppelreihigkeit der normalerweise einreihigen Areolen. — C (TEM, × 6700): *G. angustatum* mit einreihigen Areolen. — D (TEM, × 9700): *G. minutum*, Isotyp. — E–G (SEM, × 4500, TEM, × 3300, × 3300): *Gomphonema abbreviatum* sensu Kützing (1833 b non al.) nec Agardh; statt typischer Areolen wie bei anderen Gomphonemata schlitzförmige pinnulariaähnliche Kammerung, die regelmäßig am Übergang zwischen Valvarfläche und Mantelrand unterbrochen ist; Raphenäste enden an den Polen in je einer Pore ohne Polarspalt, Gallertporen fehlen.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Synuraceae and other Chrysophyceae from central Småland, Sweden

GERTRUD CRONBERG and JØRGEN KRISTIANSEN

Cronberg, G. & Kristiansen, J. 1980 12 15: Synuraceae and other Chrysophyceae from central Småland, Sweden. *Bot. Notiser 133:* 595–618. Stockholm. ISSN 0006-8195.

In spring 1979 the chrysophycean flora at 18 localities in two areas in central Småland, southern Sweden (Aneboda and Växjö) was investigated using EM. Altogether, 73 taxa of Chrysophyceae and allied groups were found, of which 15 taxa of Synuraceae and 2 other Chrysophyceae are new to Sweden. In all, 38 species of Chrysophyceae are pictured by TEM and SEM. *Paraphysomonas takahashii* nov. spec., *Synura petersenii* f. *asmundiae* nov. f., *S. petersenii* f. *bjoerkii* nov. f., and *Mallomonas pulchella* (Kisselev) nov. comb. are described. The occurrence of Chrysophyceae in the examined lakes is discussed in relation to some environmental factors and compared with their occurrence in Sweden as a whole and their general distribution.

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During May 1–5, 1979, the chrysophycean flora was investigated in 18 localities (lakes and ponds) in two areas in central Småland, southern Sweden, viz. lakes around the village of Aneboda and the town of Växjö. The investigation was made during one week after ice break-up. 73 taxa were found, including one new species and two new forms. Of these, 17 had not previously been reported from Sweden, and the occurrence in Sweden of only a few of the remaining scaled Chrysophyceae had previously been confirmed by means of electron microscopy (EM).

The lakes around Aneboda and in Växjö are in classical limnological investigation regions and were already studied by Naumann (1910–1934, for background data, see Naumann 1927), and Thunmark (1931–1968, for phytoplankton investigations, see Naumann, 1917, 1925, Thunmark 1945 a and b). Since 1968 the phytoplankton in the Växjö region has been thoroughly studied in the restoration projects (Bengtsson et al. 1972, Cronberg et al. 1975, Cronberg 1980 a).

Even if Chrysophyceae play an important part in the phytoplankton of Swedish lakes, their distribution in Sweden is not satisfactorily known. This especially applies to species with silica scales, the Synuraceae.

Fott (1955), as well as Bourrelly (1965) and Kristiansen (1979), pointed out that examination of scales by electron microscopy is necessary for a reliable identification of Chrysophyceae. Even though EM investigations have been performed occasionally in this area (Asmund 1977, Cronberg 1972, 1973, 1975, 1980 a (Lake Trummen) and b, Kristiansen 1969), the chrysophycean flora remains essentially unknown.

In addition to the works already mentioned, there are only two other EM studies on scaled Chrysophyceae from Sweden, namely Petersen and Hansen (1968), including material from Lappland, and Thomasson (1970) from Värmland.

The investigation area

The investigation comprised lakes and ponds in two adjoining but different regions.

The localities in the Aneboda region are unpolluted, clear or more or less humic. Most of them are acid, in part naturally, in part through

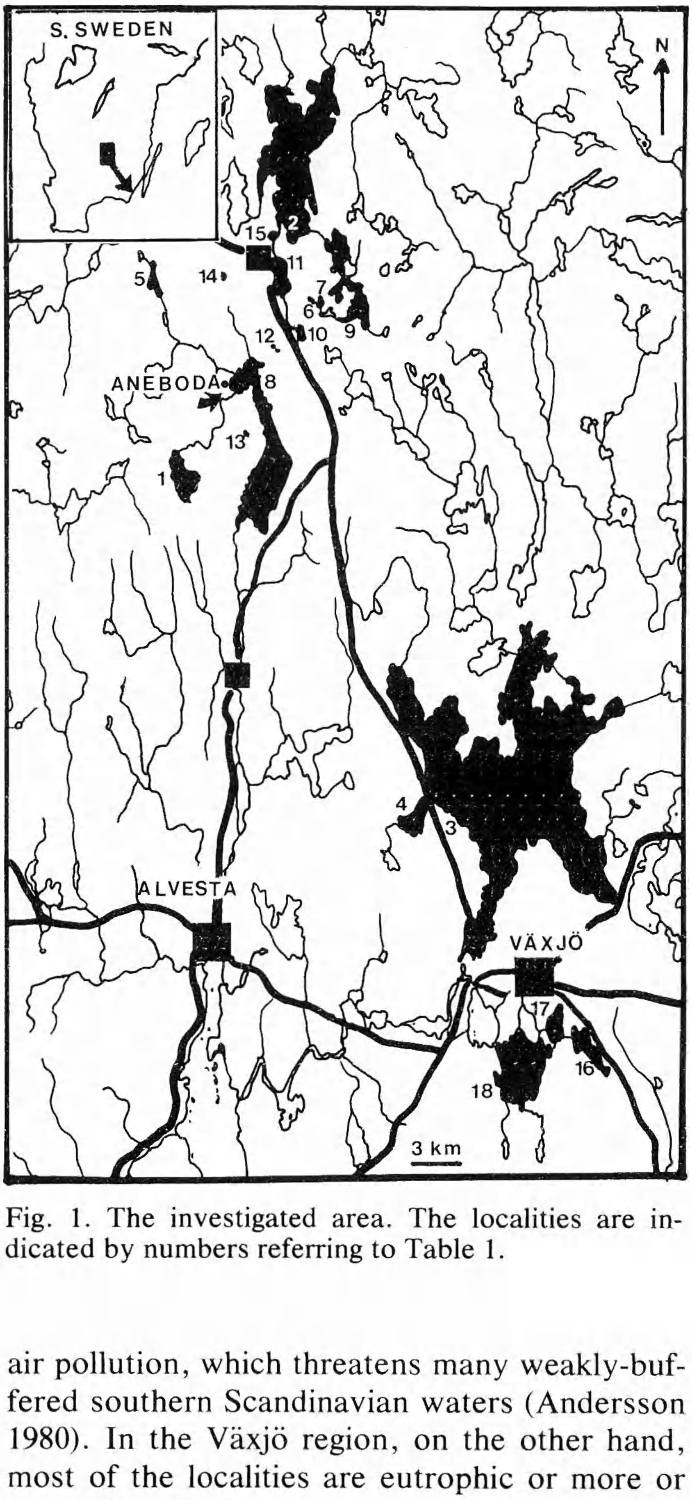

Fig. 1. The investigated area. The localities are indicated by numbers referring to Table 1.

air pollution, which threatens many weakly-buffered southern Scandinavian waters (Andersson 1980). In the Växjö region, on the other hand, most of the localities are eutrophic or more or less polluted, even though restoration measures have succeeded in bringing one of them, Lake Trummen, to a more healthy condition (Bengtsson et al. 1972, Cronberg et al. 1975).

A survey of the localities examined during this investigation is given below in Table 1, and their positions are indicated on the map (Fig. 1).

Material and methods

The material containing Chrysophyceae was collected by plankton net (mesh size 10–25 μm) from the shore. Water samples were also taken, and after centrifugation these were examined alive together with the net samples by light microscopy (LM) at the Aneboda Field Station. Parallel samples were fixed in Lugol's solution (Willén 1962) and later prepared for EM as follows: After the material was rinsed with distilled water in a centrifuge, it was dried on carbon-coated grids, some of which were shadowcast with chromium in a JEE 2B vaccuum evaporator. The grids were examined in a JEM-T7 electron microscope (Institute of Plant Anatomy & Cytology, University of Copenhagen). Additional material, mostly from previous years, was prepared according to Cronberg (1973, 1975) and photographed in a Cambridge Stereoscan Mark IIa scanning electron microscope (Institute of Zoology), and by means of a Philips EM 300 (Institute of Microbiology), both University of Lund.

Table 1. Chemical and physical data for the investigated lakes during May 1–11, 1979. · = no analyses made.

Lake	Temp. C°	pH	Colour mg Pt/l
Oligotrophic clear water lakes			
1. Fiolen	5.7	5.90	5
2. Allgunnen	5.4	6.30	30
3. Helgasjön	5.8	·	·
4. Lillesjön	5.6	·	·
Oligotrophic humic lakes			
5. Skärshultsjön	5.8	5.85	80
6. Grönegångs göl	6.0	5.47	80
7. Gårdsjön	6.4	6.23	90
8. Stråken	8.0	6.12	50
9. Lången	6.4	5.85	110
10. Frejen	7.0	5.40	120
11. Lammen	6.2	5.60	150
12. Ugglehultsdammarna	5.5	6.15	·
13. Byggets göl	6.8	4.10	160
14. Adams göl	6.6	6.72	195
Eutrophic-polluted lakes			
15. Kalven	6.0	5.50	150
16. Trummen	9.8	7.29	30
17. Växjösjön	8.0	7.35	51
18. Södra Bergundasjön	7.9	8.10	58

Results

Altogether, 73 species of Chrysophyceae were identified. Of these, 49 belonged to the Synuraceae, and these have been arranged in Table 2 which shows their occurrence by locality. Notes on the different species are given separately below, and species not previously recorded in Sweden (marked by an asterisk) or especially interesting for other reasons are discussed more thoroughly. Electron micrographs of silica scales

Table 2. Distribution of Synuraceae in the investigated lakes during May 1–5, 1979.

Taxon Lake	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Total number
Chrysosphaerella brevispina	+	·	+	·	·	·	+	+	+	·	+	·	·	·	·	+	+	+	9
C. coronacircumspina	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	1
C. multispina	·	·	·	·	·	+	+	·	+	·	·	·	·	·	·	·	·	·	3
Mallomonas acaroides	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	+	·	2
M. actinoloma v. *maramuresensis*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·	1
M. akrokomos	+	+	+	+	·	·	·	+	+	+	+	·	·	+	·	+	+	+	12
M. alpina	+	·	+	·	·	·	·	·	·	·	·	·	·	·	·	+	+	·	4
M. calceolus	·	·	·	+	·	·	·	·	·	+	+	·	·	·	·	·	·	·	3
M. caudata	+	+	+	+	+	+	+	+	+	+	+	+	·	+	+	·	·	·	14
M. crassisquama	+	+	+	+	+	+	+	+	+	+	+	+	·	·	+	+	+	·	15
M. cratis	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	1
M. elongata	·	+	·	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·	2
M. eoa	·	·	+	·	·	·	+	·	·	·	·	·	·	·	·	+	+	+	5
M. hamata	+	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	2
M. heterospina	+	+	+	+	·	·	·	·	+	·	+	·	·	+	·	+	+	+	10
M. insignis	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	+	·	2
M. intermedia	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·	1
M. lychenensis	·	·	·	·	·	+	+	·	+	·	·	·	+	·	·	·	·	·	4
M. paludosa	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	1
M. papillosa	·	·	·	·	·	·	·	+	·	·	+	+	·	+	·	·	·	·	4
M. pillula	+	·	+	+	·	+	·	·	·	·	·	·	·	·	+	·	·	·	5
M. pulchella	·	+	·	·	·	·	·	+	·	·	·	·	·	+	·	+	+	·	5
M. pumilio	·	·	·	·	·	·	+	+	+	·	·	·	·	·	·	·	·	·	3
M. schwemmlii	·	+	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·	+	3
M. striata	·	·	·	·	·	·	·	+	·	·	·	·	·	·	+	+	·	·	3
M. teilingii	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	1
M. tonsurata	·	·	+	+	·	+	·	·	·	·	·	·	·	·	·	·	·	·	3
M. torquata	·	·	·	·	·	+	+	+	+	·	·	·	·	·	·	+	+	·	6
M. transsylvanica	·	·	·	·	·	+	·	+	·	·	·	·	·	·	·	·	·	·	2
M. vannigera	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	1
Paraphysomonas corbidifera	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	1
P. takahashi	+	·	·	·	+	·	·	·	+	+	·	·	·	·	+	·	·	·	5
P. imperforata	·	+	+	·	+	·	+	·	·	·	·	·	+	+	+	+	+	·	9
P. vestita	+	+	+	+	+	+	·	+	·	·	+	+	·	+	+	·	+	·	12
Spiniferomonas bilacunosa	+	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	2
S. bourrellyi	+	+	+	+	+	+	+	+	+	+	+	·	·	·	+	·	·	+	13
S. conica	·	·	·	+	·	·	+	·	+	·	·	·	·	·	·	·	·	·	3
S. trioralis	+	·	+	+	·	·	·	·	+	·	·	·	·	·	·	+	·	·	5
Synura curtispina	·	·	+	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	2
S. echinulata	·	·	+	+	+	·	+	+	+	·	+	+	·	·	+	+	·	·	10
S. lapponica	·	·	+	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	2
S. petersenii f. *petersenii*	+	+	+	+	+	+	+	+	+	+	+	+	·	+	+	+	+	·	16
S. petersenii f. *asmundiae*	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	1
S. petersenii f. *bjoerkii*	·	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	1
S. sphagnicola	·	·	·	+	·	+	+	·	+	+	+	·	+	·	+	·	·	·	8
S. spinosa f. *spinosa*	·	·	+	+	·	·	·	+	·	+	+	+	·	·	+	+	+	+	10
S. spinosa f. *longispina*	·	·	·	·	·	+	·	·	·	·	+	·	·	·	·	·	·	·	2
S. spinosa f. *mollispina*	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	1
S. uvella	+	·	+	+	·	·	·	·	·	·	·	+	·	·	·	·	·	·	4
Number of species:	17	11	20	19	8	14	14	15	17	9	15	9	5	8	14	18	15	7	

are given mainly for species not previously illustrated from Sweden. In some cases it was not possible to provide illustrations of adequate quality using material from the localities in this investigation. We have then used material from previous years or from other lakes in the area.

Species of Synuraceae, Chrysophyceae

Chrysosphaerella brevispina Korshikov 1942, Fig. 2 A

C. rodhei Skuja 1948.

Occurrence of this species in different types of localities is in accordance with its being a very common alga in Sweden during early spring. EM micrographs by Cronberg (1980 a Figs. 63, 64).

C. coronacircumspina Wujek & Kristiansen 1977, Fig. 2 B

C. solitaria Preisig & Takahashi 1978.

Described as late as 1977 from USA this species has proved to be widely distributed. It has been found in Lake Stråken before, as Kristiansen (1969 Fig. 2 C) depicted a scale as belonging to *C. multispina* which was shown to belong to this species by Wujek et al. (1977).

In spite of occurrence in just one locality during this investigation it has now been recognized in a great number of localities all over Sweden (Cronberg, unpublished).

C. multispina Bradley 1964, Fig. 2 C

Was only found in three localities, certainly due to the unfavorable season for this alga. In fact, this is a typical species in oligotrophic humic lakes in Sweden during summer, and it has previously been recorded from Lake Stråken (Kristiansen 1969 Figs. 1–3), and from Lake Trummen (Cronberg 1980 a Figs. 65, 66).

The many LM records of *C. longispina* from Sweden mostly refer to this species (Kristiansen 1969).

Mallomonas acaroides Perty 1851 em. Ivanoff 1899, Fig. 3 A

Has been frequently recorded from Swedish lakes, but in almost all cases (except Cronberg 1980 a Figs. 78–80) based only on LM evidence. Thus other species may have been included.

During this investigation it was only found in the most eutrophic lakes, which is in accordance with its general pattern of occurrence in Sweden as well as in Denmark (Asmund 1959). Generally it occurs sparsely in spring but is more frequent during summer.

*****M. actinoloma** Asmund & Takahashi 1969 var. **maramuresensis** Péterfi & Momeu 1976, Fig. 3 B

Has not previously been reported from Sweden and has a scattered occurrence. It is also known from Denmark as pictured by Asmund (1959 Fig. 37 a) sub nomine *M. striata*, and unpublished (Kristiansen).

M. akrokomos Ruttner in Pascher 1913, Fig. 3 C

Syn.: *M. pauciseta* Naumann 1924.

Is a very common species in Sweden, known from both LM, which provides reliable identification, and EM examinations. It was one of the most frequent species during this investigation, occurring in all types of lakes, and has previously been recorded in the area (Cronberg 1980 a Figs. 81–84). It is one of the species typically occurring during ice break-up.

M. pauciseta Naumann was described from ponds in this area (Naumann 1924) and never reported elsewhere. According to the diagnosis it only diverges from *M. akrokomos* in size and cell shape. *M. akrokomos* is rather variable in these feataures (while apparently stable in scale morphology), and *M. pauciseta* fits into its variation range. Thus it was soon included in *M. akrokomos* as var. *pauciseta* (Naumann) Krieger (1930). However, we find no reason to maintain it as a taxon, and the name must be reduced to a synonym for *M. akrokomos*.

M. alpina Pascher & Ruttner 1913, Fig. 3 D

M. tonsurata Teiling var. *alpina* (Pascher & Ruttner) Krieger 1930.

Is a very common species in Sweden, reported on LM evidence by Skuja (e.g. 1948, 1963) among others; in several cases perhaps confounded with *M. tonsurata* Teiling. Electron micrographs published by Cronberg (1980 a Figs. 104–107).

Critical characters for distinguishing this taxon from *M. tonsurata* var. *tonsurata* (Asmund 1959): scales thin, without any secondary layer, only one type of bristle, serrated, spread over the cell, and giving it rather untidy appearance as compared to *M. tonsurata*.

In our opinion these characters justify its treatment as a separate species.

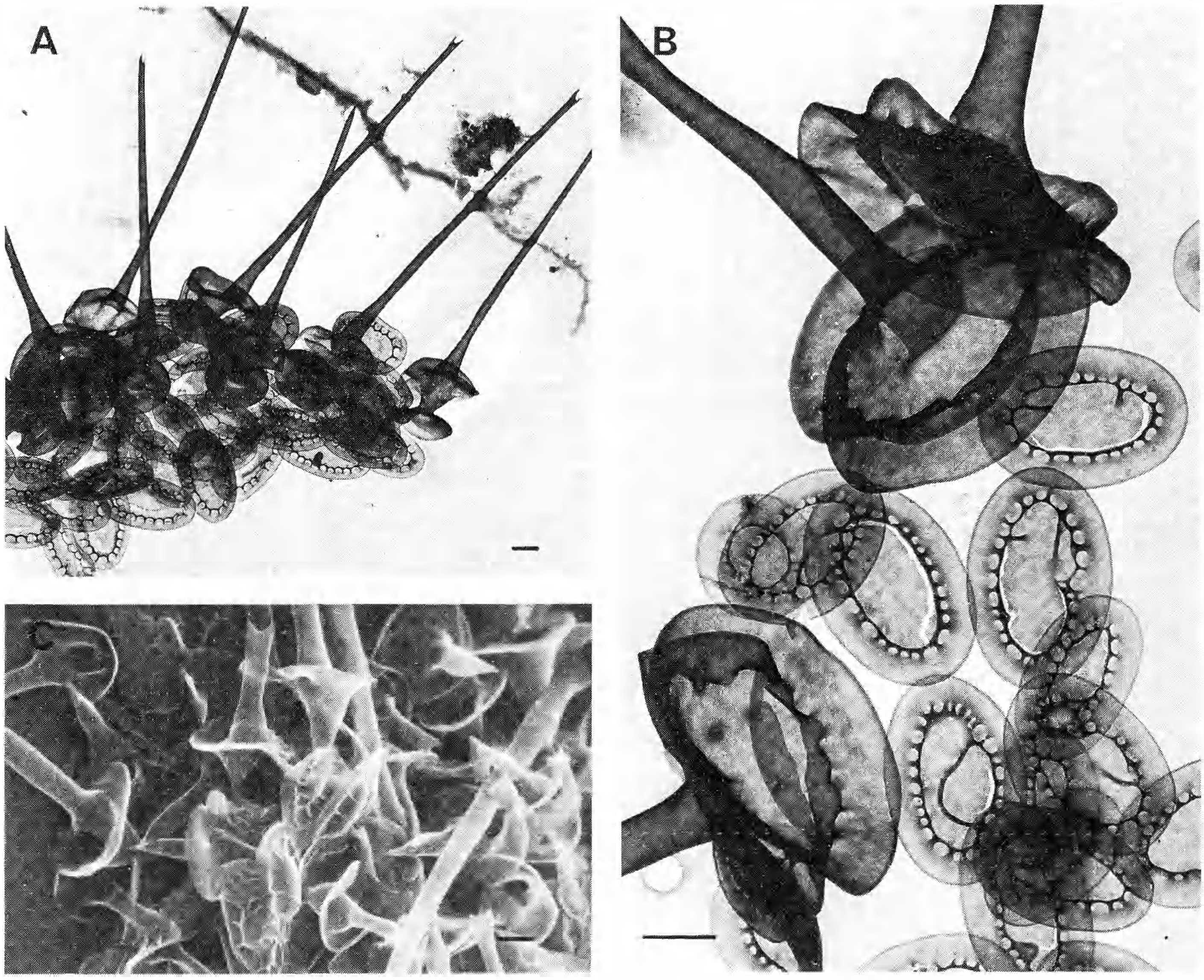

Fig. 2. — A: *Chrysosphaerella brevispina*. Scales and spines. Loc. 9. — B: *C. coronacircumspina*. Spine bases and scales. Loc. 1. — C: *C. multispina*. Scales, short spines, and bases of long spines. Note the characteristic hole in the upper plate of each spine base. Hinnasjön 11.9.69. — SEM. — 1 µm indicated.

M. calceolus Bradley 1964, Fig. 2 E

Was previously mentioned by Asmund (1977), but no illustrations published. Only found in the humic lakes.

M. caudata Iwanov 1899

Was very common in most of the lakes, except the most eutrophic and polluted.

Previously recorded with EM micrographs from the area (Kristiansen 1969 Fig. 4), it is one of the few species which can be identified with certainty by LM, as already stated by Naumann (1917).

M. crassisquama (Asmund) Fott 1962, Fig. 3 F, G

M. acaroides Perty em. Iwanov var. *crassisquama* Asmund 1959.

Is a common and widespread species with the same pattern of occurrence in Sweden as *M. caudata*, only avoiding the most acid and the most eutrophic localities. Previous records with EM micrographs from the area (Kristiansen 1969 Fig. 5) and from central Sweden (Thomasson 1970).

Even if there apparently are transitions to *M. acaroides*, well developed populations of *M. crassisquama* are so characteristic in appearance, especially regarding the long-spined pos-

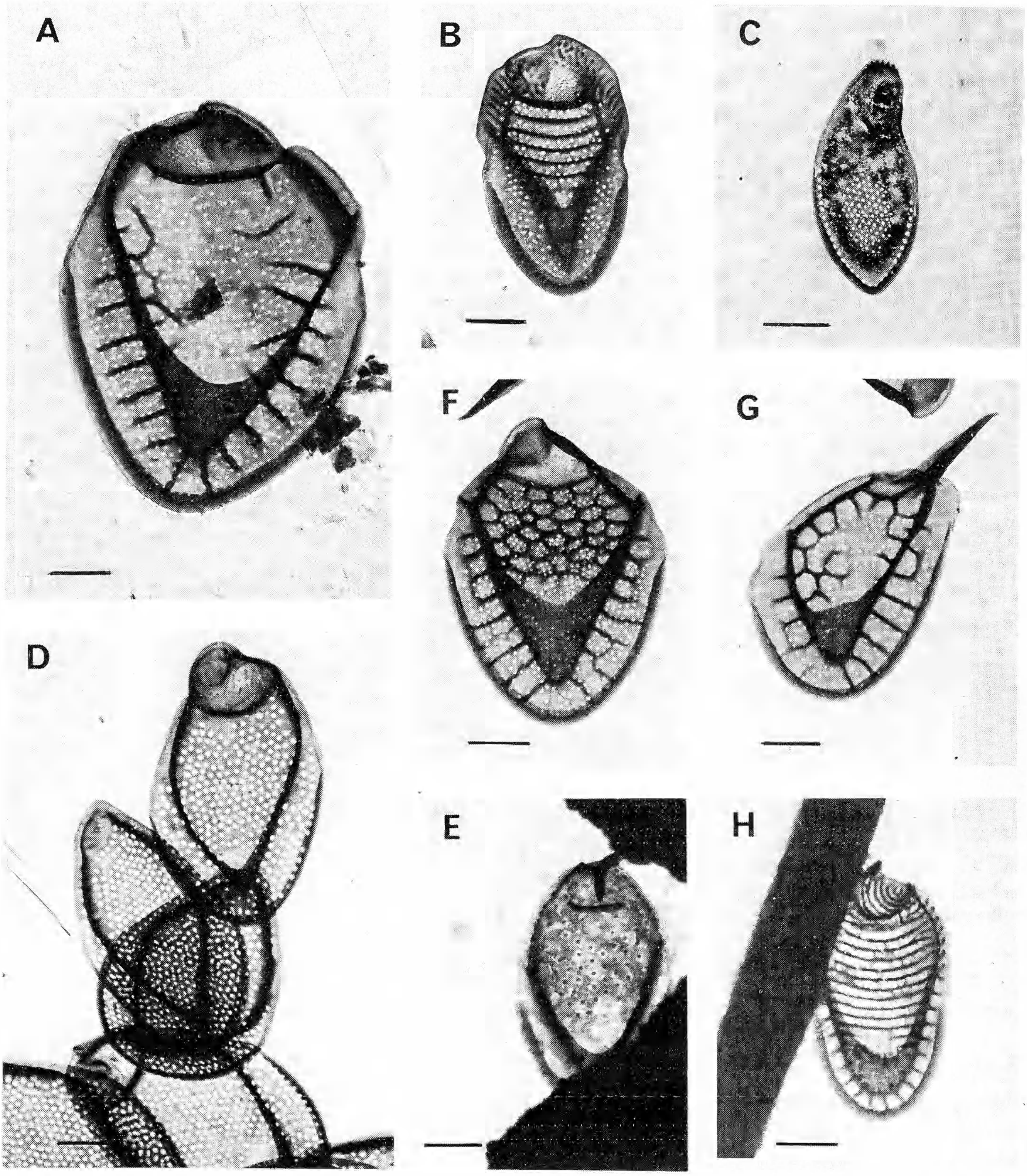

Fig. 3. — A: *Mallomonas acaroides*. Body scale. Loc. 17. — B: *M. actinoloma* var. *maramuresensis*. Scale. Loc. 15. — C: *M. akrokomos*. Apical scale. Loc. 17. — D: *M. alpina*. Apical and body scales. Loc. 17. — E: *M. calceolus*. Scale. Loc. 11. — F, G: *M. crassisquama*. Loc. 17. — F: Body scale. — G: Posterior scale. — H: *M. cratis*. Scale. Loc. 16. — 1 μm indicated.

terior scales and the thick body scales with very well developed meshwork that it appears justified to consider it a separate species. The thick and heavily silicified scales are very resistant, and they are well preserved in lake sediments (Battarbee et al. 1980).

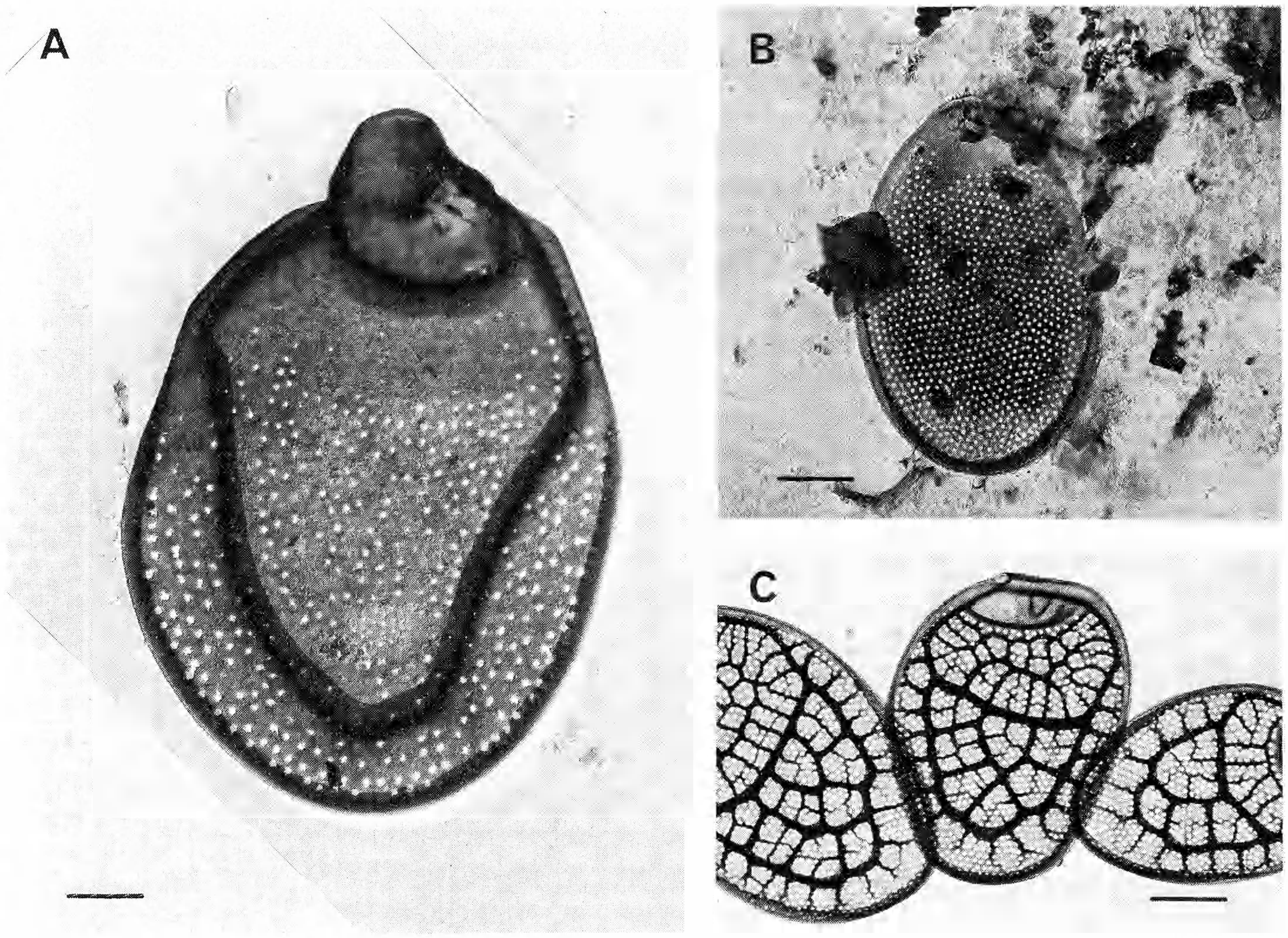

Fig. 4. — A: *Mallomonas elongata*. Scale. Loc. 2. — B: *M. hamata*. Scale. Loc. 1. — C: *M. heterospina*. Scales. Loc. 17. — 1 μm indicated.

***M. cratis** Harris & Bradley 1960, Fig. 3 H

Only one specimen found; not previously found in Sweden. It is a rarely recorded species with a scattered occurrence.

M. elongata Reverdin 1919, Fig. 4 A

Previously mentioned by Asmund (1977), recorded from Trummen and pictured by Cronberg (1980 a Fig. 88).

M. eoa Takahashi 1969 (in Asmund & Takahashi 1969)

Was found in eutrophic and polluted localities. This alga is very common in the Växjö lakes, where it often forms vernal blooms (Cronberg 1973 Figs. 1–6, 1980 a Figs. 90–92, 1980 b).

M. hamata Asmund 1959, Fig. 4 B

Appears to be mostly restricted to clear and acid waters. It has a scattered occurrence in Sweden and was recorded by Asmund (1977) but without EM micrographs.

M. heterospina Lund 1942, Fig. 4 C

Occurs in different types of lakes, including very eutrophic waters. Previously recorded from Sweden by Asmund (1977) and Cronberg (1980 a).

***M. insignis** Pénard 1919, Fig. 5 A

Has never previously been recorded from Sweden. During this investigation it was found in two eutrophic lakes only and with just a few speci-

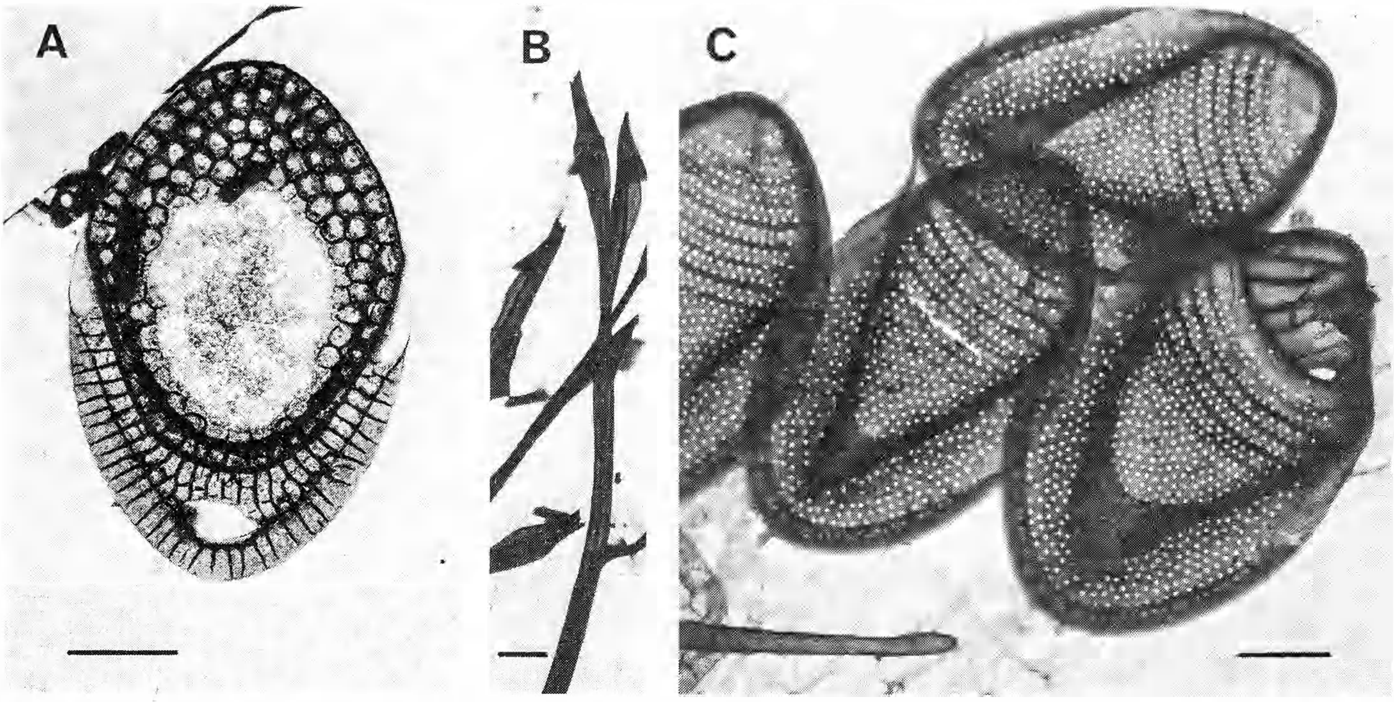

Fig. 5. — A: *Mallomonas insignis*. Body scale. Loc. 16, 7.5.73. — B–C: *M. intermedia*. Loc. 12, 1978. — B: Bristles. — C: Apical and body scales. — 1 μm indicated.

mens. It seems characteristic for this species to occur in very low numbers. It has a scattered distribution including records from Switzerland, England, Denmark and Canada.

*****M. intermedia** Kisselev 1931, Fig. 5 B, C

Not previously recorded from Sweden. Only one fragmented scale was found, with the shield provided with a secondary layer of transverse ribs. Such scales had previously been found in the same locality (Cronberg) in connection with typical *M. intermedia* bristles. Previously, *M. intermedia* has only been described with smooth scales, but several authors have depicted quite similar striated scales of unknown affiliation (e.g. Kristiansen 1978 Fig. 17).

M. lychenensis Conrad 1938, Fig. 6 A

Was previously recorded from Sweden by Skuja (1963) and Asmund (1977), but without illustrations. It is characteristic for the species to occur in humic water.

*****M. paludosa** Fott 1967, Fig. 6 B–D

Not previously recorded from Sweden. Its occurrence in a *Sphagnum* bog corresponds to the original description. Previously published only from Czechoslovakia and Rumania.

M. papillosa Harris & Bradley 1957

Was found in several of the humic lakes and was previously recorded from the area (Kristiansen 1969 Fig. 7, Cronberg 1980 a Figs. 120, 121).

*****M. pillula** Harris 1967, Fig. 7 A

Has not previously been recorded from Sweden, but it occurred in several localities. Corresponding to its scattered records on a global basis, it must be common but often overlooked.

M. pulchella (Kisselev) Cronberg & Kristiansen nov. comb.

M. elegans Lemmermann var. *pulchella* Kisselev 1931 pp. 237, 238, Fig. 3 a–f.
M. coronata Bolochonzew var. *pulchella* (Kisselev) Conrad 1933.
M. punctifera Korshikov 1941.
M. reginae Teiling 1946.

We should have preferred to maintain the combination *M. reginae* Teiling, as the species is well known under this name by many workers in different countries. However, for reasons of priority Balonov & Kuzmín (1975) pointed out that the

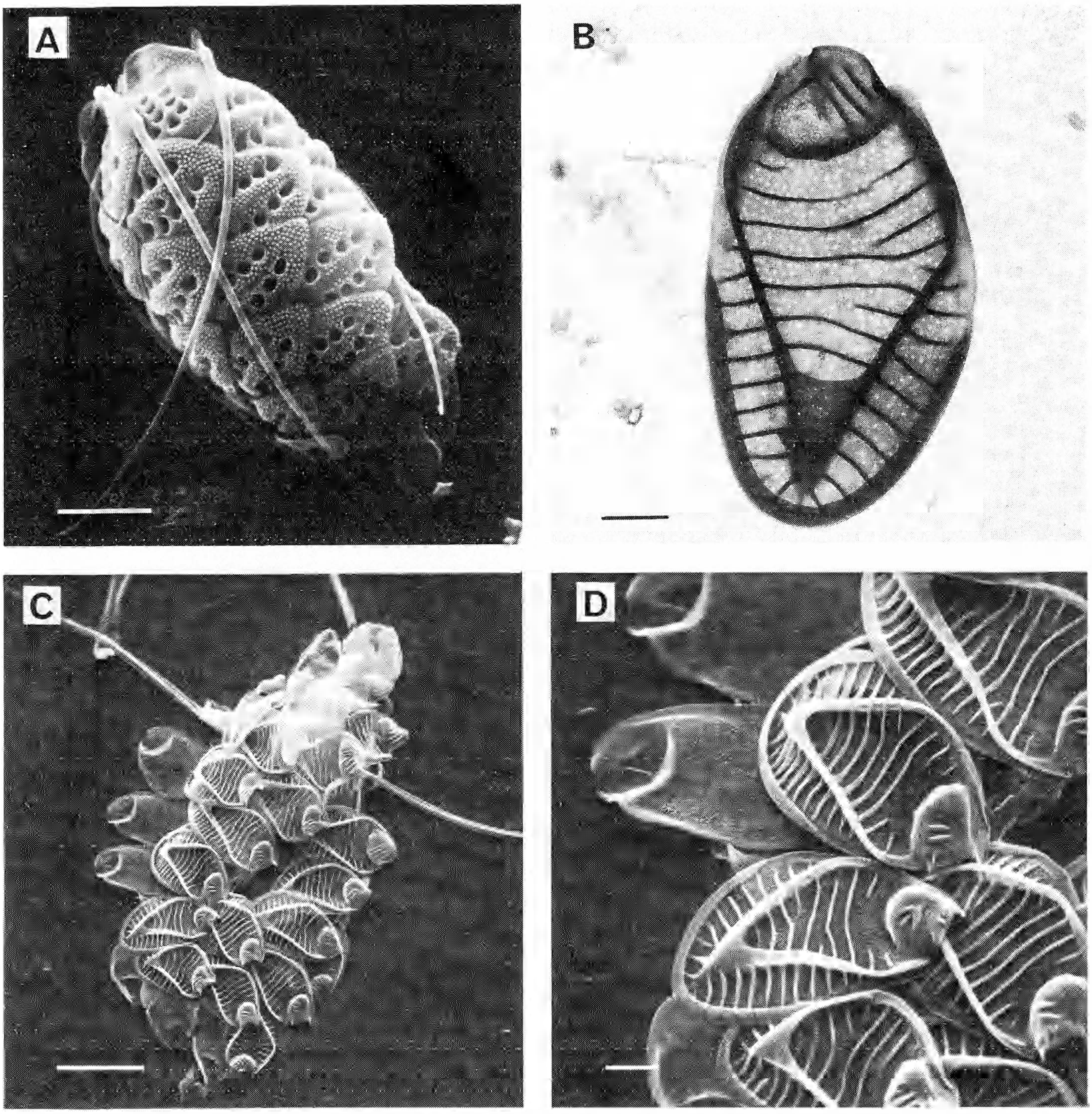

Fig. 6. — A: *Mallomonas lychenensis*. Lake Möckeln 25.2.74. SEM. — B–D: *M. paludosa*. Loc. 13. — B: Single scale. — C: Whole cell. 3.5.73. SEM. — D: Enlarged part of C, showing both surfaces of the scales. SEM. — B and D: 1 μm indicated. A and C: 5 μm.

combination *M. punctifera* Korshikov should be the correct name. If the name must be altered at all, it is necessary to go further back, as we feel that the organism described and pictured by Kisselev (1931) is undoubtedly identical. Especially convincing is a drawing (l.c. Fig. 3 f) of a scale showing its characteristic structure including the meshwork across the shield. The transverse orientation of the scales is also shown (l.c. Fig. 3 c). Lund (1950) was of the same opinion, but did not draw any taxonomical conclusions; Bourrelly (1957) to some extent agreed, but also preferred to maintain the "*reginae*" epithet.

In our opinion the correct name must then be *M. pulchella*.

Kisselev described it as a variety of *M. elegans* Lemmermann (1904), a species which cannot be identified. Later this variety was trans-

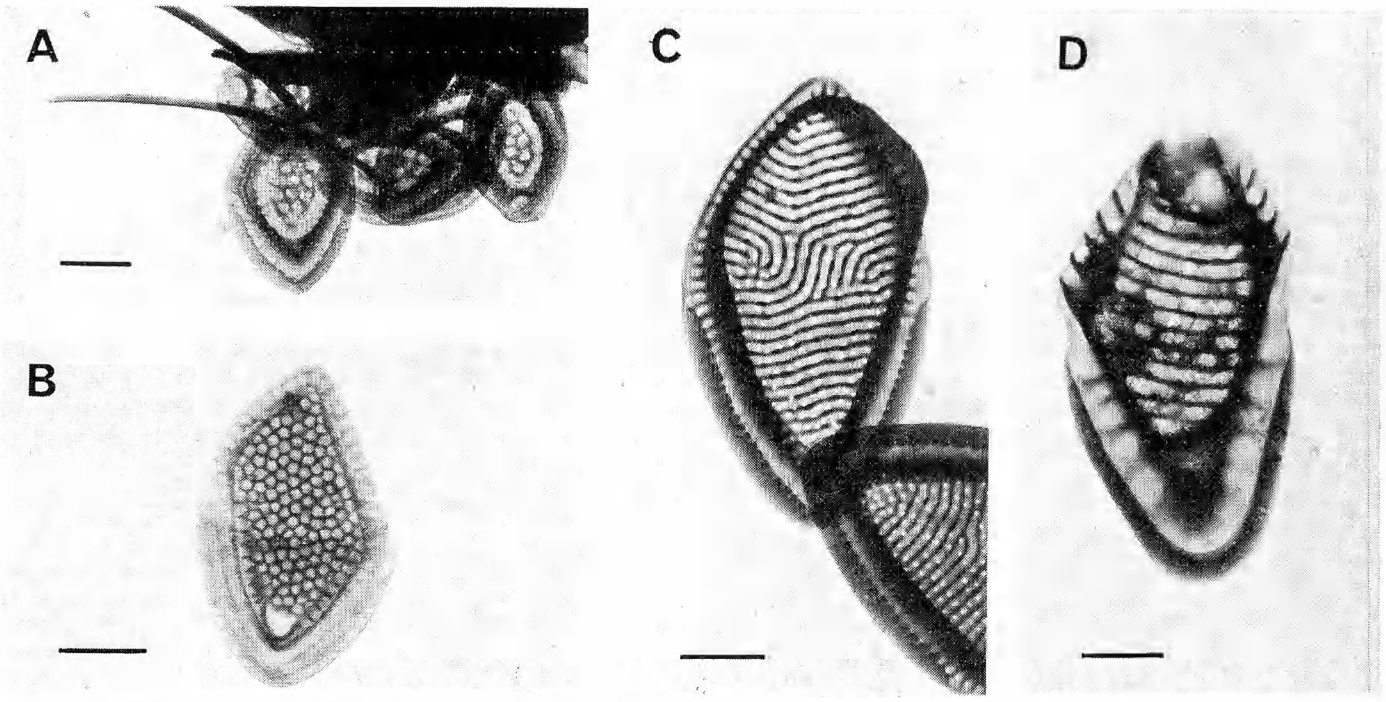

Fig. 7. A: *Mallomonas pillula*. Scales and bristles. Loc. 6. — B: *M. pumilio*? Scale. Loc. 9. — C: *M. schwemmlii*. Scale. Loc. 12. — D: *M. striata*. Scale. Loc. 12. — 1 µm indicated.

ferred to *M. coronata* Bolochonzew, which is just as dubious but has a divergent scale structure.

M. pulchella is one of the most common *Mallomonas* species in Swedish lakes (Teiling 1946). It occurs in many different types of waters. Electron micrographs have been published from the area (Kristiansen 1969 Figs. 6, 7, Cronberg 1972 Figs. 5–8, 1980 a Figs. 93–95) and by Asmund (1977 Figs. 6, 7) from an adjacent area.

The alga is spread all over the world.

?**M. pumilio** Harris & Bradley 1957, Fig. 7 B

Only one body scale was found of this alga, and posterior scales are necessary for correct identification. However, it agrees best with this species, as seen in micrographs by Harris & Bradley (1960), and by Péterfi & Momeu (1976). The ornamentation is similar, a proximal window is present on the shield, but e.g. *M. allantoides* cannot be excluded. Its further distribution includes Denmark, England and Rumania.

M. schwemmlii Glenk 1956, Fig. 7 C

Was mentioned from Sweden by Asmund (1977), but no illustrations were given. On the whole it seems to be a rare species otherwise only recorded from Germany and Czechoslovakia (Glenk & Fott 1971), but occurs rather frequently in Swedish lakes.

M. striata Asmund 1959, Fig. 7 D

Was previously reported from Sweden by Asmund (1977) and by Cronberg (1980 a Fig. 77). It is widely distributed and common in Sweden in all types of water (Cronberg, unpublished). It is also found in polluted lakes.

M. teilingii Conrad 1927

M. litomesa var. *major* Teiling 1912.

Only found in one locality, but is a common species in Sweden. Electron micrographs from the area are published by Cronberg (1980 b).

M. tonsurata Teiling em. Krieger 1930

Only found in few oligotrophic lakes during this investigation, but is one of the most common species in Sweden and is reported by many investigators on LM evidence. Electron micrographs published from the area by Kristiansen (1969 Fig. 6) and by Cronberg (1980 a Figs. 102,

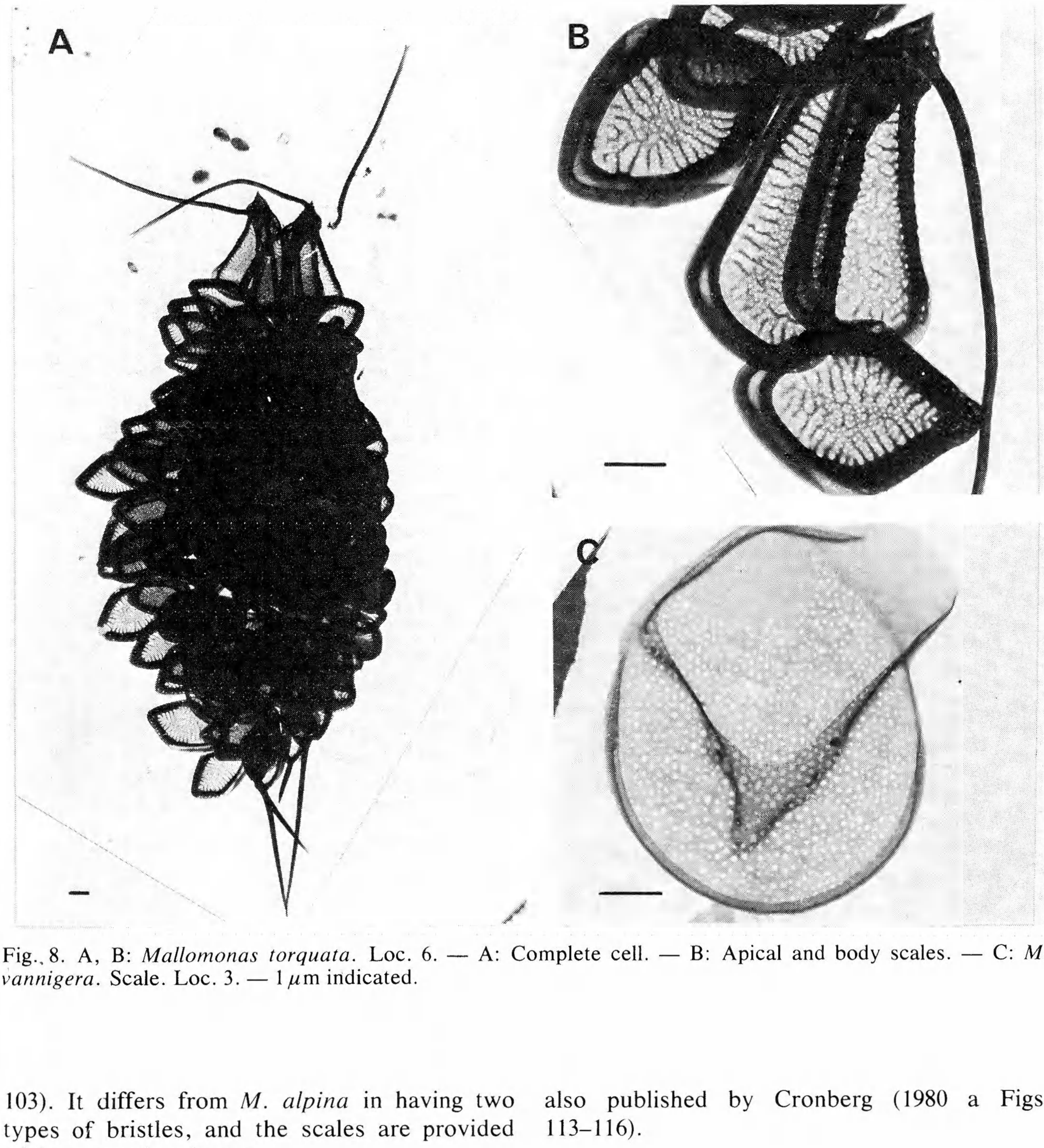

Fig. 8. A, B: *Mallomonas torquata*. Loc. 6. — A: Complete cell. — B: Apical and body scales. — C: *M. vannigera*. Scale. Loc. 3. — 1 µm indicated.

103). It differs from *M. alpina* in having two types of bristles, and the scales are provided with a secondary layer.

M. torquata Asmund & Cronberg 1979, Fig. 8 A, B

Has only recently been recognized as a distinct taxon, described from the area (Asmund & Cronberg Figs. 3–5). At present it is only reported from Sweden, Denmark and Alaska, and belongs to the typical vernal flora. It is common but previously overlooked, mainly found in humic lakes, clean or polluted. Electron micrographs also published by Cronberg (1980 a Figs. 113–116).

M. transsylvanica Péterfi & Momeu 1976, Fig. 9 A–E

M. reginae Teiling var. *glabra* Bourrelly 1957.
M. glabra (Bourrelly) Asmund 1957, non *M. glabra* Woodhead & Tweed 1959.

Bourrelly (1957) described *M. reginae* var. *glabra*, distinguished from the type by having apparently structureless scales. Later Asmund (1977 Figs. 8–10) described the EM structure of scales of similar form in material from southern

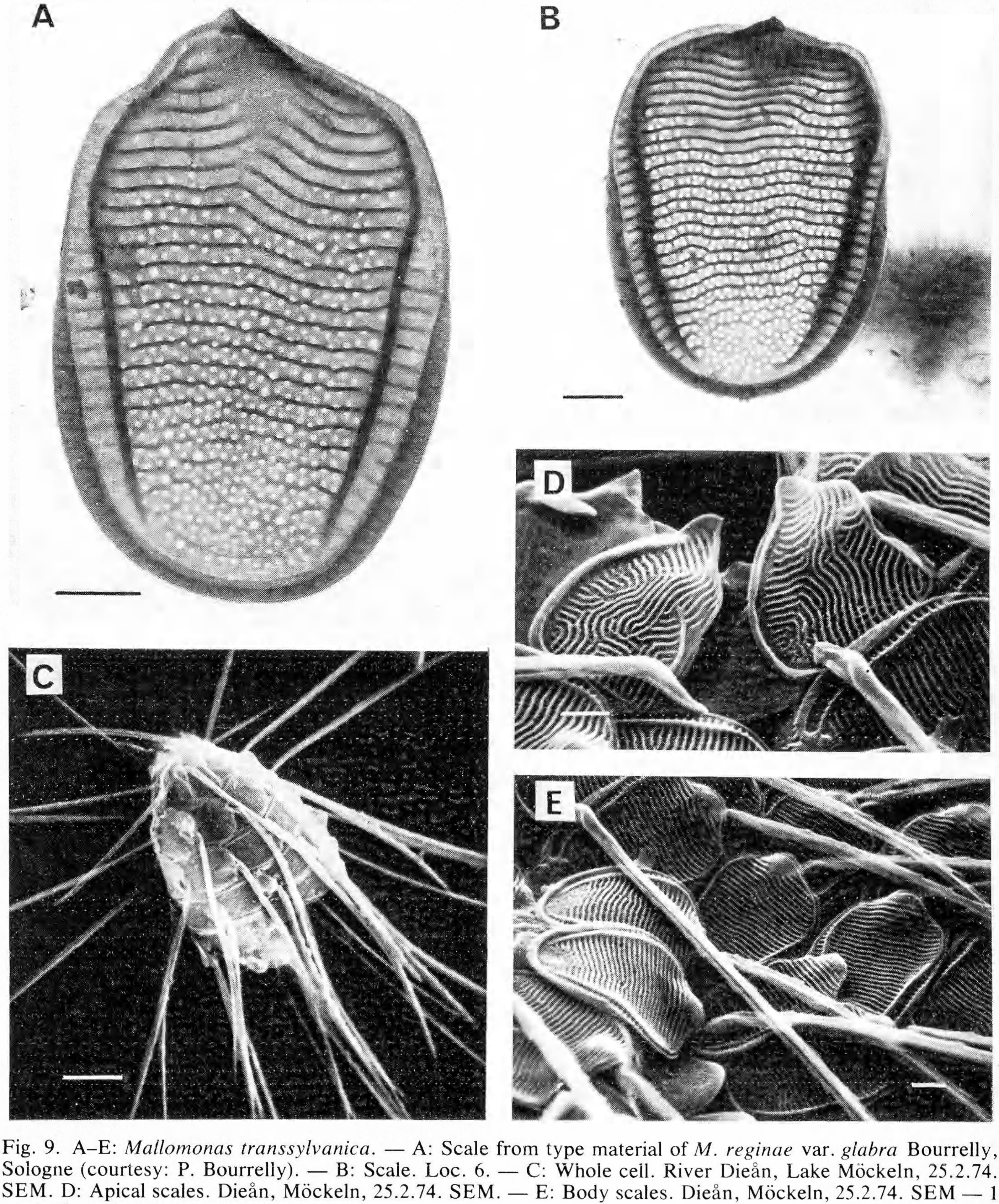

Fig. 9. A–E: *Mallomonas transsylvanica.* — A: Scale from type material of *M. reginae* var. *glabra* Bourrelly, Sologne (courtesy: P. Bourrelly). — B: Scale. Loc. 6. — C: Whole cell. River Dieån, Lake Möckeln, 25.2.74. SEM. D: Apical scales. Dieån, Möckeln, 25.2.74. SEM. — E: Body scales. Dieån, Möckeln, 25.2.74. SEM — 1 μm indicated, except C: 5 μm.

Sweden. She identified the scales with this variety, and the structure was so characteristic that the variety was given the rank of species.

Almost simultaneously, however, Petérfi & Momeu (1976) described *M. transsylvanica* in Rumanian material. They recognized the similarity with var. *glabra*, but as the ultrastructure of Bourrelly's material was not known, they considered it premature to identify var. *glabra* with their material. However, Fig. 9 A of the type material (kindly placed to our disposal by P. Bourrelly) shows the same ultrastructure as that found by Asmund and by Petérfi & Momeu, and it is now obvious that these taxa are identical. The scale structure is unique, and the organism must be a separate species, although it is closely related to *M. pulchella* (syn. *M. reginae*). However, the epithet *glabra* cannot be used, as it already indicates another species, and thus *M. transsylvanica* is the legitimate combination.

M. transsylvanica was found in acid humic lakes.

M. vannigera Asmund 1977, Fig. 8 C

This large species, so far only known from Sweden, was described with EM from one lake in an adjacent area (Asmund 1977 Figs. 1–5). It now proves to have a somewhat wider occurrence. Its size and peculiar scale shape make reliable identification by LM possible, and it should be looked for, especially in large and deep lakes. Alive, it resembles *M. caudata* and might previously have been confused with it.

***Paraphysomonas corbidifera** Pennick & Clarke 1973, Fig. 10 A

This colourless genus contains several very small species, most of which can only be detected by means of electron microscopy. The present organism must be referred to *P. corbidifera*. It is covered with basket-shaped scales consisting of a basal ring bearing, by means of upright rods, an apical structure divided into a pattern of polygonal apertures. It is characteristic that the vertical rods fuse with the apical ring half-way between the supports of its central structure.

This species was originally described from marine environments, like most other members of the genus which now are known to occur in freshwater.

P. imperforata Lucas 1967, Fig. 11 A

The scales found during this investigation completely agree with the original description as supplemented by Thomsen (1975), in having a structureless basal plate without thickened rim, and an abruptly pointed spine.

It proved to be very frequent in the lakes investigated, although originally described from sea water, and has now been found in several freshwater habitats, e.g. in Denmark, the island of Bornholm (Kristiansen 1975 b), Sweden (Cronberg 1980 a Fig. 122).

P. takahashii Cronberg & Kristiansen sp. nov., Fig. 10 B–D

Takahashi 1976 pp. 47, 48, Figs. 23, 24 (*Paraphysomonas foraminifera* Lucas form no. 1).

Cellula squamis numerosis induta. Squamae oblongae, 1,4×1,1–2,0×1,3 μm magnae, foramina paene orbiculata in quattuor anulis concentricis exhibentes, et spina acuminata longitudine variabili (usque ad 6 μm longa) instructae, e parte basali trifurcata nata.

Typus: Fig. nostra 9 B (Sweden, Småland, Lake Lången, 1979-05-01)

Scales oblong, 1.4×1.1–2.0×1.3 μm, provided with regularly arranged pores in 4 concentric rows and bearing a tapering spine of varying length, from vestigial and up to about 6 μm, with a triforked basal part.

It differs from *P. foraminifera* Lucas by the oblong scales, the triforked spine base, and the more regularly arranged pores.

Finds from other lakes in the area show more or less similar forms to be included in this species. Varying characters are the number of rows of pores, up to 6 or 7, the distinction of the outer pore row from the inner ones, the thickness of the spine, and the elaboration of the spine base.

Thus also the form of *P. foraminifera* Lucas pictured by Takahashi (1976) as "form no. 1" belongs to this species, although with smaller and more numerous pores than the type.

It was found in several lakes, clean or polluted, but all of them acid.

Apart from Sweden and Japan, this species has also been shown to occur in Denmark (James Wee leg.).

P. vestita (Stokes) de Saedeler 1929, Fig. 11 B

Was recorded by Cronberg (1980 a Fig. 123) from Lake Trummen and was found in several localities. It is in fact one of the most common Chrysophyceae in Swedish lakes, but is often overlooked.

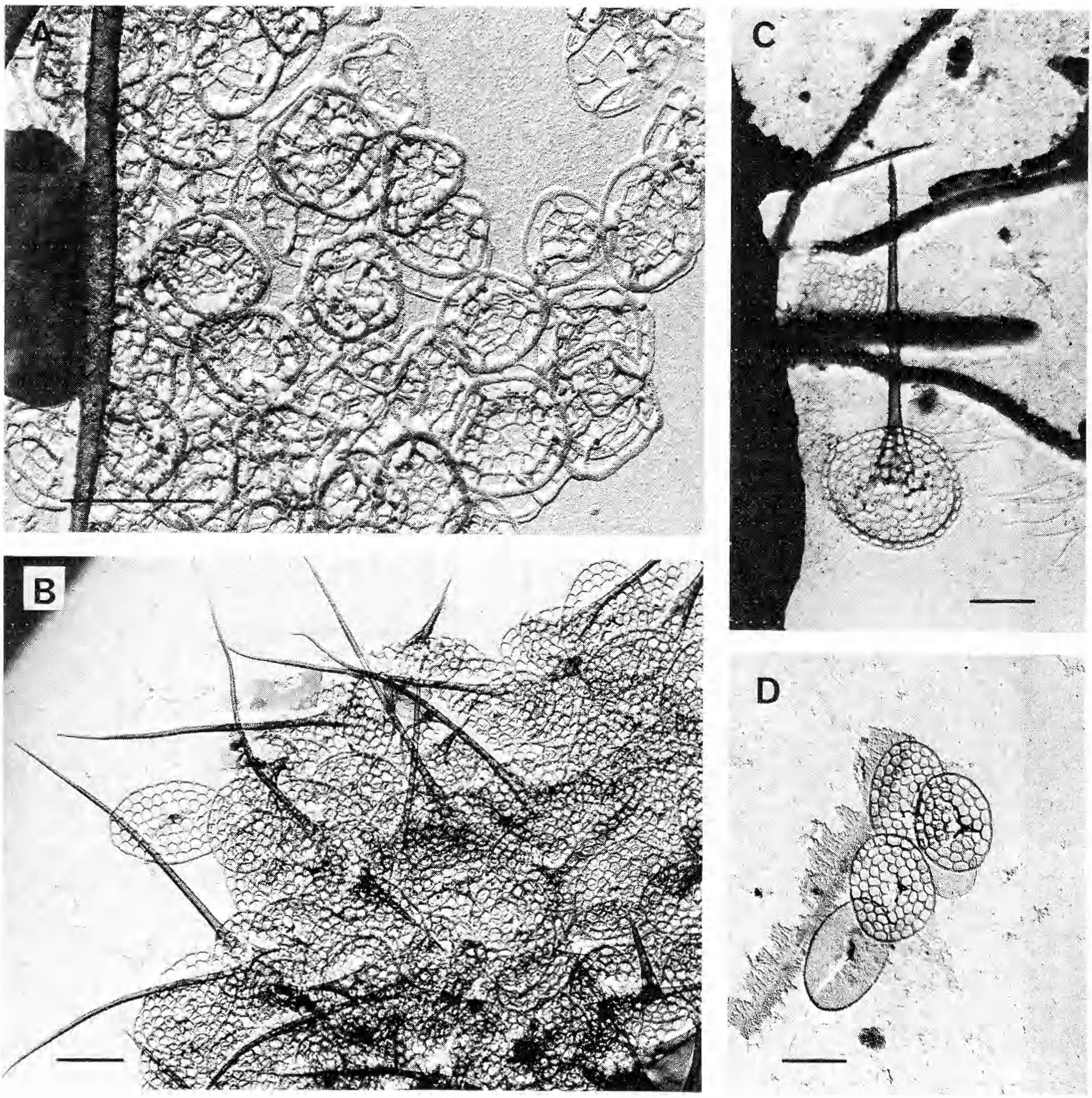

Fig. 10. A: *Paraphysomonas corbidifera*. Scales. Loc. 17. — B–D: *P. takahashii*. — B: Scale cover showing both spine-bearing and spineless scales. Loc. 9. — C: Spine-bearing scale. Loc. 11. — D: Almost spineless scales. Loc. 15. — 1 μm indicated.

Spiniferomonas bilacunosa Takahashi 1973, Fig. 12 A

Has been recorded from an adjacent area (Asmund 1977), but without illustrations.

Like the preceding genus, the members of this genus are often overlooked.

S. bourrellyi Takahashi 1973, Fig. 12 B

Proved to be the most common *Spiniferomonas* species found in the majority of the lakes. It was previously recorded from Sweden by Asmund (1977).

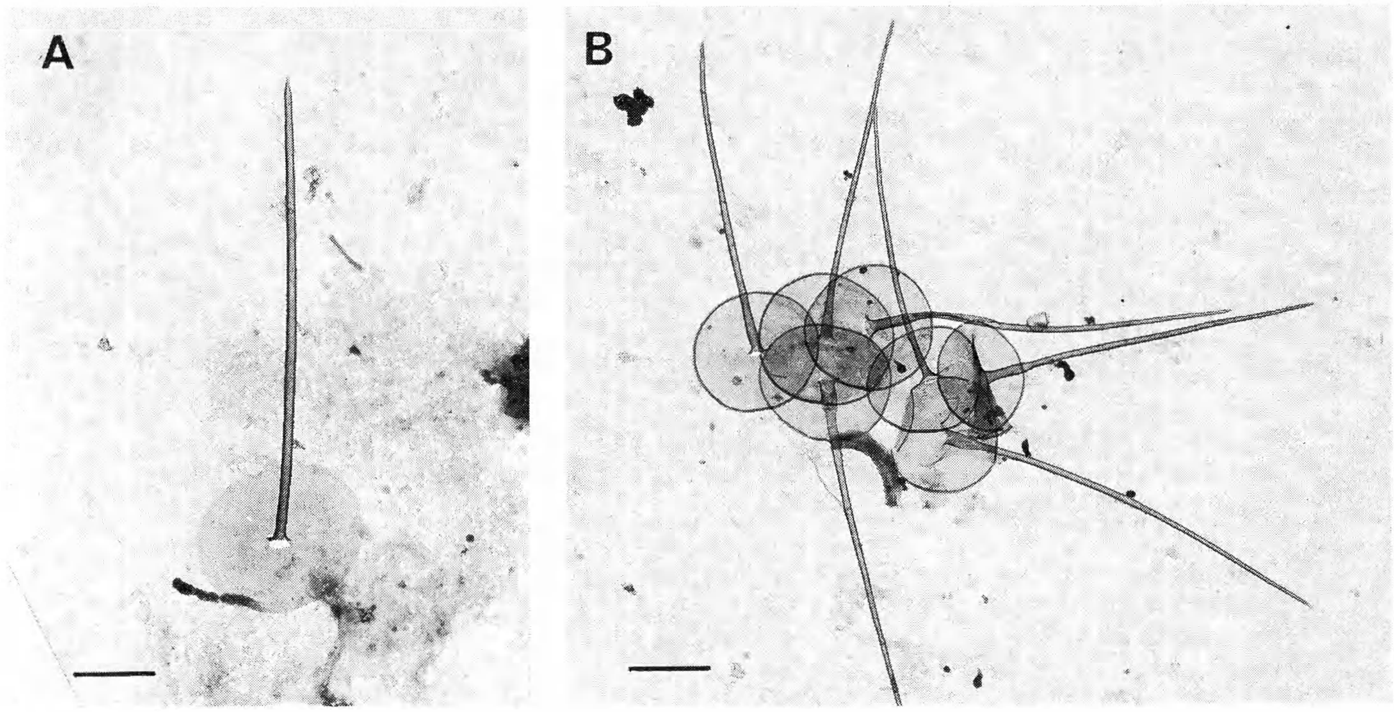

Fig. 11. A: *Paraphysomonas imperforata*. Scale. Loc. 14. — B: *P. vestita*. Scales. Loc. 14. — 1 μm indicated.

*****S. conica** Takahashi 1973, Fig. 12 C

Relatively common in the examined lakes and not previously recorded from Sweden. There are only slight differences between this and *S. bourrellyi*, and they are difficult to distinguish.

S. trioralis Takahashi 1973, Fig. 12 D

Is perhaps the most widely distributed *Spiniferomonas* species and has also been reported from Sweden by Asmund (1977) and by Cronberg (1980 a Figs. 118, 119). It occurs very frequently in Swedish lakes, and we are convinced that the records of *Mallomonas globosa* Schiller in fact may refer partly to this species. *M. globosa* as described by Schiller (1926) can hardly be a *Mallomonas* (cf. Kristiansen 1979), but Schiller's drawing has resemblance to *S. trioralis* as seen in the LM. "*M. globosa*" has often been reported in Swedish phytoplankton investigations (e.g. Nauwerck 1963, Ramberg 1976).

*****Synura curtispina** (Petersen & Hansen) Asmund 1968, Fig. 13 A

Not previously recorded from Sweden.

S. echinulata Korshikov 1929

Previously recorded from Sweden, also with EM micrographs from the area (Kristiansen 1969 Fig. 9, Cronberg 1980 a Figs. 130–132). It was very common both in clean and polluted lakes, but all of them were acid.

S. lapponica Skuja 1956, Fig. 13 B

This species, occurring sparsely in two of the lakes, was originally described from Swedish Lapland by Skuja (1956). This material was later examined in EM by Petersen & Hansen (1958). Skuja ascribed it a northern distribution, but it has later been found in several more southern localities, e.g. Bornholm, Denmark (Kristiansen 1975 a), Rumania (Péterfi 1966), as well as in several lakes in southern Sweden (Asmund 1977, Cronberg unpublished).

S. petersenii Korshikov 1929 f. **petersenii**

The most common *Synura* in Sweden, occurring in almost all the investigated lakes. Electron micrographs have been published from the area (Kristiansen 1969 Fig. 10, Cronberg 1972 Figs. 1–4, 1980 a Figs. 120–124).

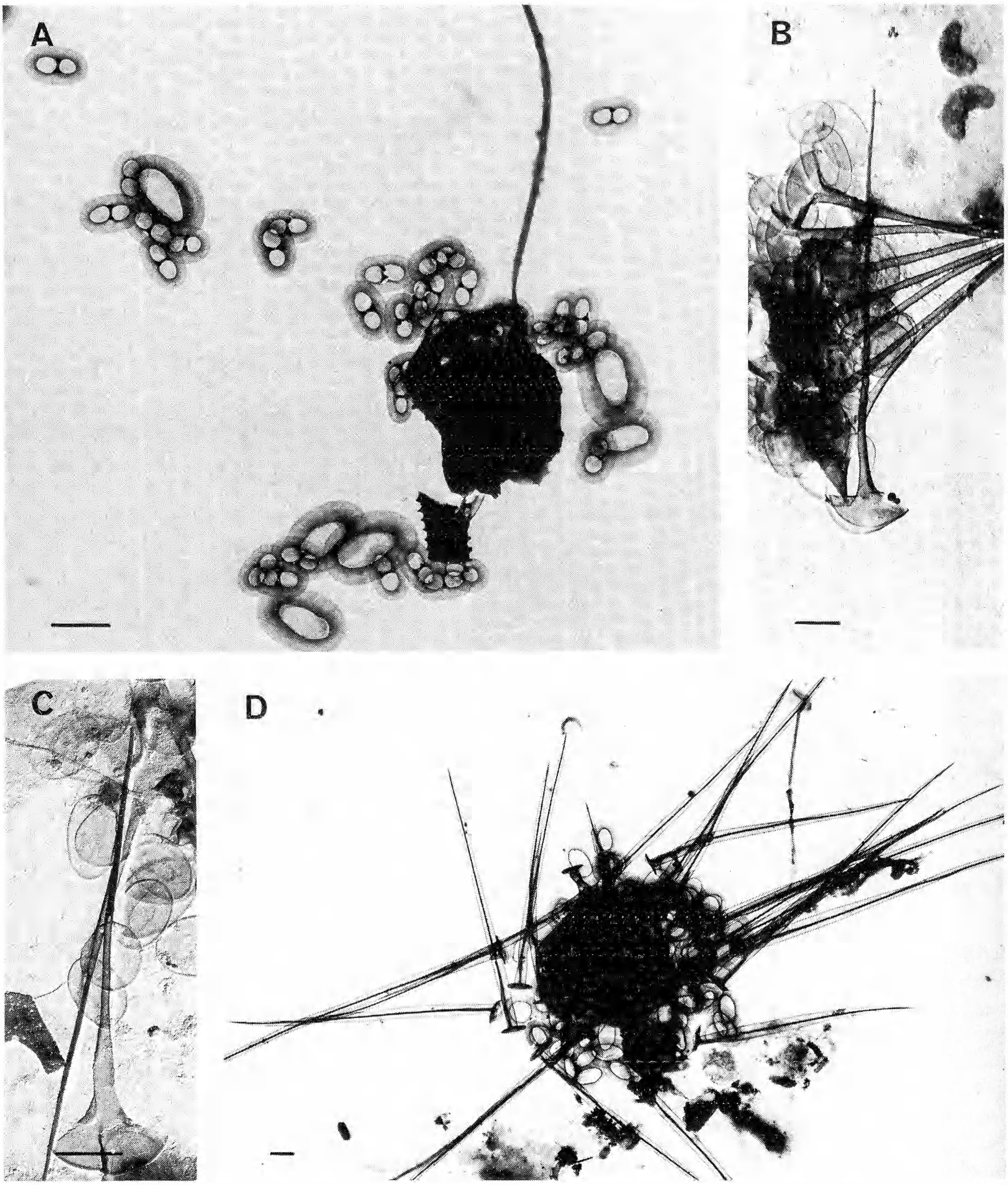

Fig. 12. A: *Spiniferomonas bilacunosa*. 2 kinds of scales. Loc. 1, 1973. — B: *S. bourrellyi*. Scales and spines. Loc. 9 — C: *S. conica*. Spine and scales. Loc. 9. — D: *S. trioralis*. Whole cell with scales and spines. Loc. 3. — 1 µm indicated.

S. petersenii Korshikov f. **asmundiae** Cronberg & Kristiansen nov. f., Fig. 14 A

Asmund 1968 p. 502, Figs. 3–5 (*Synura petersenii* forma).

A f. petersenii differt squamis parvis, oblongis vel orbiculatis (3,2×2,0–2,4×2,4 µm magnis), margine late inflexo et spina crassa sed brevi et obtusa instructis. Costae saepe furcatae vel anastomosantes.

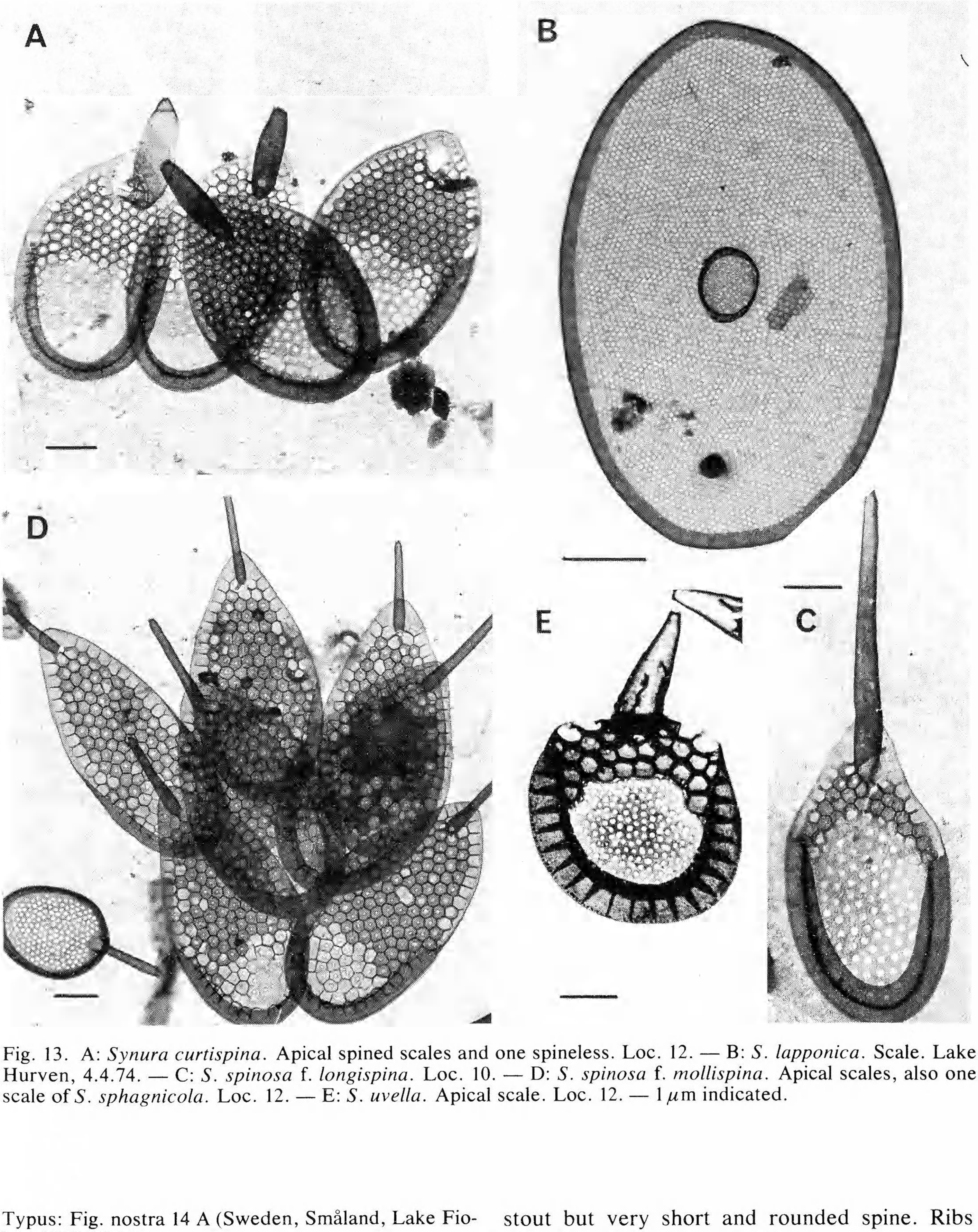

Fig. 13. A: *Synura curtispina*. Apical spined scales and one spineless. Loc. 12. — B: *S. lapponica*. Scale. Lake Hurven, 4.4.74. — C: *S. spinosa* f. *longispina*. Loc. 10. — D: *S. spinosa* f. *mollispina*. Apical scales, also one scale of *S. sphagnicola*. Loc. 12. — E: *S. uvella*. Apical scale. Loc. 12. — 1 μm indicated.

Typus: Fig. nostra 14 A (Sweden, Småland, Lake Fiolen, 1979-05-02).

This form differs from f. *petersenii* by its small, oblong (2.0×3.2 μm) to circular (2.4 μm in diameter) body scales with a very broad upturned rim almost completely around, and bearing a stout but very short and rounded spine. Ribs often furcate or anastomosing.

It is without doubt identical with the form pictured by Asmund (1968) from Alaska, her Fig. 4 bearing a striking similarity to some of the scales illustrated in our Fig. 13 A. She also showed

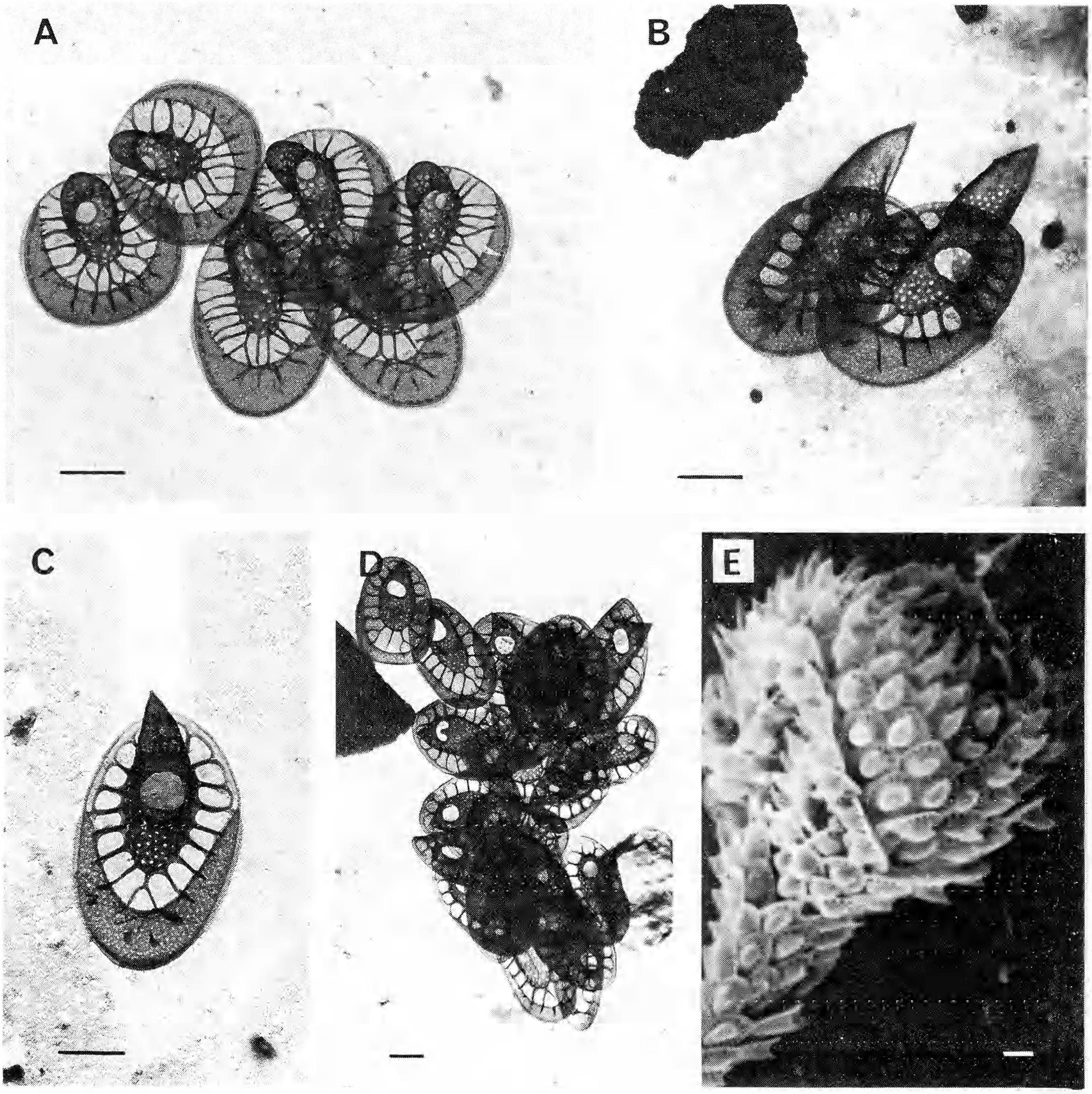

Fig. 14. A: *Synura petersenii* f. *asmundiae*. Apical scales. Loc. 1. — B–E: *S. petersenii* f. *bjoerkii*. — B, C: Scales. Loc. 10. — D: Group of scales. Loc. 10. — E: Complete cell. Loc. 10. SEM. — 1 μm indicated.

anterior and posterior scales not found by us (the former with a longer spine, the latter more elongated). However, even if we have evidence from only one type of scale, we find the similarity with Asmund's form convincing and the structure so characteristic that it appears justified to establish a separate taxon.

This form was only found in Lake Fiolen.

***S. petersenii** Korshikov f. **bjoerkii** Cronberg & Kristiansen nov. f., Fig. 14 B–E

A f. petersenii differt squamis oblongis (3,7×2,4 μm magnis), margine valde late inflexo et spina crassissima longa et acuta instructis. Costae simplices, breves, foramina interposita angularia vel paene orbiculata relinquentes.

Typus: Fig. nostra 14 B–E (Sweden, Småland, Lake Frejen, 1979-05-01).

Differs from f. petersenii in having oblong body scales ($3.7\times2.4\,\mu$m) provided with a very broad, stout and acute spine, a very broad upturned rim, and simple, short ribs leaving angular or almost circular openings between them. Posterior scales with a shorter spine.

Thus the material had such a characteristic scale structure that it deserved a taxonomic rank.

Hitherto only found in Lake Frejen.

S. sphagnicola (Korshikov) Korshikov 1929, Fig. 13 D

Is common, mostly in acid and humic waters, preferably during summer (Kristiansen 1975 a). Electron micrographs have previously been published from the area (Kristiansen 1969 Fig. 11).

It is probable that Teiling's (1946) records of the dubious *S. bioretii* Huber-Pestalozzi (1941) at least partly refer to this species. Most of his records of *S. bioretii* are based on summer samples where he states it to be the most common species, whereas he does not mention *S. sphagnicola*. Part of his material might also belong to the likewise not mentioned *S. spinosa*, from which *S. bioretii*, as described by Bourrelly (1957) from Swedish material, does not deviate in any essential characters. Nobody has so far been able to confirm the existence of *S. bioretii* by EM.

S. spinosa Korshikov 1929 f. **spinosa**

Was found in many of the localities, also previously reported with EM from the area (Kristiansen 1969 Fig. 12, Cronberg 1980 a Figs. 133, 134) and by Asmund (1977). Skuja's records (1948) of *S. bioretii* may also refer to this species, because in the publication he carefully described *S. sphagnicola*, but did not mention the almost as common *S. spinosa*.

***S. spinosa** Korshikov 1929 f. **longispina** Petersen & Hansen 1956, Fig. 13 C

Was not previously reported from Sweden.

***S. spinosa** Korshikov 1929 f. **mollispina** Petersen & Hansen, Fig. 12 C

Only a few spineless scales were found, but their elongate slightly pointed shape and the extensive reticulation are characteristic features. This was further confirmed by comparison with material previously obtained from this area (Fig. 12 D) with similar but spine-bearing scales. The form found here has more attenuated scales than the type, but in other respects (reticulation, shape of spine) it is very similar.

S. uvella Stein em. Korshikov 1929, Fig. 12 E

Has been mentioned but not pictured by Asmund (1977). There are numerous previous LM records of *S. uvella*, mostly as *S. uvella* Ehrenberg; but it cannot be ascertained with *Synura* species they refer to. The records by Skuja (1948), Nauwerck (1963), and Willén (1976) can be considered to refer to *S. uvella* s. str.

It was found in some of the clean lakes.

Other species of Chrysophyceae

Bitrichia phaseolus Fott 1937

Loc. 1, 17.

***Chrysastrella furcata** (Dolg.) Deflandre 1934, Fig. 15 A

The taxonomic position of this genus is unclear because only the stomatocyst stage is known, and thus most surveys of the Chrysophyceae do not include it. It may belong within the life history of some *Chromulina* or *Ochromonas*.

The organism found during this investigation and which appears to be common in Sweden has a more or less smooth wall and thus diverges from the type which is verrucose (Bourrelly 1957).

Otherwise it is identical in size and in shape of the bifurcate spines. Loc. 3.

C. paradoxa Chodat 1922, Fig. 15 B

The organism referred to this species was numerous in humic lakes. It is similar to the type, except that the collar may be very long, more than the diameter of the cell. Loc. 1, 2, 4, 5, 6, 9, 14, 16.

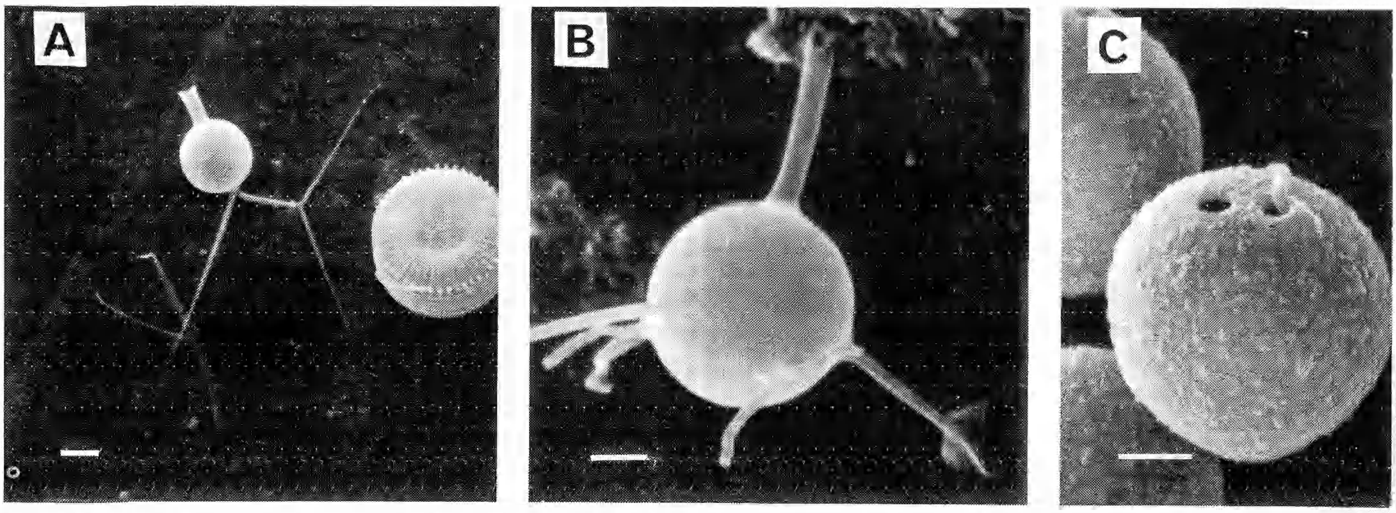

Fig. 15. A: *Chrysastrella furcata*. Loc. 3. SEM. — B: *C. paradoxa*. Loc. 6. SEM. — C: *Chrysococcus triporus*. Loc. 16, May 1976. SEM. — A and B: 5 μm indicated, C: 1 μm.

Chrysococcus minutus (Fritsch) Nygaard 1932

Loc. 14.

C. triporus Mack 1951, Fig. 15 C

The lorica construction is completely in accordance with Mack's description, with one caudal porus and two apical pores of different size. The flagellum protrudes through the smaller porus which has a thickened rim.

It was found in the eutrophic lakes: Loc. 16 (where it often forms blooms, Cronberg 1980 a), 17, 18.

Chrysolykos planctonicus Mack 1951

Loc. 17.

C. skujae (Nauwerck) Bourrelly 1957

Both of these species are common in Sweden, especially in the northern part. Compare the recent revision of the genus by Nauwerck (1979). Loc. 1, 17.

Dinobryon bavaricum Imhof 1890

Loc. 3, 4, 16, 17.

D. cylindricum Imhof 1887

Loc. 1, 3, 5, 11, 12, 16, 17.

D. divergens Imhof 1887

Loc. 3, 7.

D. pediforme (Lemmermann) Steinecke 1916

Loc. 13.

D. sertularia Ehrenberg 1838

Loc. 1, 5.

D. sociale Ehrenberg 1838

Loc. 16.

D. suecicum Lemmermann 1904

Following Hilliard's (1968) recommendation, var. *longispina* Lemmermann is not maintained, and all variation in spine length is included within the variation range of the type species. Loc. 16.

***Stenocalyx klarnetii** (Bourrelly) Fott 1959

Previously not recorded from Sweden. It appears to have a wide ecological range. Described from an acid French locality, it has later been reported from a neutral Danish pond (Kristiansen 1963), and during this investigation it was found in the highly eutrophic lake Växjösjön. Loc. 17.

S. monilifera Schmid 1934

Is common in Sweden and was reported e.g. by Skuja (1956). Loc. 16.

Stichogloea doederleinii (Schmidle) Wille 1911

Is oligotrophic and very common in Swedish lakes. Loc. 1, 11.

Uroglena volvox Ehrenberg 1838

Typical cysts with double collar were observed. Loc. 16.

Species of allied groups

Bikosoecophyceae

Bikosoeca crystallina Skuja 1956

Is certainly common in Sweden, but because of its hyaline lorica it is almost invisible without staining or use of phase contrast microscopy and therefore overlooked. Loc. 18.

B. lacustris Clarke 1871

Is very common in Swedish lakes (Skuja 1948, 1956). Loc. 18.

Craspedophyceae

Salpingoeca frequentissima (Zacharias) Lemmermann 1904

Is frequent in Swedish lakes, epiphytic on cyanophytes or on *Asterionella* (Lemmermann 1904, Skuja 1948). Loc. 4.

Sphaeroeca volvox Lauterborn 1899

Is widely distributed in Sweden (Skuja 1948, 1956). Loc. 12.

Prymnesiophyceae

Hymenomonas roseola Stein 1878

Previously recorded from Sweden by Skuja (1948, 1956), and electron micrographs of scales given by Cronberg (1980 a Figs. 137, 138). Loc. 16.

Discussion

This investigation showed that the region of Aneboda and Växjö is very rich in Chrysophyceae. This was not unexpected, as there are numerous suitable localities, more or less humic lakes, some of them slightly acid, and some of them culturally influenced.

Altogether 73 taxa of Chrysophyceae and allied groups were identified. Of these, 49 belonged to the Synuraceae, the special object of this investigation, and the following discussion will be restricted to this family. In spite of the fact that the phytoplankton of this area had been intesely studied previously, 15 taxa were found which had not been recorded from Sweden before. Among these were one new species and two new forms.

A few species previously recorded from Sweden were not found during this investigation. Three species recorded from Lake Trummen were not found, viz. *M. trummensis* (Cronberg 1975 Figs. 1, 2), *M. annulata* (Cronberg 1980 a Figs. 73–76), and *Mallomonopsis elliptica* (l.c. Fig. 117). Of the many species recorded by Asmund (1977) from western Småland, two were not found here, viz. *M. flora* and *M. areolata*.

Several species previously described and recorded only on LM evidence are impossible to recognize and have, of course, not been found. This applies to some of the species recorded by Skuja (1948, 1956). One exception among them, *S. lohammarii* Skuja (certainly = *S. splendida* Korsh.) could not, because of its size and appearance, have escaped us if present.

This examination comprised only a restricted number of localities during a very short period in spring. It is probable that still more species will be found during investigations in further localities and during other seasons of the year—which we intend to do.

Most of the species found have a very wide distribution. Many of them are certainly cosmopolitan, although hitherto to a great extent overlooked. One noteworthy exception is *M. vannigera* which was described and until now only recorded from one locality in western Småland; it is now known to have a wider although still extremely restricted occurrence. Several other species appear to be restricted to Europe.

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Germination in Swedish blackberries (Rubus L. subgen. Rubus)

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Seeds were collected from 19 *Rubus* species in Sweden. Different methods for increasing germinability were tested: 2 hour-treatments with conc. H_2SO_4 and leaching with $Ca(OCl)_2$ + $Ca(OH)_2$ proved to be the most successful. The species differ in number of pyrenes per berry, germinability and time of germination. Wide distribution in Sweden tends to be correlated with high germinability and heavy pyrenes. Heavy pyrenes are correlated with few pyrenes per berry and early ripening of berries. Germinability and time of germination were found to differ between populations. Seed from northerly populations and from the zones with a severe climate tended to germinate earlier.

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About 25 species of blackberry (*Rubus* subgen. *Rubus*) are known from Sweden (the *corylifolius* group being treated as a single species), i.e. few compared with most other European countries. The Swedish ranges of the 18 commonest species have been mapped by Oredsson (1973, 1974). Most blackberry species are dependent on open vegetation such as found along roads, ditches, in pastures, etc. Such habitats have been created by man throughout Sweden, but the severity of the climate restricts blackberries to the southern part of the country (Fig. 1), most of the species occurring in coastal regions. However, most species are restricted to certain well-defined areas which differ greatly in size. This diversity may be connected with differences in hardiness (Oredsson 1975) and differences in the time of ripening of berries (Oredsson unpubl.).

This investigation aimed to determine whether seed germinability and time of germination could also account for some of the differences in distribution.

Seed setting

All Swedish blackberries, as well as the dewberry (*R. caesius*), are polyploids and are probably facultatively apomictic and pseudogamous (Gustafsson 1943). Though blackberries form vigorous vegetative clones, long-distance dispersal is effected mainly by birds that eat the berries. Thus a high production of seed should be of selective value. Though genetic variation is restricted in an apomictic taxon occasional outcrossing no doubt occurs. Moreover some mechanism creating variation within the apomictic system is implied by the results of selection experiments (Haskell 1953).

The blackberry 'fruit' or 'berry' is an aggregate of drupelets which develop independently while adhering to a common receptacle. Each drupelet consists of one pyrene (a seed and its surrounding sclerenchymatous endocarp), a fleshy mesocarp and a thin dermatous exocarp. Kerr (1954) reported 56–84 carpels per berry a third of which developed, though up to half of these drupelets contained a collapsed seed. Scott & Ink (1957) reported 7–23 % collapsed seeds; Peitersen (1927) and Amor (1974) made similar observations. The number of pyrenes set is probably largely genetically determined (Jennings 1971 a, concerning raspberries). As blackberries are pseudogamous the nature of the pollinator is of importance for seedsetting but this aspect has, however, not been included here.

Dormancy

Rubus seeds exhibit double dormancy. External dormancy is determined by the endocarp and the seed coats which delay the uptake of water and oxygen and may also mechanically prevent the embryo from swelling. This dormancy is broken if the seed coverings are removed or scarified. Internal dormancy is regulated by biochemical and biophysical changes which occur during an after-ripening process at low temperatures (0–5°C).

Lasheen & Blackhurst (1956) report that freshly harvested blackberry seeds contain a growth inhibitor which is active for up to seven months, the highest concentration being located in the endosperm. Embryos deprived of endosperm will not germinate so it is probable that growth-promoting substances are also formed within the endosperm. Moreover seeds that have not been pre-chilled retain a high starch concentration for at least five months, whereas starch is broken down to sucrose and reducing sugars faster if the seeds are pre-chilled. Initially this process occurs even faster if the seeds are treated with H_2SO_4 prior to pre-chilling. After four months of cold treatment the auxin content reaches a maximum, and after five months there is an enzyme maximum (catalase, lipase, oxidase).

Wenzel & Smith (1975) found that the time needed for cold treatment could be much reduced if the seeds were leached with $Ca(OCl)_2$ prior to chilling.

According to Krefting & Roe (1949) passage through the digestive tracts of birds and other animals increases seed germinability, but this was not confirmed by Brunner et al. (1976).

Blackberry seeds often do not germinate readily until the second spring after the berries ripen. Krefting & Roe (1949) suggest that as external dormancy is not broken till the first winter the absorption of sufficient moisture is prevented and internal dormancy cannot therefore be broken. The following summer soil fungi and bacteria make the seed coverings permeable as a result of which internal dormancy is broken during the second winter. This agrees well with the results obtained by Scott & Ink (1957); pyrenes kept at room temperature for 12 months and then chilled germinated even better than pyrenes that had been chilled twice. On the other hand Heit & Slate (1950) found that pre-chilled non-germinating pyrenes germinated well immediately after treatment with H_2SO_4. Possibly the mechanical strength of the endocarp had previously inhibited germination.

It has recently been shown that seeds of cloudberry (*R. chamaemorus*) contain hydrocyanic acid (Warr et al. 1979). When the seeds are soaked in water these compounds produce HCN which inhibits germination unless the seed coat has been injured in some way so that the gas can escape.

In crossing experiments with raspberries (*R. idaeus*) Jennings (1971 b) established that maternal influence on germinability was great. Likewise the time when germination takes place is to some extent genetically determined. Jennings (1964) made collections from wild raspberry populations in Scotland and grew the plants under uniform conditions. Seeds from this material showed great differences between the germination time of different populations.

Material

Multi-species material (M). In 1976 2 populations each of dewberry and of 15 blackberry species were selected, 3 of *R. sulcatus* and 1 each of *R. sprengelii* and *R. scheutzii* (Table 3, Fig. 1). 2 stands at least 10 m apart were chosen from each population. One floricane was chosen at random from each stand and 10 ripe berries were collected.

Wide-range material of R. nessensis (Sw). In 1976 8 populations of *R. nessensis* were taken at random from the Swedish distributional area with the help of the extremely detailed maps made by Oredsson (deposited at Lund University Library) (Fig. 1). Each population was sampled as above.

Narrow-range material of R. nessensis (Sk). In 1977 4 populations of *R. nessensis* were selected in or near NE Skåne (Fig. 1). From each of 3 of these 2 stands were selected, from the fourth 1 stand only. From each stand 2 floricanes were taken at random, but the distance between them was not to exceed 2 m. 10 (9) ripe berries were collected from each floricane.

Methods

Untreated pyrenes

In the M material the well-developed drupelets of each berry were counted and the pyrenes removed with tweezers and dried on filter paper at room temperature for 1 week or longer. 20 large pyrenes from each floricane were sown in a pot filled with a mixture of sand, peat and soil (material M-76). As each species was represented by 2 floricanes from 2 populations this

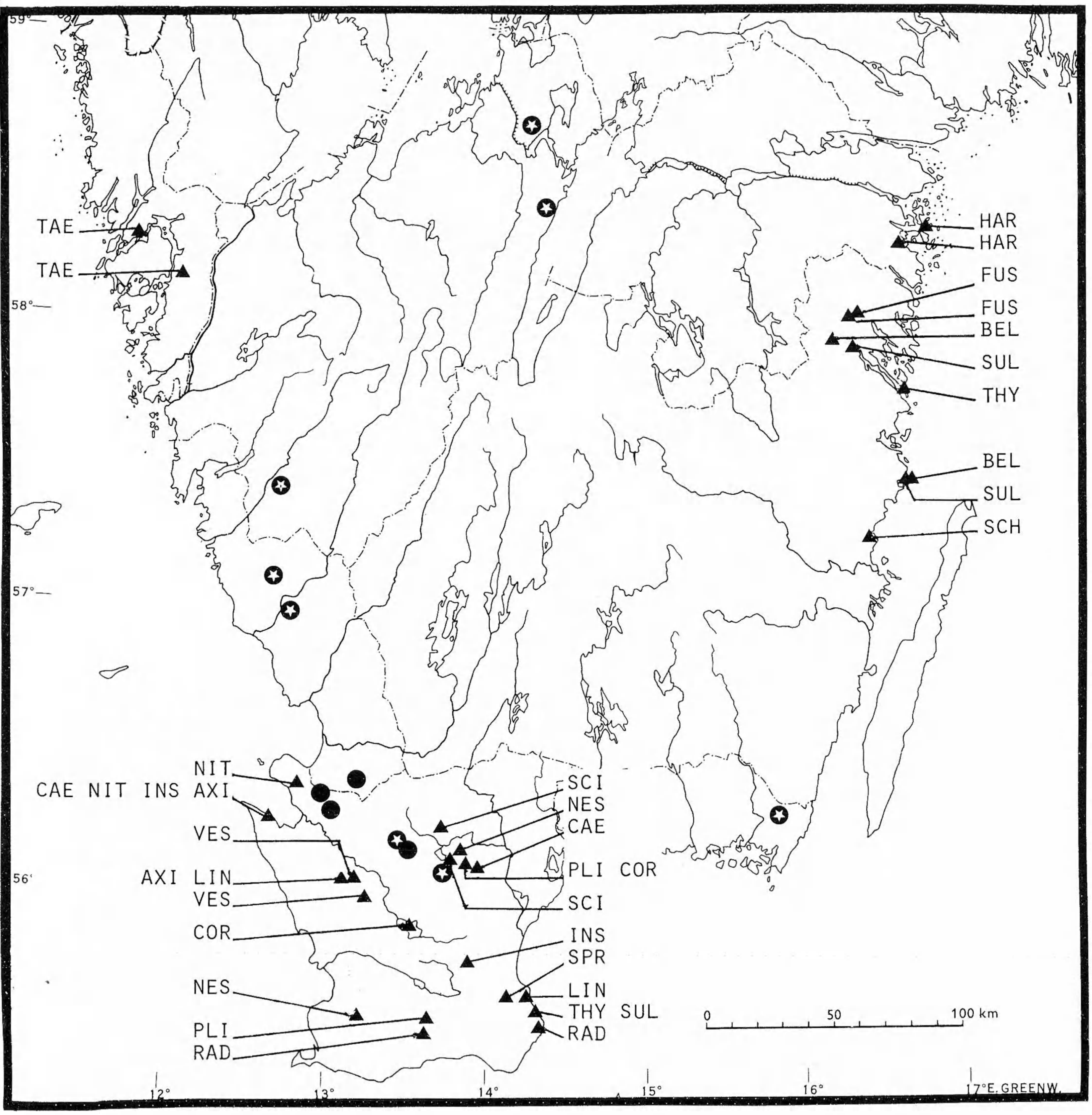

Fig. 1. The localities of blackberries collected. — ✪ wide-range *nessensis* material (Sw) — ● narrow-range *nessensis* material (Sk) — ▲ multi-species material (M); NES *R. nessensis* W. Hall, NIT *R. nitidus* Weihe & Nees (*R. divaricatus* P. J. Mueller), PLI *R. plicatus* Weihe & Nees, SCI *R. scissus* W. C. R. Watson, SUL *R. sulcatus* Tratt., AXI *R. axillaris* Lej., INS *R. insularis* F. Aresch., LIN *R. lindebergii*, P. J. Mueller, SCH *R. scheutzii* Lindeb., SPR *R. sprengelii* Weihe, THY *R. thyrsanthus* Focke, BEL *R. bellardii* Weihe & Nees, (*R. glandulosus* Bellardi), FUS *R. fuscus* Weihe & Nees, HAR *R. hartmannii* Sudre, RAD *R. radula* Weihe ex Boenn., TAE *R. taeniarum* Lindeb., VES *R. vestitus* Weihe & Nees, CAE *R. caesius* L., COR *R. corylifolius* (Sm.).

gave 4 pots per species. A fifth pot was sown with a mixture of pyrenes from both populations (20 pyrenes). The pots were kept outdoors in the Lund Botanical Garden during the winter. In the spring when the first leaf appeared in a pot, the pot was removed to an unheated glasshouse. The seedlings were counted once a week. If no further seedling had emerged in a pot after one month the pot was not used in further counts. Pots in which no seedlings survived till the autumn (or proved to be misidentified) were removed outdoors

Table 1. Different treatments employed to increase germinability. 20 pyrenes each from 3 species (abbrev. see Fig. 1) chosen at random were used in each technique. The relative germinability is expressed as the present germinability divided by that obtained from the relevant 3 species by the standard method (M-77). 1978 first-season germination i.e. first spring after sowing; 1979 second-season germination. $^{*}0.05>p>0.01$, $^{**}0.01>p>0.001$, $^{***}p<0.001$

Species	Pyrenes	Treatment	Leaching	Relative germinability 1978	χ^2 1978	Relative germinability 1979	χ^2 1979
sul, spr, tae	heavy	120 min H_2SO_4	1 % $Ca(OCl)_2$+CaOH	1.97	6.51**	–	–
pli, axi, tae	heavy	60 min H_2SO_4	1 % $Ca(OCl)_2$	0.69	1.16 ns	–	–
pli, rad, ves	heavy	60 min H_2SO_4	0.5 % $Ca(OCl)_2$+CaOH	0.73	0.95 ns	0.67	0.40 ns
thy, rad, cae	heavy	60 min H_2SO_4	none	0.36	6.18*	–	–
lin, fus, har	heavy	30 min H_2SO_4	1 % $Ca(OCl)_2$+CaOH	1.50	0.33 ns	1.43	1.06 ns
lin, thy, har	heavy	60 min 2 M KOH	none	0.25	material too small	1.69	1.16 ns
sul, bel, fus	heavy	30 min 2 M KOH	none	0.18	9.08**	0.80	0.50 ns
sci, ins, sch	heavy	cut raphe	none	0.06	18.18***	–	–
nes, nit, ins	heavy	none	none	0	23.50***	–	–
axi, ves, cor	light	60 min H_2SO_4	1 % $Ca(OCl)_2$ + CaOH	0	13.00***	0.14	material too small
sul, bel, cae	light	none	none	0.12	16.52***	–	–

again. Pots in which no seedlings emerged during the first summer were left outdoors.

In the Sw material pyrenes received similar treatment except that all pyrenes from a single berry were sown in one pot.

Treated pyrenes

The remaining pyrenes from the M material were kept in paper bags at room temperature for 1 year and then soaked in water for 2 days. Light pyrenes, i.e. those which floated, were only used in two of the treatment tests below.

The effects of various treatments were tested as follows: For each treatment 3 species were chosen at random from the M material. 20 pyrenes from each species (all pyrenes from the same population) were sown in pots after treatment, leaching and drying as shown in Table 1. The pots were kept outdoors during the winter and were removed to the glasshouse on April 7th the following spring, i.e. well before the onset of germination. Pots in which no seedlings emerged during the summer were moved outdoors again in the autumn.

For comparison between species all populations of the M material were used (only 1 of *R. nitidus*). 20 pyrenes were selected from each population and treated according to the standard technique: 60 min soaking in conc. H_2SO_4 in an ice-bath then thorough rinsing in water and $NaCO_3$, followed by leaching with 1 % $Ca(OC1)_2 \cdot 3\ H_2O$ in saturated $Ca(OH)_2$ aqueous solution for 5 days (the solution was changed on the third day) and rinsing in water. The pyrenes were then dried, weighed and sown in pots (M-77).

Delayed germination

Pots in which there were no seedlings in the autumn were observed during the second (materials M-76, Sw and Sk) and third (Sw) seasons as well.

Calculations

Germinability. The percentage of pyrenes giving rise to emergent seedlings.

Earliness of germination. For each recording date (10–12 recordings a season) the total number of seedlings that had emerged was expressed as a percentage of the total number of seedlings that emerged during that season. This percentage was multiplied by the number of days between the date and the last recording date in that season, and the products were added together. With this method of calculation differences in time of emergence were emphasized more at the beginning of the season than at the end, contrary to the otherwise similar calculations made by Jennings (1971 b).

Statistical tests. Data were analysed by the Kruskal-Wallis one-way analysis of variance (Kruskal & Wallis 1952, Siegel 1956), the Spearman rank correlation coefficient test, the χ^2 test, the Kendall coefficient of concordance test (Siegel 1956) and the nested anova (Sokal & Rohlf 1969).

Results and discussion

Treatment tests

Despite the fact that each treatment was applied to 60 pyrenes only and that different species

Table 2. The germinability of the multi-species material (M-76 and M-77), of the wide-range material of *R. nessensis* (Sw) and of the narrow-range material of *R. nessensis* (Sk). Germination was recorded for 3 consecutive seasons starting with the first spring after sowing. Some pots were kept in a glasshouse during the first summer which affected second-season germinability. Germinability is here expressed as the number of emerged seedlings in a season as a percentage of seeds available that season.

Material, treatment	Location of pots during 2nd winter	Germination season	Germinability %	n
M-76 No treatment	–	1	16	1920
Sw No treatment	–	1	1	3200
M-76 No treatment	indoors	2	47	77
Sw No treatment	indoors	2	26	500
M-76 No treatment	outdoors	2	8	600
Sw No treatment	outdoors	2	4	2560
Sw No treatment	outdoors	3	7	1460
M-77 60 min H_2SO_4	–	1	30	720
Sk 60 min H_2SO_4	–	1	10	1320
Sk 60 min H_2SO_4	indoors	2	25	520
Sk 30 min H_2SO_4	–	1	6	1400
Sk 30 min H_2SO_4	indoors	2	13	860

were used, sometimes with diverging types of germination behaviour, some trends are discernible (Table 1). H_2SO_4 gives positive results, the best results being obtained after treatment for 120 min, i.e. the longest time in this investigation. (One of the species thus treated was *R. sprengelii* which has the second lightest pyrenes of all the species (Table 3)—all pyrenes germinated, being obviously in no way harmed by the severe treatment.) For the extensive material of *R. nessensis* (Table 2) 60 min proved to be more effective than 30 min.

Leaching with $Ca(OCl)_2$ appears to increase germination, especially if $Ca(OH)_2$ is added. This agrees with the results obtained by Wenzel & Smith (1975) using blackberry pyrenes and by Jennings & Tulloch (1965) for raspberry pyrenes.

Mišić & Belić (1973) report that treatment of raspberry pyrenes with KOH is more effective than with H_2SO_4. I did not find this so with blackberries.

Baumeister (1959) cut the raphe of raspberry pyrenes with a razor blade and obtained excellent germination but I had no success with this method probably because of technical difficulties.

Kerr (1954) removed the entire endocarp from blackberry pyrenes and obtained about 90 % germination (only well-developed seeds were used). As this method is time-consuming I disregarded it.

Scarcely any of the pyrenes that floated when placed in water germinated being probably devoid of viable embryos as indicated by Kerr (1954).

In each technique the relative order of germinability of seed of each species was identical with that obtained after using the standard treatment (M-77), each species apparently benefiting, or suffering, to approximately the same degree whatever the treatment used.

Not only germinability but also time of germination was influenced by acid treatment, treated pyrenes tending to germinate more quickly (Figs. 2, 3). This was perhaps partly because the first season pots with treated seeds were brought indoors earlier and all at the same time. The time lapse between the use of seeds from the M-material in 1976 and 1977 may also be of significance.

Delayed germination

As a whole the M-76 material germinated better the first than the second season (16 % versus 8 %, Table 2). However, many species germinated better the second season. High germinability the first season is correlated with low germinability in the second: $r_s = 0.673$, $p<0.01$ ($n = 16$). Species with heavy pyrenes tend to germinate better the first season: $r_s = 0.220$, $0.25>p>0.20$ ($n = 15$). *R. nessensis* (Sw) which is number 11 with respect to pyrene weight (Table 3), increased in germinability during all the three years of the investigation (1 %, 4 %, 7 %). The same tendency was also apparent after acid treatment (Sk).

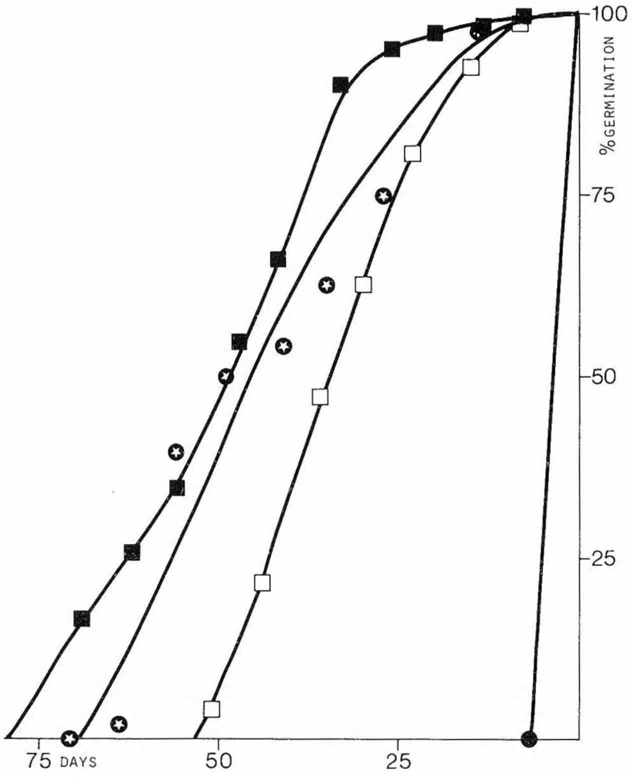

Fig. 2. Earliness of germination in the multi-species (M) material. The cumulative number of emergent seedlings at each recording date divided by the total number is plotted against time. ■ M-76 first-season germination, i.e. first spring after sowing, ● M-76 second-season, pots kept indoors during the first summer, ✪ M-76 second-season, pots kept outdoors, □ M-77 first-season.

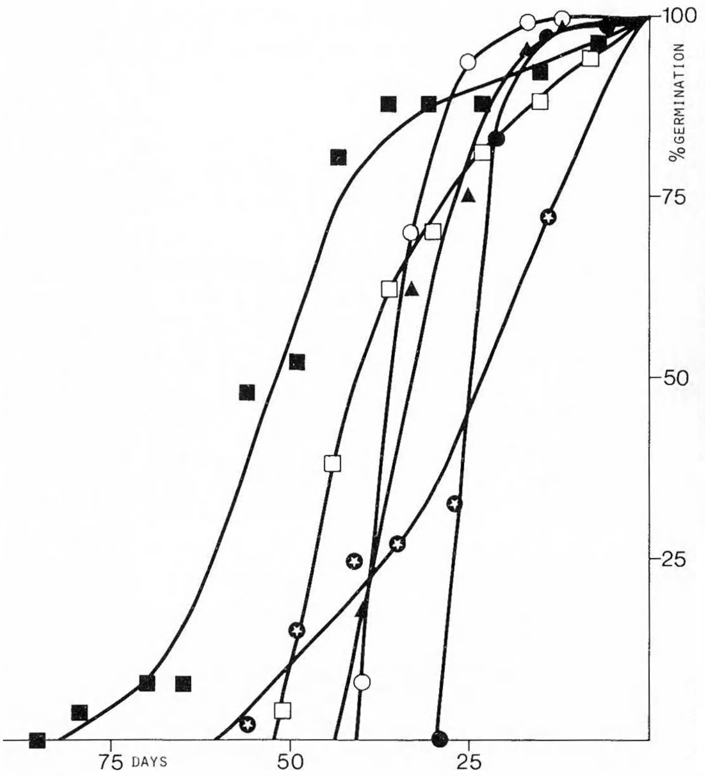

Fig. 3. Earliness of germination in the wide-range (Sw) and narrow-range (Sk) materials of *R. nessensis*. ■ Sw first-season germination, ● Sw second-season, pots kept indoors during the first summer. ✪ Sw second-season, pots kept outdoors, ▲ Sw third-season, □ Sk first-season, O Sk second-season, pots kept indoors.

Keeping the pots indoors during the first summer increased second-season germinability from 8 % to 47 % (M-76) and from 4 % to 26 % (Sw). The seeds also germinated earlier (Figs. 2, 3).

The relative earliness of germination of the various species appears to be similar whichever season the seeds germinate: $r_s = 0.248$, $0.25 > p > 0.20$ ($n = 10$).

Of the 16 species for which germination results are available for both first and second seasons, 8 showed the highest germination the first season. Lidforss (1905, native Swedish blackberries) and Haskell (1955, cultivars) note that in most blackberry species more seeds germinate the first season than the second season. However, a higher rate for second-season germination has also been reported: by Focke (1877), Krefting & Row (1949) and Heit & Slate (1950), with occasionally an even higher rate the third season (Heit 1967)—some species in this investigation behaved in this way, most obviously in the extensive material of *R. nessensis*.

When the pre-chilled but non-germinating pyrenes were kept indoors during the first growing season germination was raised the second season to a striking degree as compared with pyrenes in pots kept outdoors all the time. As it was warmer indoors the breaking of external dormancy by microorganisms in the substrate may have proceeded more effectively. Scott & Ink (1957) obtained increased germination by keeping pyrenes in a glasshouse for a few weeks before chilling.

Species with heavy pyrenes tended to germinate better the first season, which is supported by findings of Haskell (1955) who reported that only the large-pyrene collections of the cultivar Bedford Giant germinated the first season. Both the external and internal seed dormancy of these species is apparently broken by the temperatures in southern Sweden. Oddly enough the external dormancy of a species like *R. nessensis* with light pyrenes is not broken during the first winter the seeds benefiting considerably from a summer indoors—external dormancy is not broken until the seeds have received enough warmth. The dormancy mechanism is probably very complicated and far from being completely understood.

Differences between species

The 17 species each represented by at least 2 populations were used in this part of the investigation, the untreated (M-76) and the treated (M-77) pyrenes being kept separate in the calculations. The variability between species was compared with the variability between populations within species in a Kruskal-Wallis analysis of variance; germinability M-76: H = 39.7, $0.2>p>0.1$ (df = 31, n = 17), M-77: H = 41.3, $0.1>p>0.05$ (df = 29, n = 16), earliness of germination M-76: H = 33.3, $0.1>p>0.05$ (df = 22, n = 12), M-77: H = 20.9, $0.2>p>0.1$ (df = 16, n = 11).

The order of the species varies when the two categories (M-76 and M-77) are compared, though they are still correlated; germinability r_s = 0.33, $0.1>p>0.05$ (n = 19), earliness of germination r_s = 0.36, $0.1>p>0.05$ (n = 16).

For number of pyrenes per berry a nested anova was calculated for all species. The variation between species was highly significant: F = 9.195, $p<0.001$ (df = 16/18).

Such comparisons between species are seldom reported as most research is carried out on cultivars. However, Haskell (1961 b) reported germinabilities from 0 to 54 % in 33 unidentified collections of wild British blackberries.

Variation among populations

In 9 cases out of 12 treated and untreated pyrenes from one and the same of the 2 (3) populations in each species proved to have the highest germinability. This distribution yields $\chi^2 = 3.00$, $0.1>p>0.05$.

Germinability for the Sw material was recorded in the 3 consecutive years after sowing. The similarity between these series of results was investigated with the Kendall coefficient of concordance: W = 12.43, $0.1>p>0.05$ (n = 8). In this material as well populations tend to differ with respect to germinability, though earliness of germination did not differ significantly between populations.

The nested anova calculated on number of pyrenes per berry in the M material also reveals a significant variation between populations : F = 2.035, $0.05>p>0.01$ (df = 16/44).

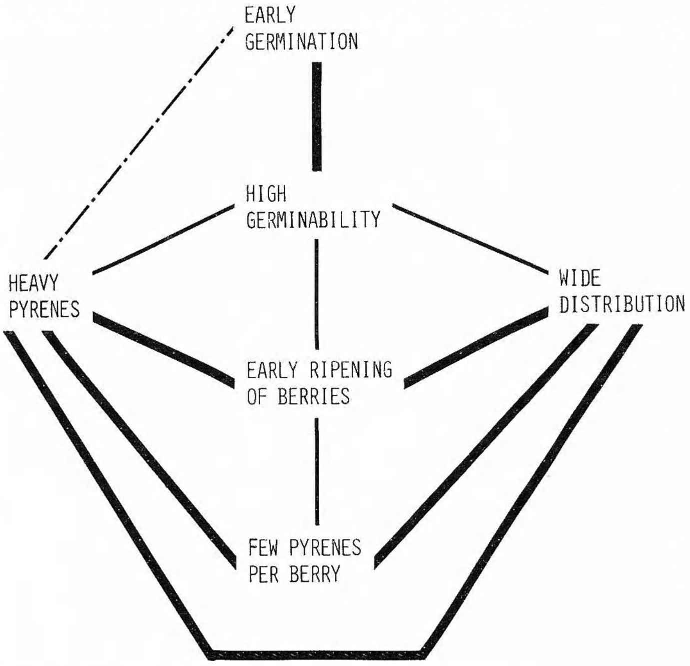

Fig. 4. Correlations between characters calculated on the multi-species material (M-76 and M-77), first-season germination only. Broken line $0.1<p<0.2$, thin lines $0.05<p<0.1$, bold lines $p<0.05$.

Evidently there are genetically determined differences between species in germinability, earliness of germination and number of pyrenes. This is shown by the results from analyses of variance (Kruskal-Wallis and nested anova), where variation is greater between species than within. Similar differences obtained between populations within a species are more difficult to interpret. They may be genetically or environmentally controlled, or probably a combination of both. To investigate this plants from different populations are now being grown under uniform conditions at the Lund Botanical Garden.

Correlation between characters

Correlation tests were carried out on data on the germinability, earliness of germination, pyrene weight, number of pyrenes per berry, earliness of ripening and size of distribution area for the M-76 and M-77 materials (Tables 3, 4 and Fig. 4). When investigating so many presumptive correlations a certain number of significant results will be obtained by chance. However, in this material many statistically significant positive correlations and no negative correlations have been found. Furthermore, the correlations are logical-

Table 3. Data and ranks (italics) for some characters for the multi-species material: mean pyrene weight (n = 20), germinability, earliness of germination and number of pyrenes per berry. For germinability, earliness of germination and number of pyrenes per berry data are given for each population and the mean for each species. Data from pots where seeds from 2(3) populations were sown together are also included in the mean. Ranks for distribution and earliness of ripening were obtained from Oredsson.

Species	Mean pyrene weight mg		Germinability % M-76 each pop.	$\bar{X}$		Germinability % M-77 each pop.	$\bar{X}$		Earliness of germination M-76 each pop.	$\bar{X}$	
nessensis	1.93	*11*	0 0	0	*19*	50 70	60	*2*	– –	–	
nitidus	1.99	*10*	8 10	11	*11*	10	10	*15.5*	394.0 245.0	362.2	*7*
plicatus	2.54	*5*	18 38	35	*2*	40 40	40	*7*	342.8 365.5	392.9	*5*
scissus	1.74	*15*	0 2	1	*18*	25 55	40	*7*	– 203.0	203.0	*18*
sulcatus	1.52	*17*	0 0 0	2	*17*	10 25 35	23	*12*	– –	324.0	*10*
axillaris	1.79	*13*	8 10	9	*14*	60 20	40	*7*	288.7 261.8	226.5	*16*
insularis	2.37	*8*	2 58	28	*5*	0 95	48	*5*	394.0 418.7	419.8	*4*
lindebergii	2.78	*1*	5 8	6	*16*	0 0	0	*18.5*	259.0 324.6	314.4	*11*
scheutzii	2.36	*9*	20	20	*7*	15	15	*14*	366.8	366.8	*6*
sprengelii	1.32	*18*	29	29	*4*	50	50	*4*	335.9	335.9	*9*
thyrsanthus	2.52	*6*	5 13	9	*14*	5 15	10	*15.5*	22.0 252.3	226.8	*17*
bellardii	1.75	*14*	15 28	22	*6*	50 65	58	*3*	259.5 243.7	252.9	*15*
fuscus	1.15	*19*	5 8	9	*14*	0 0	0	*18.5*	326.5 349.4	341.8	*8*
hartmannii	1.82	*12*	15 15	17	*9*	20 30	25	*11*	359.8 416.8	428.6	*3*
radula	2.66	*3.5*	38 40	31	*3*	65 65	65	*1*	386.3 236.5	309.5	*13*
taeniarum	2.66	*3.5*	2 15	10	*12*	45 10	28	*10*	259.0 259.0	253.4	*14*
vestitus	1.60	*16*	0 22	13	*10*	0 10	5	*17*	– 300.0	313.0	*12*
caesius	2.72	*2*	0 85	43	*1*	15 50	32	*9*	– 626.0	632.2	*1*
corylifolius	2.46	*7*	2 35	18	*8*	0 40	20	*13*	558.0 578.0	588.0	*2*

ly interrelated. It is thus possible to draw conclusions.

Species with heavy pyrenes tend to have few pyrenes per berry ($p<0.05$). Similar results can be calculated on material described by Darrow & Sherwood (1932, 40 Rubus cultivars) with $r_s = 0.235$, $0.1>p>0.05$, though Moore, Brown & Brown (1974, 41 blackberry cultivars) found no correlation between pyrene weight and number.

The berries of species with few pyrenes tended to ripen earlier ($p<0.1$). Topham (1967) found that tetraploid raspberries tend to ripen earlier than the corresponding diploids which have more drupelets per berry.

There is a positive correlation between heavy pyrenes and early ripening ($p<0.05$). Fewer pyrenes may imply that the amount of growth-promoting substances available is greater in each pyrene making for earlier ripening and greater weight.

Species with heavy pyrenes often have a wide distributional area ($p<0.05$). Several species ripen very late and the ripening process is generally broken by frost. Early ripening, which is therefore an advantage, is correlated with heavy pyrenes ($p<0.05$).

Is pyrene weight of significance for germinability? In this material a low positive correlation ($p\approx0.1$) can be discerned, but Moore, Brown & Brown (1974, 41 cultivars) found no correlation, and Amor (1974, 6 tetraploid blackberry species) reports negatively correlated weight and germinabilities (germinability was, however, generally remarkably low: 0.5–6.0 %). In hybrids between tetraploid and diploid raspberries Topham & Carmichael (1972) found large seeds (exclusive of endocarp) and high germinabilities to be positively correlated. Moore, Brown & Lundergan (1974, 20 blackberry clones) report a positive correlation between pyrene weight and endocarp thickness, and a negative correlation between endocarp thickness and germinability, but found no correlation between pyrene weight and germinability.

Earliness of germination M-77 each pop.	X̄		Number of pyrenes per berry each pop.	X̄		Distribution in Sweden wide range	north. occurr.	severe climatic zone	Earliness of berry ripening
398.3 298.4	341.1	*9*	8.3 19.8	16.0	*7*	*1*	*2*	*1.5*	*2*
193.5	193.5	*17*	9.0 5.6	7.3	*2*	*17.5*	*17*	*16.5*	*15*
330.6 313.4	323.0	*14*	30.7 20.2	23.7	*12*	*2*	*6*	*3*	*3*
275.4 256.5	261.7	*15*	5.8 9.9	8.5	*4*	*7*	*13.5*	*4.5*	*1*
193.5 431.6 282.2	333.6	*11*	49.8 17.0 41.6	33.4	*16*	*8*	*4.5*	*6.5*	*11*
323.5 338.0	327.6	*13*	20.4 24.4	22.4	*10*	*12*	*17*	*16.5*	*12*
– 370.7	370.7	*7*	35.4 39.8	37.6	*18*	*10.5*	*17*	*16.5*	*8*
– –	–		8.0 10.2	9.1	*5*	*5*	*15*	*12*	*6*
223.6	223.6	*16*	27.3	27.3	*14*	*14*	*13.5*	*9.5*	*9*
459.5	459.5	*3*	22.8	22.8	*11*	*15.5*	*11*	*16.5*	*13*
511.0 379.1	413.0	*6*	7.7 8.1	7.9	*3*	*4*	*3*	*6.5*	*18*
380.1 291.5	329.6	*12*	20.9 28.4	24.7	*13*	*9*	*8.5*	*16.5*	*14*
– –	–		34.9 35.8	35.4	*17*	*15.5*	*10*	*9.5*	*19*
434.0 420.7	426.2	*4*	32.8 23.4	28.1	*15*	*13*	*7*	*9.5*	*17*
496.9 423.3	460.6	*2*	14.5 19.0	16.8	*8*	*6*	*12*	*13*	*10*
316.2 430.0	336.6	*10*	17.6 23.2	20.2	*9*	*10.5*	*8.5*	*9.5*	*5*
– 357.0	357.0	*8*	38.0 39.8	38.9	*19*	*17.5*	*19*	*16.5*	*16*
575.0 406.5	499.2	*1*	11.0 8.1	9.2	*6*	–	*1*	*1.5*	*7*
– 414.5	414.5	*5*	8.0 4.4	6.2	*1*	*3*	*4.5*	*4.5*	*4*

Table 4. Correlation coefficients calculated for some characters (see Table 3) from the multi-species material.

Earliness of germination M-76	0.550 $p<0.05$ (n=18)	−0.112 ns (n=18)					
Earliness of germination M-77	0.409 $p<0.1$ (n=17)	0.215 ns (n=17)					
Heavy pyrenes	0.306 $p\approx0.1$ (n=19)	0.014 ns (n=19)	0.184 ns (n=18)	0.253 $p<0.2$ (n=17)			
Few pyrenes per berry	−0.167 ns (n=19)	−0.007 ns (n=19)	−0.146 ns (n=18)	0.037 ns (n=17)	0.487 $p<0.05$ (n=19)		
Early ripening berries	−0.038 ns (n=19)	0.382 $p<0.1$ (n=19)	0.119 ns (n=18)	−0.137 ns (n=17)	0.438 $p<0.05$ (n=19)	0.372 $p<0.1$ (n=19)	
Wide area of distribution	−0.142 ns (n=18)	0.320 $p<0.1$ (n=18)	−0.101 ns (n=17)	0.140 ns (n=16)	0.530 $p<0.05$ (n=18)	0.474 $p<0.05$ (n=18)	0.625 $p<0.01$ (n=18)
	Germinability M-76	Germinability M-77	Earlin. of germ. M-76	Earlin. of germ. M-77	Heavy pyrenes	Few pyrenes per berry	Early ripening berries

Table 5. Correlations between earliness of germination and origin of populations for the wide-range material of *R. nessensis*.

Germination season	Populations ranked from north to south	Populations ranked from severe to mild climatic zones
First, n = 6	$r_s = 0.886$ $0.05>p>0.01$	$r_s = 0.926$ $0.05>p>0.01$
Second, pots kept outdoors first summer, n = 8	$r_s = 0.339$ $p\approx0.2$	$r_s = -0.203$ ns
Second, pots kept indoors first summer, n = 6	$r_s = 0.543$ $p\approx0.15$	$r_s = 0.370$ ns
Third, n = 8	$r_s = 0.714$ $0.05>p>0.01$	$r_s = 0.274$ ns

Environmental adaptations

Germination has probably partially adapted to environmental factors such as severity of climate and day-length. The severity of the climate of the localities from which seeds were collected can be seen in the map of fruit-growing zones of Sveriges Pomologiska Förening (Swedish Society of Pomologists) (Troedsson & Nykvist 1973). Sweden as a whole is divided into 8 climatic zones 4 of which are accessible to blackberries.

Relative day-length is obtained by ranking the origin of the seed collections from north to south.

The 8 populations of the Sw material were ranked according to severity of climate and day-length in the locality of origin. These rankings were compared with earliness of germination, as evidenced by 4 series of results: 1. pyrenes germinating first season, 2. second season and moved indoors, 3. second season and left outdoors and 4. third season (Table 5).

In the M-76 material the northern population within a species germinated earlier than the southern one in 7.5 cases out of 12 ($\chi^2 = 0.75$, ns) and in the M-77 material in 10 cases out of 13 ($\chi^2 = 3.77$, $p<0.05$). Severity of climate and earliness of germination were positively correlated to a similar degree; 2 cases out of 4 (M-76) and 6 cases out of 7 (M-77).

However, when all populations, irrespective of species, were ranked according to origin from N to S there was no correlation with earliness of germination (M-76: $r_s = 0.014$, ns, n = 29, and M-77: $r_s = -0.054$, ns, n = 29). Neither were severity of climate nor earliness of germination correlated.

Finally the species comprising the M material were ranked according to occurrence from N to S and to least favourable climatic zone (distribution maps by Oredsson 1973, and Hultén 1971, dewberry). These rankings are correlated with earliness of germination as follows: M-76 $r_s = 0.214$, $0.2>p>0.1$ (n = 18), and M-77 $r_s = 0.400$, $0.1>p>0.05$ (n = 17) for northernmost occurrence, and M-76 $r_s = 0.243$, $0.2>p>0.1$ (n = 18), and M-77 $r_s = 0.079$, ns (n = 17) for least favourable climatic zone.

Germinability is clearly greatly increased by light as shown by Scott & Draper (1967, blackberries) and Jennings & Tulloch (1965, raspberries), as is also earliness of germination (Jennings 1971 b). Seeds from localities with different day-lengths may have adapted their dormancy system accordingly. When sown in Lund they exhibited a variation in earliness of germination which is correlated with the latitude of origin. This is particularly obvious in the extensive material of *R. nessensis*.

The critical temperature for initiation of germination in spring may also vary between populations. Crosby (1958) noted that seeds of *Primula* from colder regions are the first to germinate as spring temperatures start rising. Similar results were obtained by Thompson (1970) in experiments on *Silene, Lychnis* and *Petrorhagia*. For several caryophyllaceous genera and for *Gentiana* he has also shown that this temperature requirement usually decreases as afterripening proceeds (Thompson 1968). A similar variability in the temperatures that trigger off germinability is probably present in cloudberries (*R. chamaemorus*) judging by results by Taylor (1971) and Warr et al. (1979).

Rousi (1965) collected and grew raspberries from various parts of Finland. He found that some physiological characters (such as flowering time, fruit ripening and onset of winter dormancy) were correlated with origin, the northerly populations taking the lead in all cases. Unfortunately, he did not study germination. Jennings (1964) worked with wild Scottish raspberry populations which he grew under uniform conditions. Earliness of germination varied greatly between populations but no correlation was found with climate or day-length.

In this investigation blackberry populations have been found to germinate earlier in the season where climate is less favourable. As only 4 of the 8 climatic zones came into question there were many tied ranks and the test was rather crude.

Pleiocots

Deviations from the normal number of two cotyledons are usually caused by a polygenic complex, the pleiocots having a disturbed genic balance (Haskell 1954). In the present study pleiocots were recorded in 1978 and 1979. The pleiocot average varied from 8 to 17 % depending on the treatment applied to the pyrenes. Treatments that increased germinability also gave rise to a higher percentage of pleiocots ($r_s = 0.700$, $0.1>p>0.05$, $n = 6$). The species differ markedly in pleiocot percentages (0–50 %). Species with high germinability tend to have a high percentage of pleiocots ($r_s = 0.391$, $0.1>p>0.05$, $n = 17$). On the average pleiocots emerged later in the season than normal plants (Fig. 5), which agrees with observations by Haskell (1955). However, the relative ranking of the species with respect to earliness of germination is not correlated with pleiocot percentage ($r_s = 0.564$, ns, $n = 17$).

Subsectional differences

It has been suggested that subsections and other species groups differ with respect to pyrene size (Peitersen 1921, Darrow & Sherwood 1932) and relative first-season germinability (Focke 1877). A Kruskall-Wallis analysis of variance for subsections according to Heslop-Harrison (1968) indicates a relationship in this material between earliness of germination and subsections; material M-76, $H = 12.0$, $0.1>p>0.05$, $df = 6.5$, and M-77, $H = 11.1$, $p \approx 0.1$, $df = 6.5$. Neither germinability nor pyrene weight showed any corresponding differences between subsections.

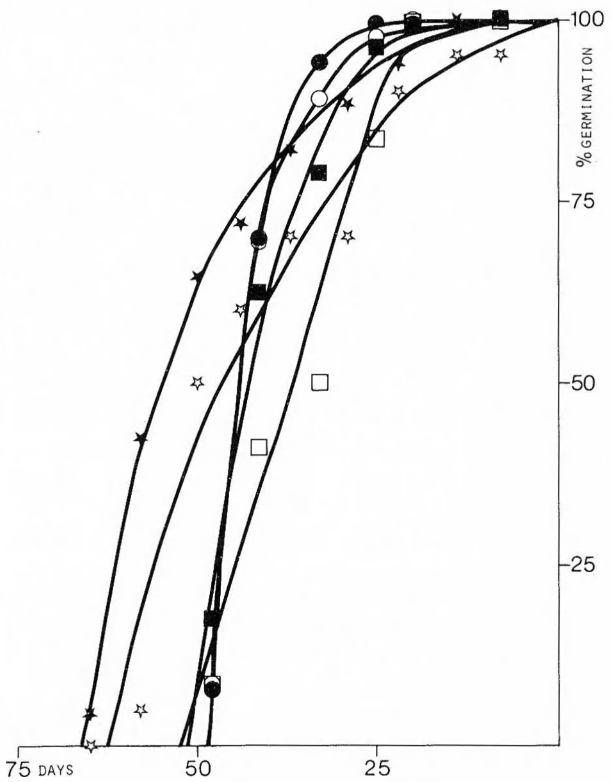

Fig. 5. Earliness of germination in the wide-range (Sw) and narrow-range (Sk) materials of *R. nessensis* for pleiocots and normal seedlings respectively. ☆ Sk first-season germination normal and ★ pleiocots, O Sk second-season normal and ● pleiocots, □ Sw third-season normal and ■ pleiocots.

Mixed seed germination

Haskell (1961 a) notes that when pyrenes from different *Rubus* species were mixed they germinated more quickly than when sown separately. The same tendency was observed in this material though at population level. In the M-76 material 20 pyrenes of each species were sown in 4 pots, each pot representing 1 stand, 2 stands from each population. A fifth pot was sown with 20 pyrenes which were a mixture from the 4 stands. The pyrenes in this pot germinated earlier than the average of the other 4 pots in 10 cases out of 12

($\chi^2 = 5.333$, $0.025>p>0.01$). Germinability was also higher ($\chi^2 = 2.09$, $0.1>p>0.05$, df = 1).

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Botanical literature

Hjelmqvist, H. 1979: *Beiträge zur Kenntnis der prähistorischen Nutzpflanzen in Schweden.* Opera Botanica 47. Stockholm. 58 pp. ISSN 0078-5237. ISBN 91-546-0255-6. Price SKr 33:–, libraries SKr 55:– (wrappers).

For three decades Professor Hakon Hjelmqvist in Lund has been the leading palaeoethnobotanist of Sweden. He has been consulting expert for many archaeologists and has identified culture plants and weeds mainly on the basis of their grain impressions in ceramics found at excavated dwelling sites. This technique is an important complement to traditional macrofossil and pollen analysis for deepening our knowledge of Prehistoric cultures, their economy and environment. Already in 1955 Hjelmqvist published a monograph (Opera Botanica 1:3) in which he describes the history of the culture plants in Sweden. Since then he has studied numerous collections of ceramics of different ages—from Neolithic to Mediaeval time (5000 to 500 years B.P.). Some of these have been published separately, others are unpublished. In the paper reviewed he has gathered this new information which makes it possible to discuss the occurrence of culture plants with more accuracy than before.

The identifications are based on careful, critical studies at the microscope, the interpretations reveal experience of palaeobotanical problems and deep knowledge of palaeobotanical as well as archaeological literature. As an example of the archaeological importance of such research it may be mentioned that the combinations of species of the cereals at Early Neolithic dwelling sites indicate the existence of two culture groups, which were related to two different cultures in Central Europe: one characterized by the dominance of naked barley and wheat (introduced by the very first farmers in Sweden) and one characterized by the dominance of spelt wheats. The study also gives information on the history of some weeds. The book is well illustrated and has tables presenting the finds of the different species for each archaeological period. Since the occurrence of the Prehistoric cereal species is now statistically well documented one would expect a total diagram illustrating the relations between these species along the time scale 5000 to 1000 years B.P.

Hakon Hjelmqvist's main papers on Swedish Prehistoric palaeoethnobotany from 1955 and 1979 are indispensable for archaeologists and palaeoecologists, and all others with an interest in the history of our culture plants and our weed flora. Hopefully the recent paper will stimulate the preparation of similar survey papers from our neighbouring countries in Scandinavia.

Björn E. Berglund

The dynamics of seed banks in an area of sandy soil in southern Sweden

DAN ZIMMERGREN

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The vegetation was removed from 15 permanent plots (1 m^2), 5 in each of 3 relevés in an area of sandy soil which included a sand pit and an abandoned arable field (sandy peat soil). Each plot was divided into half-plots. The soil from the one half-plot was dug up, sterilized and replaced; the soil of the other half-plot was removed and replaced without being sterilized. Emergent seedlings were periodically identified, counted and removed. In the sterilized half-plot the number of seedlings originating from invading seeds was recorded. In the unsterilized half-plot, which had been divided into quarters for the investigation of distribution, the number of seedlings originating from the seed bank plus invading seeds was recorded. The seed bank was seen to be of prime significance for regeneration, to be mainly comprised of seeds of species found in the original vegetation, to have a varying distribution and to be dominated by the seeds of annuals. The greatest number of viable seeds was found in the surface layer.

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Viable seeds (in this context diaspores of embryonic origin), in the soil or on the soil surface, constitute the seed bank. Seed banks occur in most soil types and plant communities (for an exception see Frank & Safford 1970).

In nature the vegetation is continually changing, either because of natural causes such as ageing or by human agency. Where vegetation is temporarily absent regeneration takes place. Where regeneration is by seed the new vegetation may originate from the seed bank (i.e. dispersal in time) or from newly shed seeds produced elsewhere (i.e. dispersal in space), in this context referred to as invasion. Regeneration by seed mainly occurs after some sort of disturbance. Deforestation, agricultural activity and the activity of badgers, moles, worms etc., create habitats suitable for germination and seedling emergence. The seed bank, at least in the layer below the surface, is by definition conservative in its effect on evolution as it is largely composed of older seeds. Old genetic configurations may thus be preserved and in the event of the entire vegetation of an area being destroyed (e.g. by fire), regeneration from the seed bank could change the appearance of the whole plant community.

Most investigations on seed banks have been confined to agricultural soils (e.g. Jalloq 1975, Jensen 1969, Roberts 1970) or to sites of archaeological interest (e.g. Jensen 1979, Ødum 1965, 1978).

In general the method of investigation has been as follows: (1) Soil samples have been taken in the field, (2) each soil sample has been washed through a series of sieves to diminish the size of the samples, and (3) the soil samples have been placed in porous earthenware pans or petri dishes for germination tests (Brenchley & Warington 1930, Jensen 1969). In Ødum (1978) a method using permanent plots in nature is presented, but a net cover used to prevent invasion, though effective, produced an undesirable greenhouse effect.

In essence the aim of my investigation was to determine the origin of seedlings emerging in an area of sand and sandy peat soil. The experiment was designed to compare the establishment of seedlings in plots where the soil had been dug up, sterilized and replaced, with that in plots where

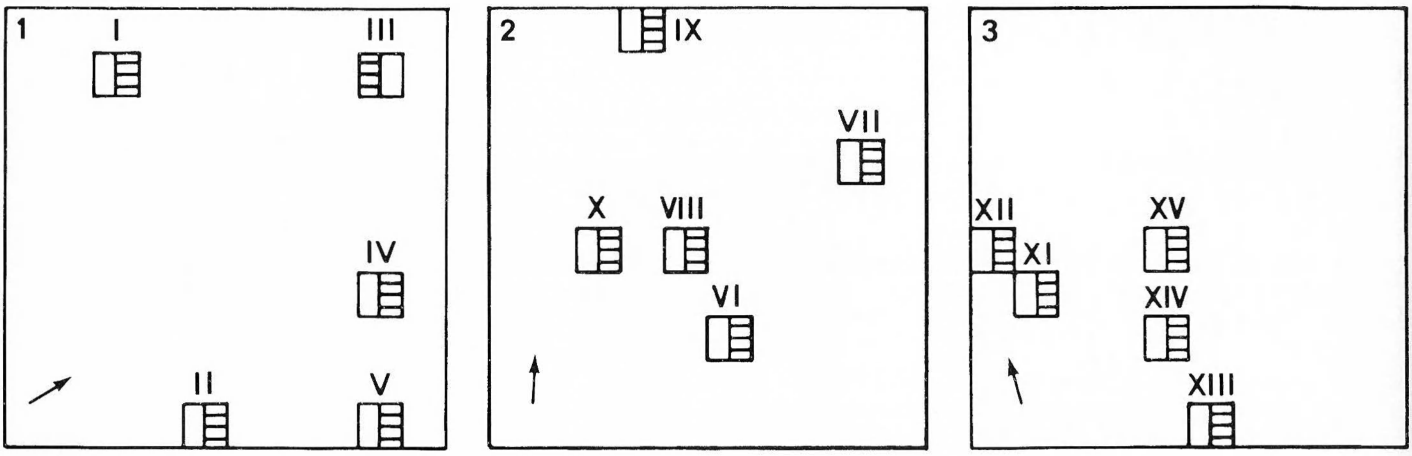

Fig. 1. The random distribution of plots (divided into half-plots and subdivisions) within each of the 3 relevés (100 m^2); arrows point N.

the soil had not been sterilized. In theory seedlings appearing on the sterilized soil should originate from invading seeds and on the unsterilized soil from invading seeds plus the seed bank. In addition soil samples were taken and placed on sterile soil in a greenhouse to determine the viable seed content of the soil.

The area of investigation was chosen partly as being close to Lund because of transport problems, and partly because the soil was light and easy to handle and supported few species.

Material and methods

Nomenclature is according to Lid (1974).

The area investigated, described in greater detail in Zimmergren (1980), is situated in a sandy area (old lake bottom) near the lake Krankesjön in Skåne, S Sweden. The sand is in part covered by a sandy peat soil.

Three relevés, each 10×10 m, were marked out: Relevé 1, in a small exposed sand pit (pure sand) that has not been in use since 1959 and that is now dominated by *Corynephorus canescens*; Relevés 2 and 3, in different parts of an arable field that has not been cultivated since 1959 but that is now occasionally used as pasture and is dominated by *Dactylis glomerata*. More than half the ground in all plots of Relevé 1 was bare, but only up to 6 % in 4 of the plots in Relevé 2, and 3 in Relevé 3. The vegetation was apparently uniform in each of the relevés. In each relevé 5 plots of 1 m^2 had been randomly distributed and were surrounded by plastic board to a depth of c. 10 cm (Fig. 1). The vegetation in each plot was recorded in June 1975 by using the small square analysis technique (Malmer 1962), and the F^c-value (F = small square frequency, i.e. no. of plots where the species was found, expressed as per cent; ^{c} = characteristic degree of cover) was calculated for each species. Species found outside the plots but within the relevés were also recorded. These together with the species found in the plots are referred to as the original vegetation. The vegetation was then removed from all plots by cutting off the above-ground parts, and the plots were divided into half-plots using plastic board down to c. 10 cm. The soil from the one half-plot was dug up down to a depth of c. 10 cm and placed in an autoclave for 20 minutes at 120°C, 1 atm. to destroy any seeds. To obtain data on the distribution of the seed bank plus invading seeds I divided the other half into quarters by plastic board extending to a depth of c. 10 cm, dug up the soil down to c. 10 cm from one subdivision at a time, removed the tillers and roots and replaced the soil. Finally the plots were fenced in to prevent grazing by animals. This marks the starting point of the main part of the investigation (9.7.1975).

Seedlings were identified, counted and removed from each section at intervals. To prevent seed shedding within the plots I made a weekly check and removed any plants that had reached the seed-shedding stage. Unfortunately this could not be done during the spring of 1976 as a result of which the annuals confirmed the fact that they are successful pioneers. Seedlings that could not be identified were cultivated.

Voucher specimens and complete tables of data are available from the Department of Plant Taxonomy, Lund.

Seedling emergence is presented for four periods: summer (9.7–28.8) 1975, autumn (29.8–13.11) 1975, spring (30.3–11.6) 1976 and summer (12.6–6.9) 1976. The number of surviving seedlings that had emerged during the winter of 1975–76 was estimated to be less than 10 % of the number of seedlings that emerged during the autumn of 1975. The figures for autumn 1976 had to be disregarded as it had not been possible to remove the seedlings early in the spring that year and several annuals had completed their life cycles by the time the count was made. As these were all species that germinate mainly during the autumn this does not affect the data obtained before autumn 1976. *Erophila* *verna*, for instance, was represented by 375 dead plants in June 1976. These and an unknown but presumably limited number of plants growing outside the plots gave rise to 36,431 seedlings during autumn 1976 and 1,876 during spring 1977.

Six series of soil samples, 2 per relevé, were taken before the soil was removed for sterilization. The samples of each series were taken from depths of 0–2, 2–4, 4–6, 6–8 and 8–10 cm, with the aid of a specially constructed steel frame measuring 10×10×2 cm. Each sample was divided into halves, one of which was placed on top of sterilized soil in a pot which was left in a greenhouse for 4 months (30 pots in all) together with pots containing sterilized soil only (invasion control). Seedlings were identified, counted and removed. An attempt to extract the seeds from the soil of the other half by floatation was not successful.

Samples for a second soil-sample test were taken in October 1976 using the same frame. A hole 1 m in diameter and c. 1.7 m deep was first dug in the middle of Relevé 2. Five series of soil samples (125 in all) were then taken round the circumference of the hole, each series from 0–2, 2–4 cm, etc. down to 50 cm. The exact volume of each sample was recorded and the whole of each sample was then placed on top of sterilized soil in a pot. The 125 pots were placed in a greenhouse together with 125 pots containing sterilized soil only (invasion control); both categories were randomized together. Seedlings were identified, counted and removed during a period of 10 months. No seedlings appeared in pots with soil from a depth of more than 30 cm. In some pots with soil from below 22 cm an occasional seedling was recorded but these seedlings were disregarded as the seeds from which they originated may well have fallen down from higher levels during the process of sampling.

Sources of error

The species of the original vegetation of each relevé were recorded once only (June 1975). By summer many annuals have completed their life cycles and can be difficult or even impossible to identify (cf. Jensen 1969 p. 47). The characteristic degree of cover (^{c}) for these species is thus presumably an underestimate.

Soil samples taken from the sterilized soil (sandy peat) of Relevés 2 and 3 were found to contain some viable seeds—presumably the time of sterilization had been too short. Thus in these two relevés the total number of invading seeds could not be determined exactly. No seedlings appeared in the pots with soil samples from Relevé 1 (sand). This may indicate that the sterilization of the soil from this relevé had been successful.

The number of seedlings recorded is an underestimate of the number of seeds that have germinated as seedling mortality is high. Some species were found to be capable of vegetative propagation so that it was difficult to obtain reliable data on emergence for them. The seedlings of *Cerastium fontanum* and *semidecandrum* were so alike as to be indistinguishable and were recorded as *Cerastium* spp. The same applied to *Geranium molle* and *pusillum* and *Veronica agrestis* and *arvensis*.

Results

Importance and distribution of the seed bank

In 56 of the 60 recordings of seedlings most of them could be seen to have originated from the seed bank (Fig. 2).

The distribution of the seed bank, as expressed by the total number of seedlings, varied both within and between plots. This was confirmed by the soil-sample tests. Distribution also varied with depth. As expected the surface layer (0–2 cm) was found to contain most viable seeds, the number declining with depth (Table 1, Fig. 3). In data from the second soil-sample test (0–50 cm) there was also a conspicuous rise in the number of viable seeds found in soil samples from between 10 and 20 cm (Fig. 3). The seed bank did not extend further than 25–30 cm, corresponding with the depth of the sandy peat soil on the old lake bottom. As the area has previously been under cultivation ploughing in the past will have disturbed the soil down to 25–30 cm.

Regenerating vegetation

Only 33 % of the species of the original vegetation appeared in the unsterilized half-plots (i.e. from the seed bank) of Relevé 1, compared with 67 % in Relevé 2 and 69 % in Relevé 3.

In all relevés most seedlings were of species found in the original vegetation. Few of the 'alien' species (i.e. not found in the original vegetation) were represented by 25 or more seedlings (Zimmergren 1980 Table 7).

The species originating from the seed bank were present in varying combinations in each of the relevés. Relevé 1 (sand pit) differed conspicuously from Relevés 2 and 3, which corresponds roughly to the differences observed in the original vegetation (see Zimmergren 1980 Tables

Table 1. The viable seed content in soil samples taken from varying depths in June 1975. Number of emergent seedlings represents the sum of the two series per relevé (i.e. per 200 ml soil).

Depth (cm)	No. of emergent seedlings Rel. 1	Rel. 2	Rel. 3
0–2	43	55	18
2–4	17	22	8
4–6	23	17	8
6–8	7	15	6
8–10	0	13	7

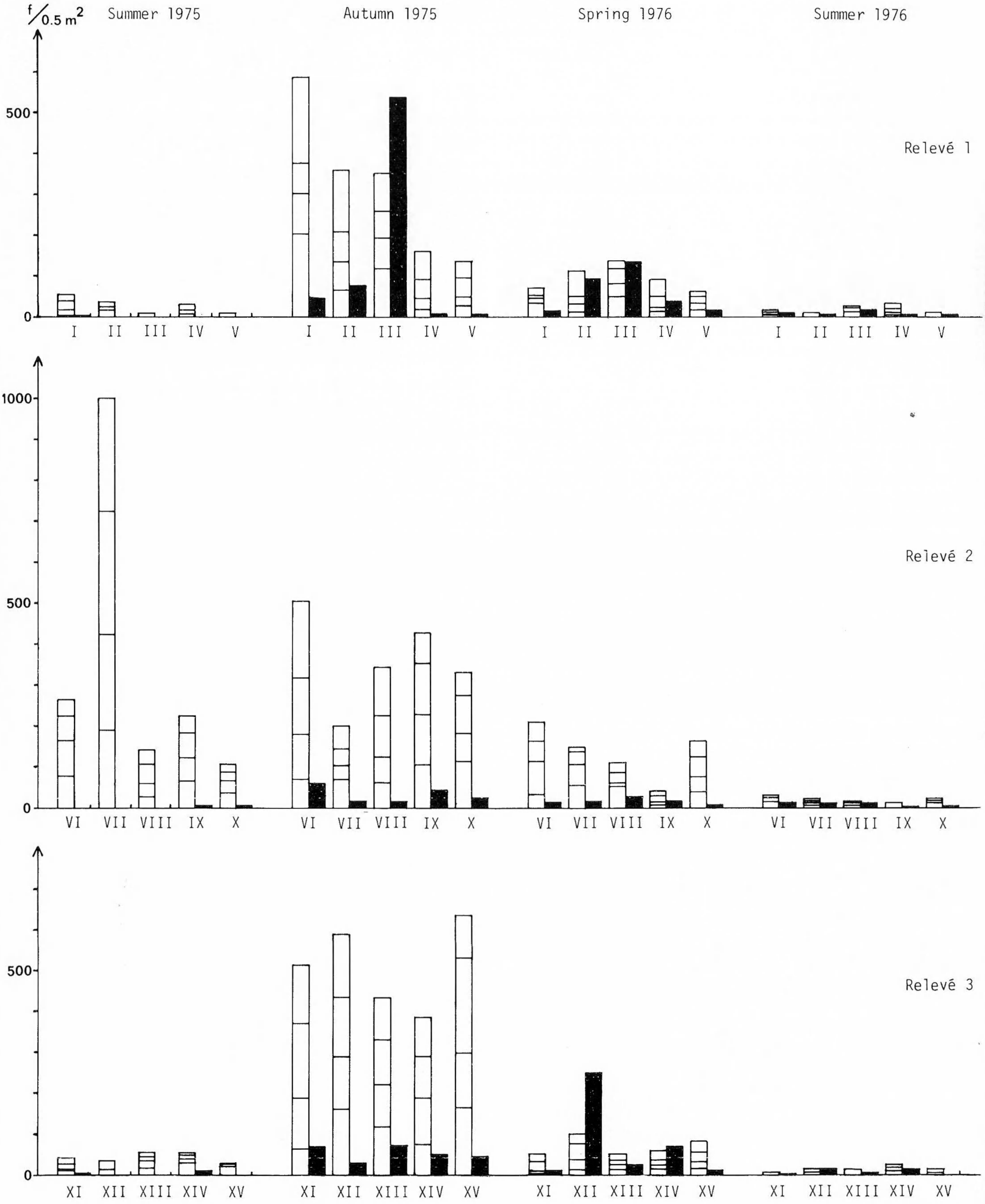

Fig. 2. The number of seedlings (f) within each of the 5 plots per relevé during the periods investigated. Each unfilled column represents the 4 subdivisions of an unsterilized half-plot separated by horizontal lines. The filled column represents a sterilized half-plot.

1–3) and to the differences in soil type. In each relevé the combination of species varied widely both between and within plots.

The original vegetation was dominated by perennials both as regards number of species and small square frequency, F. After the ground had been disturbed the number of annual species in unsterilized half-plots had increased in proportion to the number of perennial species. The total number of seedlings of annuals in the unsterilized half-plots equalled the total number of seedlings of perennials in Relevé 1 and exceeded them in Relevés 2 and 3. There were fewer seedlings of perennials that are capable of vegetative propagation than of other perennials (cf. Jensen 1969 p. 48).

Almost all seedlings emerging during the 10 months of greenhouse cultivation (see second soil-sample test) originated from seeds of annual species, *Erophila verna* and *Arabidopsis thaliana* dominating (Fig. 3).

Time of germination

Data obtained from Tables 1–3 in Zimmergren (1980).

Most seeds germinated during the autumn of 1975. (Plot VII, however, was dominated by *Trifolium arvense* which germinated within a few weeks of the starting point in July 1975.) In 1976 more seeds germinated during the spring than during the summer (Fig. 2).

As regards the individual species some few germinated mainly during the spring, the most striking example being *Senecio viscosus* followed by *Brassica rapa, Chenopodium album, Polygonum convolvulus, Thlaspi arvense* and *Trifolium repens*.

Setaria viridis was the only species in which germination was confined to the summer.

The following species germinated mainly during the autumn: in plots of Relevé 1 *Arenaria serpyllifolia, Cerastium semidecandrum, Erigeron canadensis, Filago* spp. and *Rumex acetosella,* in Relevés 2 and 3 *Arenaria serpyllifolia, Cerastium* spp., *Dactylis glomerata* and *Veronica* spp. and in Relevé 3 alone *Erophila verna, Geranium* ssp. and *Myosotis* spp. The number of seedlings of these species had decreased to roughly the same low level by the end of spring (1976), and continued to decrease during the summer, despite marked initial differences in numbers of viable seeds available. *Geranium* spp. deviated slightly.

Some of the species that in plots of Relevés 1 and 3 were mainly autumn-germinating, and some with few or no seedlings, germinated within a few weeks of the starting point in Relevé 2 or during the following spring and summer: *Chenopodium album, Myosotis* spp., *Trifolium arvense* and *Viola arvensis* emerged within a few weeks of the starting point. The number of emerging seedlings had decreased to roughly the same low level by the end of autumn 1975 and continued to decrease during the following spring and summer (cf. autumn-germinating species). In Relevé 2 all seedlings of *Geranium* spp. emerged within a few weeks. In Relevé 2 all seedlings of *Capsella bursa-pastoris* emerged within a few weeks (summer 1975); in Relevé 3 more than half emerged within a few weeks and of the remainder equal numbers emerged during autumn 1975 and spring 1976. No seedlings of *C. bursa-pastoris* appeared in Relevé 1.

Comments on individual species in plots

Arenaria serpyllifolia. Fig. 4 shows the varying distribution of seedlings in the unsterilized half-plots of Relevé 2. There is a clear connection between the distribution of seedlings and the location of plots (in Plots VI, VIII and X, which lie 1 m apart, there are more seedlings than in the other two which lie farther apart). Throughout the four periods of emergence the number of seedlings of *A. serpyllifolia* was highest in Relevé 2 and lowest in Relevé 1.

Corynephorus canescens. (Fig. 5). As the greatest number of seedlings of *C. canescens* was found in Plot III, followed by Plot II, caryopses from a concentration of the grass in the northern corner of the relevé (immediately outside Plot III) may have been blown in a southerly direction during the late summer of 1975. The number of seedlings within the subdivisions of Plots II to V declines in a manner that could support this hypothesis. Additional support can be found in Plot I which has noticeably fewer seedlings of *C. canescens*. Moreover, the number of seedlings in the subdivisions of Plot I declines in a northerly direction.

Fewer seedlings emerged on sterilized soil, except in Plot III. This can perhaps be explained

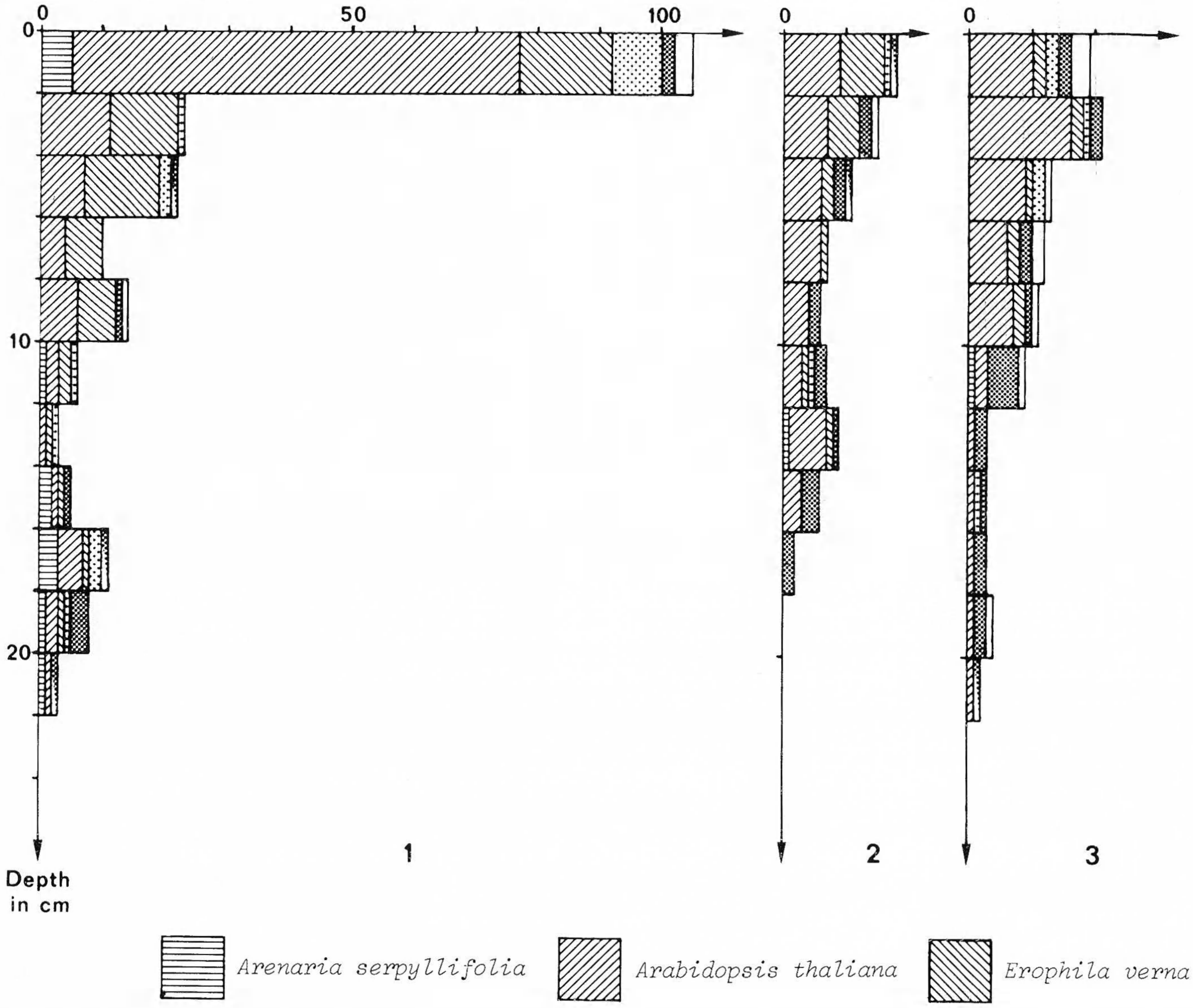

Fig. 3. The vertical distribution of viable seeds, i.e. number of seedlings (f), in the soil of Relevé 2, October 1976.

by the fact that the only plastic boards that could help to retain seeds were those surrounding the half-plots.

Dactylis glomerata. As in most Poaceae, the seeds of *D. glomerata* are short-lived in the soil (see Lewis 1973 pp. 179, 181). In Relevés 2 and 3 almost 1/3 of all seedlings emerging during autumn 1975 originated from seeds produced in the same year (2/3 from the seed bank). In 1976 more seedlings originated from seeds produced in 1975 than from the initial seed bank.

In the sterilized half-plots of Relevés 2 and 3 *Dactylis* was the dominant species (as in the original vegetation). In Relevé 1 a few plants of *Dactylis* were found outside the plots but none in the plots.

Jasione montana, found only in Relevé 1, was one of the few species present in the original vegetation that did not produce seedlings originating from the seed bank.

Senecio viscosus was not present in the original vegetation but a large number of seedlings appeared in the unsterilized half-plots of Relevé 1.

Setaria viridis presumably invaded some plots of Relevés 1 and 2, mainly unsterilized subdivisions (cf. *Corynephorus* above), shortly after the starting point. This finds support in the total absence of seedlings of *S. viridis* in Plot III during both summers, and in the fact that the sterilization of the sand in Relevé 1 had apparently been successful (see Sources of error).

Taraxacum sect. *Vulgaria* was found in similar proportions in the original vegetation (Relevés 1,

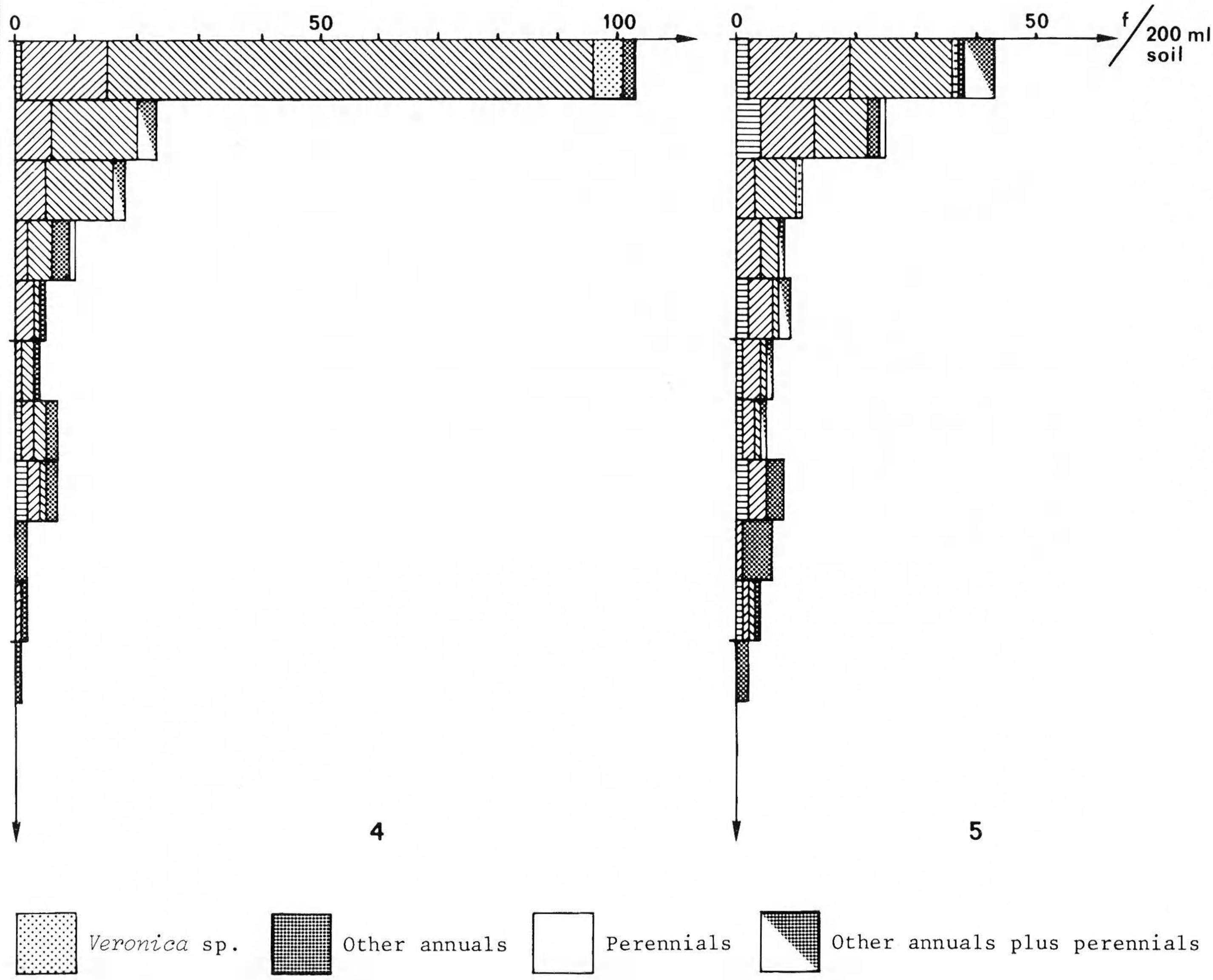

Fig. 3 (contd.).

2 and 3; $F^c = 20^1$, 100^2 and 80^1 respectively) and in the unsterilized half-plots (no. of seedlings 2, 427 and 84 respectively). This positive correlation was not found for any other species (cf. Jensen 1969 p. 40).

Torilis japonica and *Chenopodium album* both invaded one plot each in Relevé 3 (Plots XII and XIV respectively). This can be seen by the far greater number of seedlings that emerged in the sterilized half-plots compared with the unsterilized half-plots during spring 1976 (see Zimmergren 1980 Tables 3 and 10).

Trifolium arvense had a similar distribution in Relevé 2 to that of *Torilis* and *Chenopodium* in Relevé 3, but in all relevés all seedlings of *T. arvense* originated from the seed bank. Of a total of 828 seedlings that emerged in the unsterilized half-plots of Relevé 2, 812 appeared in Plot VII (see Zimmergren 1980 Table 11).

Viola arvensis. In Relevé 2 the majority of seedlings emerged within a few weeks. In Relevés 1 and 3 the few seedlings that emerged were evenly distributed in time from the starting point to the end of the summer of 1976. In Relevé 2 the species had a similar pattern of emergence during autumn 1975 and spring and summer 1976.

Discussion

The method of dividing permanent plots into sterilized and unsterilized halves was rewarding even though sterilization had not been completely successful. The time of sterilization has, however, since been extended from 20 to 40

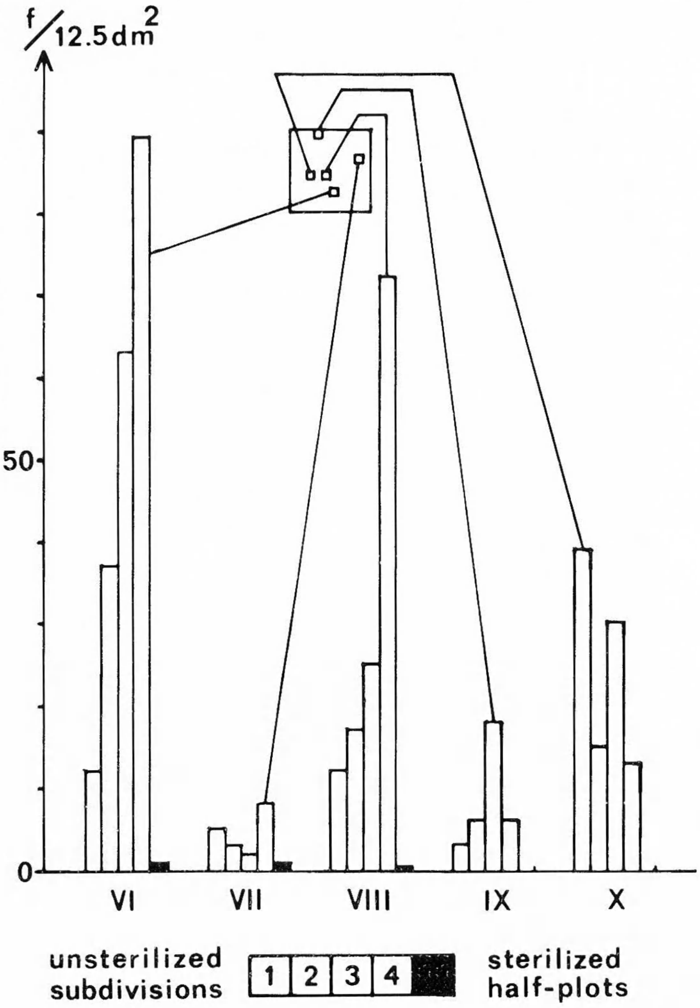

Fig. 4. The distribution of seedlings of *Arenaria serpyllifolia* in Relevé 2, autumn 1975. The number of seedlings (f) in the sterilized half-plots has been divided by 4 for comparison with the subdivisions of the unsterilized half-plot.

minutes, which has proved to be 100 per cent effective. In addition the size of the plots has been decreased from 1 m² to 0.25 m², the number of plots has been increased from 15 to 48 and sterilized and unsterilized plots have been randomized separately.

The seed bank (dispersal in time) was, with few exceptions (including the two dominants in the original vegetation, i.e. *Corynephorus* and *Dactylis*), of prime significance for regeneration. Invasion (dispersal in space) was shown to be of significance to 5 species only: *Chenopodium album, Corynephorus canescens, Dactylis glomerata, Jasione montana* and *Torilis japonica*. Seeds of the last four apparently do not remain viable in the soil for long. *Chenopodium album* on the other hand has the reputation of remaining viable for extremely long periods (Ødum 1965: 1,700 years!).

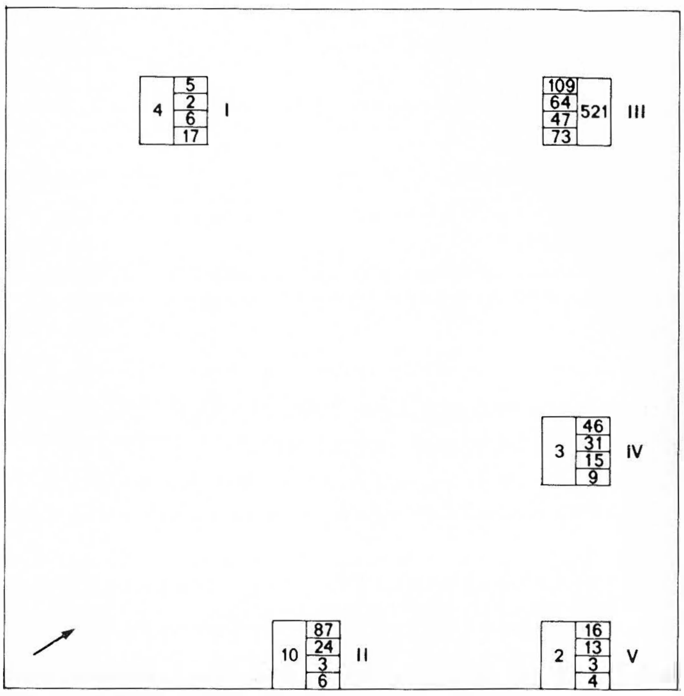

Fig. 5. The distribution of seedlings of *Corynephorus canescens* in Relevé 1, autumn 1975. Subdivided half-plots are unsterilized, undivided half-plots are sterilized; arrow points N.

The paucity of seedlings originating from invading seeds is probably connected with the microtopography (cf. Campbell & Swain 1973). The radicle must penetrate the soil surface before the seedlings can establish and the losses are great during this stage (Dowling et al. 1971). The grasses have a smaller radicle diameter and develop seminal roots (Campbell & Swain 1973), which could in part explain the dominance in all relevés of grass seedlings originating from invading seeds.

That the total number of seedlings emerging in Relevé 1 was less than in Relevés 2 and 3, and was less in Relevé 3 than in Relevé 2, is probably connected with edaphic conditions. In Relevé 1 (sand pit) the porosity of the sand allows free passage to elements, including oxygen and other elements that have a negative effect on viability. The moist soil conditions of Relevé 3 may also have had a negative effect. Ødum (1965) states that a slight to moderate amount of moisture in the soil provides the seeds with optimal conditions for survival.

Slight differences in the microenvironment can profoundly affect biological processes (cf. Dawson & Bruns 1975 on the longevity of seeds in the soil). I found that the number of seedlings varied considerably between the adjacent subdivisions of the unsterilized half-plots—total number of seedlings and number of seedlings of each species. Though it is difficult to determine the relative importance of the distribution of the seed bank and variation in microenvironment, the second soil-sample test revealed that under uniform conditions variation similar to that found in the field occurred. The conspicuous rise in the number of viable seeds (as indicated by emergent seedlings) found in soil samples that came from between 10 and 20 cm is difficult to explain. Ploughing during the 50's may have in some way influenced conditions necessary for preserving viability and/or may have helped to concentrate seeds to this level. In Relevés 2 and 3 the layer of sandy peat soil varies in thickness and the surface is uneven. Both these factors may account for the slight variation in the depth at which the rise in the number of viable seeds was found.

In all relevés the species composition of the seed bank closely resembled that of the original vegetation.

Autumn 1975 was the main germinating period in Relevés 1 and 3. In Relevé 2 the number of seedlings emerging during summer 1975 about equalled the number appearing in the autumn, owing to the fact that in Relevé 2 certain species germinated within a few weeks of the starting point (July 1975). In Relevé 2 the seeds of these species may thus represent ecotypes that differ from those found in Relevés 1 and 3. Relevé 2 is intermediate between Relevé 1 (very dry) and Relevé 3 (moist).

Annuals were favoured by the removal of the vegetation and the removal and replacement of the soil, as in a well-established perennial community the competitive ability of annuals is poor. The almost total prevalence of seedlings of annual species in the second soil-sample test is, however, difficult to interpret.

Several winter annuals germinated not only during autumn (1975) but also in smaller numbers during the following spring. This could be interpreted as a means of guarding against extinction (e.g. due to extremely low temperatures). The genotypes of the seeds that germinate during the autumn presumably differ from those germinating during the spring.

Finally, when interpreting the results of this type of investigation, the past and present environment, the past and present flora, and past and present land use must all be taken into account.

Acknowledgements. I am greatly indebted to Drs Torsten Askaner and Sten Rundgren for valuable information on the historical background of the area, to Professor John L. Harper, Bangor, Wales, and Mr Søren Ødum, Dendrologist at the Hørsholm Arboretum, Denmark, for critically reading the manuscript and to Mrs Margaret Greenwood Petersson for linguistic help. I am also grateful to my colleagues at the Department of Plant Taxonomy for discussions and to the Department of Microbiological Ecology for the use of their autoclaves.

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Botanical literature

Jensen, H. A. 1979: *Seeds and other diaspores in medieval layers from Svendborg.* (The Archaeology of Svendborg, Denmark. Vol. 2.) 101 pp., 17 figs., 9 tables and 3 fold-outs (1 map and 2 profile drawings). Odense University Press. ISBN 87-7492-281-5. Price Dan. kr. 100.00 (in Denmark plus V.A.T.).

This, the second volume in a series about the town of Svendborg during the Middle Ages, is a fine example of the use of seeds found in dated soil samples for determining the significance of different species during different ages of human history. It can be recommended to anyone who is interested in archaeology or related subjects such as the history of cultivated plants.

This type of investigation has a long tradition in Denmark, as can be seen in the first two chapters (Introduction and Literature) as well as in the References.

The methods used are old established ones and are briefly referred to in Chapter 3 (Materials and methods) which also presents the four sites investigated (Foldagers Gård: 8 samples; Korsgade 4: 5 samples; Krøyers Have, inner and outer moat: 3 and 5 samples respectively; and the Franciscan Monastery: 5 samples).

In Chapter 4 (Results and discussion) the results from the different sites are presented. The Tables on seed content, etc., found in this chapter may at first seem a little inconveniently oriented but are in fact very practical to use.

The find of seeds of *Agrostemma githago* in soil samples from two of the sites is of particular interest, as the species is now almost extinct both in Denmark and Sweden. Unfortunately no data on germinability are given.

The measurements of seeds which among other things can be used as an indication of the conditions under which they were produced is given. *Linum usitatissimum*, investigated by Helbæk in 1959, is cited as a good example.

In Chapter 5 (General discussion) Cultivated and collected plants, and Medicinal plants are sections of special interest. By comparing old Danish names found in Herbals with Latin names, it has been possible to determine the approximate time when the plants first came into common use during the Middle Ages, the monks in some cases being responsible for introducing them.

Humulus lupulus and *Myrica gale* are among the species that receive special attention, both being used in the brewing of beer. The find of caryopses resembling two-rowed barley is especially interesting, as it is the first record from the Middle Ages in Denmark. The need for a more thorough examination of better material of the species is pointed out.

Interspersed in Chapters 4 and 5 are four pages of colour prints of seeds. Each of the altogether 24 prints compares seeds from the archaeological sites (left) with present-day seeds. Taking the photographic difficulties into consideration they are excellent, but unfortunately no scale is given.

A fold-out map of Svendborg is appended, with the location of the sites indicated. There are also two fold-out profile drawings showing two of the sites. Profile drawings of the other sites are to be found in the text. A Danish resumé is included.

In all this is an extremely interesting book.

Dan Zimmergren

Two ^{14}C dates of wood samples from Rondane, Norway

E. K. BARTH, A. LIMA-DE-FARIA and B. E. BERGLUND

Barth, E. K., Lima-de-Faria, A. & Berglund, B. E. 1980 12 15: Two ^{14}C dates of wood samples from Rondane, Norway. *Bot. Notiser 133:* 643–644. Stockholm. ISSN 0006-8195.

Two ^{14}C dates were obtained from samples of (1) *Betula* wood from Fremre Illmanntjern (1220 m a.s.l.), 8320±80 years B.P., and (2) *Pinus* wood from Haverdalen (1030 m a.s.l.), 8240±80 years B.P. There are similarities between these findings and dates obtained from Jämtland (Sweden) and Hardangervidda (Norway).

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The Rondane National Park comprises a considerable part (572 km^2) of the Rondane Mountains situated in C Norway. The early post-glacial flora of this area has recently been investigated by means of ^{14}C dating. The first dating made on wood samples collected in this region was carried out at the University of Lund, Sweden. A specimen of *Pinus sylvestris* collected in 1974 turned out to be 4914±65 years old (Lima-de-Faria 1977). This specimen was found at the bottom of a small lake situated 960 m a.s.l. near the top of the small mountain Kåsi (1060 m a.s.l.; Fig. 1, No. 1). Two new findings are described, one of birch and one of pine.

New records

Two new findings have now been made of tree stumps within the same area. The first one is from Fremre Illmanntjern which is located at 1220 m a.s.l. (No. 2 in Fig. 1). The tree samples, which were 2–3 cm thick, were found in peat 70 cm below ground level. The species was identified as belonging to the genus *Betula* by Mr Thomas Bartholin, University of Lund. The ^{14}C dating gave 8320±80 years B.P.

A pollen analysis of the peat accompanying the samples was carried out by Asbjørn Simonsen, Archaeological Museum, Stavanger, Norway (Table 1). No pollen was found from *Alnus* or from broad-leaved trees. This indicates that the peat belongs to the Boreal time (9–8000 B.P.).

Selsing (1979) has pointed out that it is doubtful whether the birch forest extended higher in former times than it does today. However, she points out that the post-glacial pine forest in the Ryfylke/Setesdal area has been found up to 200 m higher than today.

At present the nearest birch forest is found in Rondane at an altitude of c. 1050 m, 6–7 km from Fremre Illmanntjern. This suggests that the *Betula* species occupied higher altitudes c. 8000 years ago.

The second tree sample was collected at Haverdalen in a typical moraine region c. 500 m SE of the Haverdalssetrene at 1030 m a.s.l. (No. 3 in Fig. 1). The ^{14}C dating gave the age 8240±80 years B.P. and the tree was identified as belonging to the genus *Pinus*. Today the nearest pine forest is found at an altitude of about 900 m, 10–12 km away. In this case it is difficult to draw conclusions concerning the highest limit of pine in former times.

Discussion

Outside the Rondane mountains there have been found a number of remains of pine forest in Norway at high altitudes and of high ages, viz.:

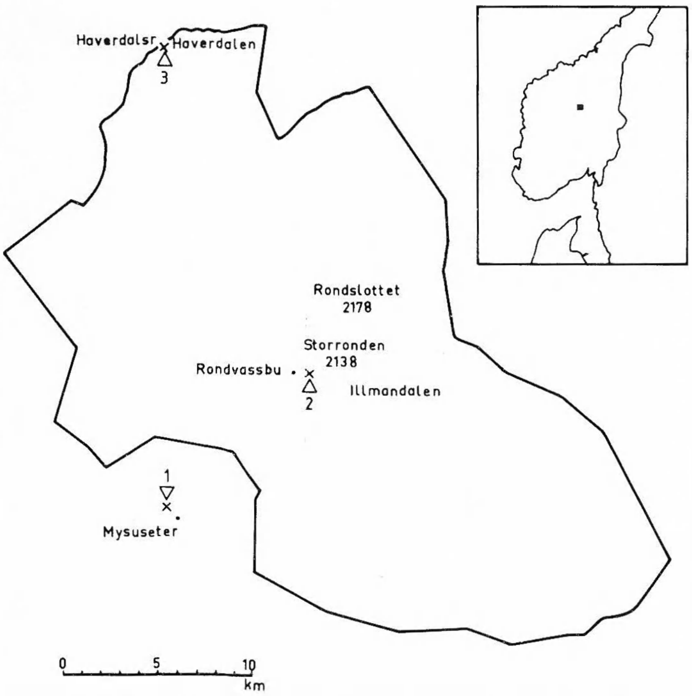

Fig. 1. Location in the Rondane region of the tree samples which were ^{14}C dated: No. 1: near Kåsi (Lima-de-Faria 1977). No. 2: at Fremre Illmanntjern. No. 3: near Haverdalssetrene. The sites Nos. 2 and 3 are described in this communication. The boundary of the National Park is indicated.

Table 1. Pollen analysis of the sample from Fremre Illmanntjern.

Pollen type	Number of pollen grains	Per cent
Pinus	227	42.3
Betula	56	10.4
Corylus	12	2.2
Salix	9	1.7
Total	304	56.6
Ericales	4	0.7
Cyperaceae	124	23.1
Poaceae	47	8.8
Melampyrum	43	8.0
Apiaceae	1	0.2
Rumex	8	1.5
Polypodiaceae	5	0.9
Various species	2	0.4
Total	234	43.6

(1) at 1413 m (not ^{14}C-dated) in Nord-Fron in Gudbrandsdalen (Sandmo 1960),
(2) at 1180 m (7740±160 B.P.) at Mårvann on SE Hardangervidda (Moe 1979),
(3) at c. 600–1050 m (c. 5000 to more than 8000 B.P.) in the Ryfylke mountains in SW Norway (Selsing 1979),
(4) at 1100 m (8310±110 B.P.) on W Hardangervidda (Moe 1979),
(5) at 1100 m (8180±110 B.P.) on NE Hardangervidda (Moe 1979), and
(6) at 1060 m (8400±200 B.P.) on Mt Gravfjellet in Östre Slidre, Valdres (Sandmo 1960).

In Sweden there are results from the province of Jämtland which are similar to those from the region of Hardangervidda (Lundqvist 1969). Moe (1979) points out that the pine forest developed on the Hardangervidda about 500 years after the ice melted in this region, i.e. c. 8400 to 8500 years ago. He also suggests that in Scandinavia the highest limit of the forest was reached 8000 years ago and that it was successively lowered around 6000 to 5000 years ago.

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Botanical literature

Tutin, T. G., Heywood, V. H., Burges, N. A., Moore, D. M., Valentine, D. H., Walters, S. M. & Webb, D. A. 1980: *Flora Europaea Vol. 5*. 425 pp. + 5 maps. Cambridge University Press. ISBN 0-521-20108-X. Price £37.50 net in U.K.

With the publication of Volume 5 the formidable project *Flora Europaea* is now complete. The volume has been eagerly awaited for over a year and is welcomed by innumerable botanists.

A period of fifteen years is not excessive for a task of this magnitude. It is true that the only slightly more than 11,550 species included in Flora Europaea are less than was anticipated at the outset, or even at a late stage, of the work. Rarely has a Flora project been brought to such a successful conclusion and rarely has a botanical project been led by such an efficient body of editors, authors and regional advisors. The scientific resources placed at the disposal of the project have been impressive and the amount of enthusiasm displayed has been out of the ordinary. The influence of *Flora Europaea* on other Floras is considerable. It will probably become increasingly so now that the nomenclatural framework for all the higher plant groups in Europe has been set up, because the nomenclature of *Flora Europaea* will presumably be followed by a great number of regional and national Floras all over Europe.

Though I join in the felicitations I wish to add a word of caution to taxonomists working on revisions and monographs of groups included in *Flora Europaea*: Do not refrain from reconsidering its classifications and taxonomic conclusions. Even though most treatments have been effected with competence and care and with generous help from regional advisors, many of the taxonomic decisions made, especially of course for locally and regionally restricted taxa, rest on a fragile basis that lacks support from field studies. This must necessarily be so in a project where the time limit, the lack of resources for field work and the lack of specialists in certain given groups has to be accepted. Nor can it be denied that some discussion has arisen among even the most influential and active contributors as to the sparsity of citation of synonyms and the complete lack of citation of types. It has been claimed, and probably rightly so, that a little extra space would have sufficed to provide much more information that after all had to be collected in the course of the revisional work entailed.

Thus the work on the flowering plants of Europe should not be considered complete, as some may think. New conceptions of species, numerous changes in nomenclature and also a number of species new to Europe, especially to peripheral countries such as Greece, are to be expected and have already begun to accumulate. This is self-evident to those who have worked on *Flora Europaea*, and indeed the intention has never been to produce something final. As a reference standard and a phytogeographic document the Flora is of tremendous value, not to mention its important rôle in improving nomenclatural agreement in Floras of different countries. Many erroneous Latin combinations that have been retained as a matter of course in various Floras can now be done away with.

What is not only urgent but also comparatively easy to accomplish is to ensure that a skeleton staff remains available to collect and evaluate constructive criticism leading to changes and additions. These should be collected in a fascicle and subsequently be incorporated in a revised edition of the Flora.

Volume 5 comprises the monocotyledons which amount to almost 2,000 species distributed among 336 genera in 34 families. The family concept is conservative both as regards splitting and lumping together. Thus Lilaeaceae is kept separate from Juncaginaceae, and Ruppiaceae is kept separate from Potamogetonaceae, while Alliaceae and Asparagaceae are included in Liliaceae. No objections should be raised to this practice; the purpose of a Flora is not to be radical in regard to classification at higher levels. At genus level the reader will find that several small genera are acknowledged in the *Scilla-Muscari* group, whereas *Isolepis* and *Trichophorum* are included in *Scirpus*.

It may surprise some readers to see that among the grasses the genus *Elymus* includes a number of species previously included in *Agropyron,* e.g. *E. farctus* (*A. junceum*), *E. repens* (*A. repens*) and *E. caninus* (*A. caninum*). This is in accordance with the findings of Runemark and Heneen (1968), for example; the actual combinations having, however, mostly been made by Melderis as late as 1978. *Elymus arenarius,* which some botanists may erroneously believe was the type species of *Elymus,* now turns up under the genus *Leymus*, and the former *Elymus caput-medusae* is found under the genus *Taeniatherum*. All this is no doubt the sound consequence of recent cytotaxonomic and experimental research, but can be a bitter potion to swallow. Further it may surprise many botanists to find *Avena* (*Avenastrum, Arrhenatherum*) *pubescens* and *A. pratense* under the genus *Avenula*. *Oryzopsis* (*miliaceum,* etc.) occurs under the name of *Piptatherum*.

It is also interesting to find the former *Arum maculatum* subsp. *danicum*—undoubtedly specificly distinct from *Arum maculatum* s. str.—as a subspecies under *Arum orientale*.

The grass key has been constructed by Tutin. Among other more extensive contributions in Volume 5 are the revisions of the European species of *Carex* (180 species) by Chater, *Festuca* (170 species) by Markgraf-Dannenberg, *Allium* (100 species) by Stearn, *Juncus* (53 species) by Snogerup, *Poa* (49 species) by Edmondson and *Bromus* (37 species) by P. M. Smith.

It is unnecessary to say that *Flora Europaea* is indispensable for all botanical departments and for taxonomists and plant sociologists who aim to work outside the boundaries of their own country and aim to keep abreast of international concepts of taxonomical entities and nomenclature. Thus my advice to all readers is to buy Volume 5 of *Flora Europaea* before it is out of print.

Rolf Dahlgren

Krog, H., Østhagen, H. & Tønsberg, T. 1980: *Lavflora. Norske busk- og bladlav*. 312 pp. cloth. *Supplement in English*. 52 pp. wrappers. Universitetsforlaget, Box 7502, Skillebekk, Oslo 2, Norway. ISBN 82-00-01907-1 and 82-00-01988-8. Price N.Cr. 189.00 or N.Cr. 209.00 (with Supplement).

Macrolichens of Denmark, Finland, Norway and Sweden, issued by Eilif Dahl and Hildur Krog in 1973, has ''certainly promoted a wider knowledge of the macrolichens of our area'' (quoted from my review, *Bot. Notiser 126:* 133, 1973). The present work is a much enlarged work written in Norwegian, but its geographical scope has been reduced to Norway only. The somewhat vague concept 'Macrolichens' has been retained as in 1973, with the addition of a few genera such as *Massalongia* and *Normandina*.

56 genera and 398 species have been recognized. A list of species known from Denmark, Finland and Sweden, but not from Norway, records 26 species. The *Macrolichens* of 1973 treated 396 species from the four countries. The great interest in lichens during the 70's has resulted in a remarkable number of new finds in the Norwegian lichen flora. Several of them are species of *Peltigera*, which will be treated in detail in a forthcoming thesis by O. Vitikainen, Helsinki. Otherwise the species concept used is not too narrow. *Thamnolia vermicularis* is recorded as one species though the different 'chemical strains' are mentioned. *Parmelia discordans* (founded on chemical characters only) is treated as a variety of *P. omphalodes*.

The generic concept is also fairly broad. However, recent subdivisions in *Alectoria* (Brodo & Hawksworth) have been accepted, whereas the splitting of *Parmelia* proposed by Hale has not been followed. *Umbilicaria* has been retained as one genus.

Some general chapters, which are well illustrated, deal with morphology, distribution (with dot maps of many species), ecology, chemistry and economic importance.

Most species have been illustrated by

black-and-white photographs in the text, most of them being of high quality. The 30 colour photographs are excellent with a few exceptions. *Cladonia bellidiflora* has come out blue instead of yellowish and *C. stellaris* (formerly known as *C. alpestris*) is too strong a yellow.

The warm recommendation I gave the *Macrolichens* in 1973 can be repeated and enhanced for the *Lavflora*. It will certainly stimulate the interest in lichens within the Nordic countries, and, with the aid of the useful Supplement in English, also in other parts of Europe.

Ove Almborn

Jahns, H. M. 1980: *BLV Bestimmungsbuch. Farne, Moose, Flechten Mittel-, Nord- und Westeuropas*. 256 pp. 655 colour photographs. BLV Verlagsgesellschaft München. ISBN 3-405-11893-X.

Recent years have seen an increasing interest in cryptogams (not only edible fungi) among the general public. This has caused a need for concise floras, where the text has been reduced to a minimum and much emphasis has been laid on good illustrations, preferably in colour.

Professor H. M. Jahns, Frankfurt-am-Main, is responsible for this guide to the pteridophytes, bryophytes and lichens of central, northern and western Europe. Brief introductory chapters (with illustrations in black-and-white) treat the morphology and biology of these groups. The taxonomic part is preceded by keys leading to genera and in some cases also to species. The major part of the book is devoted to colour photographs of a selected number of species (74 ferns, 228 mosses and 306 lichens) with short descriptions (mostly 4–8 lines) on the opposite page. The photographs are good (many of the can be considered as masterpieces); only a few do not come up to standard, for instance the lichen *Peltigera erumpens* (no. 574), which has turned out a bright blue-violet.

This attractive booklet can definitely be recommended as a first guide to these groups. However, it must be emphasized that most species of mosses and lichens need a good magnifier (lens or microscope) for correct identification. The advanced student would have appreciated a more detailed list of comprehensive Floras for further studies.

Ove Almborn

Seaward, Mark R. D. (ed.) 1977: *Lichen ecology*. Academic Press, London. 10+550 pp. ISBN 0-12-634350-0. Price £ 23.00 (cloth).

Within a few years the Academic Press has published several multi-authored surveys of recent developments in lichenology. *The Lichens* (eds. Ahmadjian & Hale 1974) was followed by *Lichenology. Progress and problems* (eds. Brown et al., 1976). Cf. reviews in *Botaniska Notiser 128* (1975) and *129* (1976), respectively. *Lichen Ecology* is an important complement to these. The concept of 'ecology' has been used in a wide sense including many aspects that could as well have been classified as regional plant geography.

Some articles will be especially mentioned. "Environmental modification and lichen taxonomy" (W. A. Weber) deals with environmental extremes, such as 'vagant life forms', from wind-swept steppes and deserts. Such forms, often not attached to the substrate, may display bizarre morphology and have often been regarded as proper species. "Colonisation, succession and competition" (P. B. Topham) outlines some of the important roles which lichens have in Nature: as pioneers on bare ground and as producers of soil. "Lichens of the boreal coniferous zone" (T. Ahti) discusses some distributional types of boreal lichens and, very briefly, some lichen communities. "Lichens of cold deserts" (D. C. Lindsay) and "Lichens of hot arid and semi-arid lands" (R. W. Rogers) treat the reactions of lichens, including distribution patterns, under extreme conditions of temperature.

A major part of the work is devoted to "Lichen communities in the British Isles" (P. W. James, D. L. Hawksworth & F. Rose). This "preliminary conspectus" mainly surveys the lichens occurring in different habitats in Great Britain, but sometimes communities first described from central or northern Europe are recorded. Efforts are even made to establish a phytosociological nomenclature, using author's names and discussing priority, a rather hopeless task.

"A bibliographic guide to the lichen floras of the world" (D. L. Hawksworth) appears as an appendix. It is a comprehensive and useful article. Mention is also made of monographs, exsiccata and periodicals. The book concludes with a "Selected Glossary" of terms used in lichenology (M. R. D. Seaward & D. L. Hawksworth).

Lichen ecology will certainly promote research in lichenology. Unfortunately some of the photographs (all black-and-white) of lichen communities are not very informative.

Ove Almborn

Farr, Ellen A., Leussink, Jan A. & Stafleu, Frans A. (eds.) 1979: *Index Nominum Genericorum (Plantarum)*. Vols. I–III. Regnum vegetabile 100–102. 16+1896 pp. Bohn, Scheltema & Holkema, Utrecht. ISBN 90-313-0327-2. Price US $144.00 for institutional members of the International Association for Plant Taxonomy (IAPT), US $230.00 for personal members if prepaid by cheque to the publishers, P.O. Box 23, 7400 G A Deventer, Netherlands.

The 8th International Botanical Congress held in Paris in 1954 approved a proposal to compile an Index Nominum Genericorum (ING). The scope of the project was to cover all generic names published in the Plant Kingdom (all groups, except bacteria). It was initiated by J. Lanjouw and F. A. Stafleu, both in Utrecht, in cooperation with many specialists (finally more than one hundred) of various taxonomic groups. In the beginning (from 1955) the texts were printed on cards which were distributed in sets of 1000. Up till 1971 some 35,000 cards had been published, but it became evident that these did not cover much more than half of the generic names to be considered.

In 1965 the project received a grant from the National Science Foundation (U.S.A.) in order to support a staff of bibliographers housed in the Department of Botany, Smithsonian Institution, Washington D.C. Another group, including the technical staff, remained in Utrecht. In 1972 it was decided to computerize all material, as well the texts already published as the new ones. The production of printed cards ceased and a publication in book form was announced.

The complete work appears in three large volumes containing some 63,500 generic names. A first guess estimated that "the dream of the Paris Congress" should contain 30,000 entries and be issued within three years. These three years grew into twenty-five. As a matter of fact a project such as this will never be finished. New generic names will be published, and future modifications of the Code of Nomenclature will affect the status of names already published. Supplements are planned, which will include forthcoming additions and corrections.

Each entry gives the generic name, author's name(s), reference to the source (book, periodical, etc.) and time of the first valid publication, record of homonymy, if existing, and of taxonomic placement. In many cases information is given concerning conservation, typification and nomenclatural status. It must be stressed that the ING is a compilation of previously published information. It does not give new combinations, new lectotypifications or substitute names or effect a change in the status of a taxon. The references to homonyms are specially useful. It is well known that the lack of a complete index of valid generic names has led to the publication of a great number of illegitimate later homonyms. A main impetus for the ING is to avoid such unnecessary names in future.

Some checks (also in very obscure sources) have revealed that the number of validly published generic names which have been omitted is exceedingly low. It should be noticed, however, that the coverage during the 1970's was not uniform for all plant groups. For vascular plants the ING is complete to around 1970, whereas most cryptogams have been recorded till around 1974–1978. For instance, *Santessonia* Hale & Vobis (Lichens; *Bot. Notiser* 1978) is included but not *Gunillaea* Thulin (Campanulaceae; *Bot. Notiser* 1974).

The preface modestly describes the ING as "a tool for every taxonomist". It can be added that it is indispensable in every Herbarium or Institute of Systematic Botany. However, the high price will unfortunately prevent many botanists from buying it for their private book-shelves.

Ove Almborn

Cramer, J. (ed.): *Bibliotheca Lichenologica. A series of original papers and reprints of books on lichens published by J. Cramer*, Box 48, 3301 Lehre, W. Germany. Volumes 1–5 were reviewed in *Bot. Notiser 130* (1977). The following further volumes are now available.

6. Keuck, G. 1977: *Ontogenetisch-systematische Studie über Erioderma im Vergleich mit anderen cyanophilen Flechtengattungen.* 175 pp. 5 tables, 217 plates, 20 figures in text. ISBN 3-7862-1051-5. Price DM 60:– (paperback).

Dr Keuck is a student of Professor Aino Henssen, Marburg, BRD, the leading expert on the ontogeny of the lichen apothecia. His thesis deals with morphology, symbiosis and development of the fruitbodies of the mainly tropical genus, *Erioderma*. A large number of species have been studied, and the work is an important milestone for a world monograph.

7. Ritschel, Gabrielle Aiko. 1977: *Verbreitung und Soziologie epiphytischer Flechten in Nordwestbayern.* 192 pp., 29 tables, 75 figures in text. ISBN 3-7682-1122-3. Price DM 50:– (paperback).

The author has studied the corticolous lichens in a limited area in northwestern Bavaria from a sociological point of view. Some 25 epiphytic lichen communities are described mainly following the terminology known from Barkman's classical work. Climatic and edaphic factors are discussed. The distributional areas of many of the species treated are demonstrated by dot maps.

8. Rodenborg, L. 1977: *Epilitische Vegetation in einem alten Weidegebiet auf Mittel-Öland, Schweden.* 108 pp., 4 tables, 5 plates. ISBN 3-7682-1151-7. Price DM 30:– (paperback).

The lichen flora and lichen vegetation of the Baltic islands of Öland and Gotland is interesting but little known. The present work by Lars Rodenborg, Institute of Plant Ecology, Uppsala, deals with the epilithic vegetation (mainly lichens and mosses) in an old pasture on central Öland. Stonewalls, burial mounds and boulders are important substrates. Six communities on limestone and 7 on siliceous rock are described and discussed. Lichenologists would certainly have appreciated a discussion on the taxonomy of some 'critical' species as well as information on the deposition of herbarium material.

9. Poelt, J. & Vězda, A. 1977: *Bestimmungsschlüssel europäischer Flechten. Ergänzungsheft 1.* 258 pp. No illustrations. ISBN 3-7682-1162-2. Price DM 50:– (cloth; as the following volumes).

In 1969 Professor Josef Poelt (now at Graz, Austria) published *Bestimmungsschlüssel europäischer Flechten* (see review in *Botaniska Notiser 124* 1971). This work has proved to be a useful introduction to the groups treated, mainly the macrolichens. In the crustose lichens some genera were treated partially. Many groups with complicated or poorly known taxonomy were omitted.

The present *Supplement 1* records many of these neglected groups and also provides new revisions of some macrolichens treated in 1969. As previously, the descriptions are compiled as brief dichotomous keys. Among the 53 genera treated the following should be mentioned: *Acaraspora* subg. *Xanthothallia, Anaptychia, Cladonia* (by T. Ahti), *Cyphelium, Lecanora* subg. *Placodium, Leptogium*, (by P. M. Jørgensen; only some sections treated), *Micarea, Porina* and *Rhizocarpon* (yellow species). A *Supplement 2* is in preparation.

10. Buschardt, A. 1979: *Zur Flechtenflora der inneralpinen Trocken-Täler unter besonderer Berücksichtigung des Vinschgaus.* 419 pp., 157 distribution maps. ISBN 3-7682-1226-2. Price DM 80:–.

This thesis, supervised by Professor J. Poelt, presents a first compilation of the lichen flora of some dry valleys in the Alps (eastern Tyrol and adjacent parts of Switzerland). The ecological factors prevailing there are discussed: low precipitation and low humidity, many hours of sunshine, human influence, etc.

The major part of the work treats 124 lichen species found on dry, hot sites in this area. Useful remarks on the taxonomy (particularly in *Physcia* and related genera), ecology and distribution are given.

11. Beltman, H. A. 1978: *Vegetative Strukturen der Parmeliaceae und ihre Entwicklung*. 193 pp., 51 plates. ISBN 3-7682-1199-1. Price DM 60:–.

The subject of the present thesis by Mrs H. A. Beltman, Groningen, Netherlands, was suggested by Professor H. M. Jahns, now in Frankfurt-am-Main, BRD. It is a study on the morphology, development and function of some vegetative organs in the family Parmeliaceae, such as soralia, isidia, pseudocyphellae, cilia and rhizines. Their importance for the taxonomy of genera and species is discussed.

The many new genera recently segregated by Hale are recorded under *Parmelia*. Unfortunately, the genus *Relicina* Hale is consistently misspelt "*Recilina*".

12. Mayrhofer, H. & Poelt, J. 1979: *Die saxicolen Arten der Flechtengattung Rinodina in Europa*. 186 pp., 13 figures (drawings of spores). ISBN 3-7682-1237-8. Price DM 50:–.

The revision deals with the saxicolous species of *Rinodina* occurring in Europe (with the addition of a few North African species). The traditional delimitation of *Rinodina* from *Buellia* is rejected and a new taxonomy founded primarily on differences in spore structure is established. A total of 52 species are treated with detailed descriptions and lists of localities. Twelve species are described as new and 3 subspecific taxa are raised to specific level. Twenty-nine former species are placed in synonymy. A continuation dealing with the saxicolous species of *Rinodina* from other parts of the Old World is in preparation.

13. Schneider, G. 1979: *Die Flechtengattung Psora sensu Zahlbruckner*. 291 pp., 18 plates, 48 figures in text. ISBN 3-7682-1257-2. Price DM 50:–.

The genus *Psora* has been considered as being one of the best distinguished segregates of the old genus *Lecidea* containing species with a squamulose or effigurate thallus. Recent investigations by Dr. G. Schneider, Botanische Staatssammlung, Munich, BRD, have shown that *Psora* is also heterogeneous. His thesis has been initiated by Professor H. Hertel, the well-known expert on *Lecidea* and allied lichen genera. It is a thorough and skilful examination of the some 150 species, from all parts of the world, recorded as *Psora*. This genus has now been amended to include only 17 species. Four genera (each containing 1–5 species) are described as new. A great many species have been transferred to other genera or reduced to synonymy.

This revision is an important step towards a badly needed monograph of the whole Lecideaceae. The illustrations, (drawings and plates in black-and-white) are of good quality. It is evident, however, that the typification of *Psora* needs further investigation.

14. Vobis, G. 1980: *Bau und Entwicklung der Flechten-Pycnidien und ihre Conidien*. 141 pp., 215 plates, 15 figures in text. ISBN 3-7682-1270-X. Price DM 50:–.

Pycnidia are small flask-shaped structures which have been known since the early days of lichenology. Lindsay (1859, 1872) published comprehensive studies of their morphology. Nylander and many subsequent lichenologists used them as taxonomic criteria, even for the description of new species.

Dr. G. Vobis, Department of Botany, University of Marburg, also one of Professor Henssen's students, has devoted his thesis to a comparative study of the development and morphology of the pycnidia and the conidia produced by them. Some 40 species from most parts of the lichen system have been investigated. Five main groups showing different types of development are distinguished. The drawings and micrographs from the light microscope or the electron microscope are very informative.

It is evident, however, that this thorough morphological treatment has not solved the old problem of the function of the pycnidia and the conidia. Are they male organs fertilizing the female trichogyne or merely vegetative organs of reproduction?

Ove Almborn

Baum, B. R. 1978: *The genus Tamarix*. Israel Academy of Sciences and Humanities. Jerusalem. 209 pp., linenbound. Price $25.

The treatise presented is a monograph on *Tamarix* based on the study of 8000 herbarium specimens from 42 Herbaria and the author's field experience, mainly from Israel. All species recognized are amply described with notes on habitat and distribution and a list of selected specimens. Complete lists of synonyms are given and much care has been paid to the location and examination of types. For each species a distribution map has been prepared and there is a full-page illustration showing details of branches, flowers and androecia. A dichotomous key to the species is provided. Chapters dealing with morphology, evolutionary trends in the androecia, phylogenetic relationships and migration routes, etc. are presented. The monograph is well prepared technically and the illustrations are excellently executed.

A mimeographed edition of the monograph was widely distributed in 1966 and has often been cited, e.g. by Baum himself in his treatment of *Tamarix* for *Flora Europaea* in 1968. This first edition is not mentioned in the present printed version but there is a note on page 204 stating that the work was "originally submitted to the Israel Academy of Sciences and Humanities more than 10 years ago". Names of new taxa and new combinations have priority from 1966 and not from 1978 as indicated in the printed version.

Tamarix is an important constituent of the flora of arid regions of the Old World. Many of the species are exceptionally salt-tolerant and are among the very few shrubs and trees on strongly saline soils. Others grow along rivers and streams or on sand dunes. Taxonomically *Tamarix* is an unusually difficult genus, sometimes with a pronounced difference between vernal and aestival inflorescences and often with varying numbers of floral parts in flowers of the same inflorescence. Baum has used an apparently well-founded, conservative species concept. He accepts only 54 species compared with 78 in Niedenzu's revised account in the second edition of *Die Natürlichen Pflanzenfamilien*.

The monograph is an important taxonomic contribution and an indispensable source of information for students of arid vegetation and flora of the Old World. However, some criticism is in place:

(1) The maps have been unusually carelessly prepared. A comparison with the lists of selected specimens shows that many dots have been wrongly placed or omitted, even for localities easily found in an atlas. For 17 of the species there are no dots in countries enumerated under "Distribution" in the text. For 14 species dots have been placed in countries not mentioned under "Distribution". The survey on page 187 of the distribution of the species does not always agree with the information in the text. Moreover the area of distribution for some species in southern Europe has been considerably extended in Baum's treatment of *Tamarix* in *Flora Europaea* (1968) compared with the monograph.

(2) The genus has its centre of variation in Iran and surrounding regions. The herbarium material available at the time of the preparation of the monograph, especially that from southern Iran and Pakistan, was very restricted. The situation, as revealed from the much more extensive material now available, seems to be more complex than is indicated in the monograph.

(3) Nothing is mentioned about breeding system, vegetative reproduction or the existence of hybrids and introgression, all of which are phenomena that have a great influence on the variation pattern.

Hans Runemark

Feinbrun-Dothan, N. 1978: *Flora Palaestina. Part Three*. The Israel Academy of Sciences and Humanities. Jerusalem. Text volume 481 pp.; Plate volume with 757 full-page illustrations (line drawings). Both linenbound. Price $55.

Flora Palaestina is a commendable contribution to the botanical knowledge of the East Mediterranean. It covers the flora of Israel, Jordan and the Gaza Strip. The phytogeographical complexity of the area, where the Mediterranean, the Irano-Turanian, the Saharo-Sindian and the Sudanian regions meet, means that revisions, taxonomic treatment and notes in *Flora Palaestina* apply far beyond the area covered.

Each part of the Flora consists of a text volume and a companion volume with plates, both linenbound. The Flora project is an ambitious one with ample space allowed for full descriptions of families, genera and species and dichotomous keys at all levels. Notes on habitat and distribution within "Palaestina" as well as a survey of the general distribution are given for the species. All species and sometimes also subspecies and varieties are depicted in separate plates (in natural size together with enlargements of diagnostically important details). The Flora is well executed technically and the plates are with few exceptions very good.

The first two parts, which are still available, were written by Michael Zohary and published in 1966 and 1972, respectively. The third part, with Naomi Feinbrun-Dothan as the author, covers the families from Ericaceae to Compositae (the sequence in *Syllabus der Pflanzenfamilien* is followed) and concludes the treatment of the dicotyledons. A final fourth part will deal with the monocotyledons.

Scientific Floras are, as indeed they should be, written in a very concentrated style. For accuracy a specialized, technical terminology must be used. The disadvantage is that such Floras can only be fully utilized by professional botanists, familiar with the style and the terms. Other presumptive and very important users such as ecologists, agronomists, foresters and students of the medical properties of plants will be faced with information barely accessible to them. *Flora Palaestina* is a rare exception, all species being fully illustrated, which greatly extends its use. It can therefore be recommended to all students of plants in the East Mediterranean and the Middle East. Moreover, the price is remarkably low, altogether $145 for the three parts published.

The monumental *Flora Orientalis* published by Boissier from 1867 to 1881 (supplement 1888) has for almost a century been an indispensable but incomplete source of information regarding plants from the East Mediterranean and the Middle East. It has been stimulating to follow the many successful regional Flora projects during the last few decades now replacing *Flora Orientalis* (*Flora of Turkey, Flora of Cyprus, Flora of Egypt, Flora of Libya, Flora Palaestina, Flore de Liban et de la Syrie, Flora of Iraq, Flora Iranica, Flora of Pakistan*). The contributions already published represent great and devoted efforts by many botanists. When the Flora projects are all completed, it is to be hoped before the end of this decade, they will together represent a major contribution to biological science. But there are still gaps, the Arabian peninsula and Greece have not yet been covered by regional Flora projects. Let us hope that these gaps will soon vanish.

Hans Runemark

Gjaerevoll, O. and Rønning, O. I. 1980: *Flowers of Svalbard*. 58 pp. + 48 colour plates + 1 map. Paperback. Universitetsforlaget, Oslo, Bergen, Tromsø. ISBN 82-00-05398-9. Price Nkr 69.00, US$ 14.

Svalbard (Spitzbergen) has been the subject of botanical exploration for more than 150 years. During the second half of the nineteenth century important floristic contributions were made by Swedish botanists in particular. On the expeditions led by Torell, Nordenskiöld and others extensive collections were made. A number of floristic reports and surveys have been published by A. J. Malmgren, N. J. Andersson, A. G. Nathorst, Th. M. Fries, F. R. Kjellman, O. Ekstam, and Th. Wulff, etc. Since the 1920s , when Svalbard was incorporated into Norway, Norwegian scientists have led the investigation of these islands. Of the botanists can be mentioned O. A. Høeg, P. F. Scholander, E. Dahl, J. Lid, P. Sunding, A. H. Neilson and O. I. Rønning, who is the leading expert on the flora of Svalbard. The first comprehensive survey of the flora was published in 1927 by H. Resvoll-Holmsen. A modern floristic survey is *Svalbards Flora* (first edition 1964), published by O. I. Rønning (second, revised edition 1979).

The present booklet, *Flowers of Svalbard,* can be seen as a brief popular outline of *Svalbards Flora,* complete with colour photographs of the 48 species described. It is the first popular survey in English on the flora of Svalbard, all previous floras having been written in Norwegian.

There is a brief but informative introduction outlining the topographical, climatic and pedological features of Svalbard, and the floristic and vegetational patterns. The life-forms and means of propagation characteristic of the Arctic are noted. Arctic plant life is characterized by the very short but intense growing season, with a flowering period lasting for a few weaks only. In this connection the authors also give prominence to the importance of conservation for the sensitive Arctic flora.

The rest of the book presents a selection of in all 48 species that are either commonly seen or that are less common but beautiful or otherwise interesting. The flora of the whole Svalbard archipelago comprises more than 160 species of vascular plants with the addition of some 60 introduced species. Although it must be difficult to make a representative choice while keeping within the limits of a handy guide I still think that the selection could have been better. The title excuses the exclusion of the pteridophytes, though *Equisetum arvense,* for example, is extraordinarily common throughout the whole area. A more serious omission, however, is that of the monocotyledons of Svalbard which constitute some third of the vascular plants and of which only one, *Eriophorum scheuchzeri,* is mentioned. The monocotyledons, mainly grasses but in large areas also many sedges, dominate the vegetation. For this reason at least many grasses and *Carex* species should be included in a book like this. The selection is otherwise fairly representative. For some strange reason *Ranunculus spitsbergensis* is not so much as mentioned by the authors. It has certainly arisen through hybridization between *R. lapponicus* and *R. pallasii* and whether it should be regarded as a species or not is a matter for discussion. It is, however, characteristic of Svalbard and in certain regions is both common and conspicuous.

Each species is illustrated and accompanied by a brief but informative text. The general morphological characteristics of the species are included, with short notes on their ecology and distribution. To the distribution of *Polemonium boreale* can be added that it occurs not only in the Isfjord area but also rather commonly within Reindalen and possibly in other places.

The nomenclature and taxonomic treatment follow Rønning's *Svalbards Flora.* I will not discuss here the intricate taxonomic problems within the arctic flora but as an example can be mentioned the Woolly Lousewort, which is treated by some taxonomists as a subspecies of *Pedicularis lanata.* In the present booklet as well as in the Flora it appears as a species, *P. dasyantha.*

The photographs are of varying quality; most are good and some even excellent. Unfortunately the colour-printing technique does not do full justice to the pictures.

Taken as a whole the booklet is a welcome and readable introduction to the flora of Svalbard. It is my hope that it will awaken an increased interest in the beautiful and remarkable plants of these islands and promote a greater understanding of their flora.

Jan Thomas Johansson

Stanley, R. G. & Linskens, H. F. 1974: *Pollen. Biology, Biochemistry, Management.* 307 pp. including 64 figures and 66 tables. Springer-Verlag, Berlin, Heidelberg, New York. ISBN 3-540-06827-9. (Springer-Verlag, New York, Heidelberg, Berlin. ISBN 0-387-06827-9.)

Most textbooks on pollen either deal with comparative palynology, defined as a description of mature pollen, fossil pollen types and pollen development, or emphasize the different pollination mechanisms. In this book the authors have discussed the subject from an entirely different angle.

In the first part of the book the biology of pollen is treated. The general development is described as well as the sequences in origin and differentiation. Morphologically and taxonomically the wall structures are of great significance and their development is dealt with in some detail, the elaborate exine layers being exemplified. The nomenclature used for the different wall layers is confused, but Stanley and Linskens give a full account of the differences between authors.

Some fundamental aspects of pollen propagation such as dehiscence and pattern of distribution are discussed and exemplified, but the authors refer to other textbooks for further details.

The second part of the book deals with management and includes a review on pollen collection and storage for plant-breeding purposes, different physiological and medical applications, etc. Pollen storage presents great problems as many factors affect pollen longevity. Pollen from different plant groups reacts in different ways, and in some groups no physiological treatment has yet been devised for storing pollen for more than a few hours.

In Plant Breeding and Experimental Botany different methods for measuring 'fertility' are of great importance. In particular methods are needed for rapidly screening extensive material with an acceptable degree of accuracy and with known sources of error. Stanley and Linskens give a comprehensive description of methods of testing viability in vivo and in vitro, as well as tests for germinability and 'pseudo-germination' that are of importance when investigating self-incompatibility mechanisms, and interaction between stigmatic surface and pollen, etc.

Since mainly bees but even representatives for other animal groups such as moths, butterflies and birds are highly dependant on pollen production for their nutrition, one chapter is devoted to the discussion of these vectors, their morphology, anatomy, physiology and special adaptations.

The third part of the book, on the biochemistry of pollen, is the longest and the most informative. It starts with a general survey of compounds and composition, and each specific chemical group is then treated in greater detail. Special chapters are devoted to carbohydrates, organic acids, lipids and sterols, amino acids and proteins, nucleic acids, enzymes, pigments and growth regulators. One chapter describes pollinosis, i.e. human allergic reactions.

The book can be recommended to students interested in vital biological processes, and as background for investigations in Experimental Botany or Population Biology. It provides a stimulus to further reading and investigation in the fascinating fields of Pollen Biology and Biochemistry. A second volume is proposed and is to include more about incompatibility reactions, metabolic and cytological changes during growth, and the influence of different chemicals and treatments on in vitro and in vivo growth. Such a volume would be welcomed.

Roland von Bothmer

Moore, P. D. & Webb, J. A. 1978: *An illustrated guide to pollen analysis*. 133 pp. Biological Science Texts. Hodder and Stoughton, London. £ 4.95 net in the U.K.

The pollen-analytical technique has been developed gradually during this century. As a quantitative palaeoecological method it has been more elaborate during the last twenty years. From being a mainly geological/biostratigraphical method it has become applied more and more in palaeoecological research. The leading textbooks have been Gunnar Erdtman's 'Introduction' from 1943 and Knut Faegri & Johannes Iversen's 'Textbook' with three editions (1950, 1964, 1974). However, there has been a need for a more simplified introduction, useful for everybody with a general interest in palynology, viz., geologists, geographers, ecologists or taxonomists. Such a book has recently been prepared by the palaeoecologist Dr Peter D. Moore and his colleague Miss J. A. Webb, both at King's College, London. The book is designed for use at universities as well as for sixth-formers in school. Although the pollen-analytical technique was first developed in Scandinavia it is quite evident that it is nowadays better known and more applied at British schools and universities. Let us hope that this book will improve the situation in our countries. The book is indeed prepared in a pedagogical way, it is well illustrated and written in simple, clear language. The marginal comments below may be useful for the authors when preparing the second edition.

The first chapter describes briefly the applications of pollen analysis, the second chapter the deposits containing fossil pollen. One would expect a slightly more comprehensive description of soils and mor humus, as pollen analysis of such deposits is an important tool for research on local ecosystem successions. Danish colleagues in particular have obtained interesting results from such studies. The third chapter describes peat and sediment samplers and preparation technique. Bromoform flotation is described as one method for extracting pollen in minerogenic samples. Such a poisonous liquid should not be recommended in a text-book; other heavy liquids are available and used for this purpose. Among the methods for obtaining absolute pollen values nothing is mentioned about one widely applied technique: the adding of exotic pollen grains by carefully calibrated pollen pellets, so-called Stockmarr pellets, named after a Danish geologist. As a whole I find the references in these introductory chapters too dominated by British literature. Ideas and applications should be searched for in a wider geographical area, although the text-book was originally written for British students.

The two main chapters of the book are devoted to pollen morphology and a pollen/spore key respectively. The application of pollen morphological terms is well balanced to the aim: a logical, unequivocal language for identifying pollen and spores by using a key. Instead of using one of the dominant terminologies (Faegri & Iversen and Erdtman) the authors have adopted the compromising suggestions of Reitsma (1970). I think this is a good solution in order to simplify the understanding of the key. The pollen morphological chapter is also well illustrated. The pollen/spore key seems to be quite robust and safe for the North-West European pollen flora, which is promised by the authors in the introductory words. It is also illustrated by 48 fullpage plates of photomicrographs. Without going into details one would wish for some more references to earlier published special keys, e.g. Gramineae and Cyperaceae (Faegri & Iversen 1974, Beug 1961). Furthermore, the text-book would be even more useful if extended by additional pollen/spore keys for i.a. the Mediterranean and the North American pollen floras. But this is a difficult task!

Chapters six and seven describe pollen diagram construction and interpretation. They are both written in a concise way, also useful for introductory teaching, although some parts could well be extended. Especially the numerical treatment of pollen data is an expanding field, which makes it possible to handle enormous data sets. This has recently made pollen analysis a more powerful method in palaeoclimatology and palaeoecology.

This text-book is consequently recommended to everyone with an interest in palynology and its applications in botany, ecology, geology, geography and archaeology. This is a book which may fulfil the expectations of the authors, mentioned in the last chapter, that pollen analysis will be more widely taught and applied. We should also be grateful to the publisher for the reasonable price.

Björn E. Berglund

W. Nagl, V. Hemleben & F. Ehrendorfer (eds.) 1979: *Genome and chromatin: organization, evolution, function.* Symposium, Kaiserslautern, October 13–15, 1978. Plant Systematics and Evolution. Supplementum 2. VIII + 284 pages. Springer-Verlag, Wien, New York. ISBN 3-211-81539-2, ISBN 0-387-81539-2 (hardback).

The theme of the book, outlined in the introductory chapter, is genome differentiation and modification, a common denominator of phylogeny and ontogeny. Of relevance are thus processes such as polyploidy, structural chromosome changes, differential DNA replication and gene amplification. A further important aspect is the role of noncoding repetitive DNA, whether it has to do with gene regulation or the promotion of some other function. In the majority of the following articles experimental data in line with this general framework are presented. Cases are described where differential amounts of DNA and extent of heterochromatinization and chromatin condensation are expressed at different developmental stages of a species and in taxonomically related species. Quantitative and qualitative chromatin differences seem to be correlated with specific developmental and phylogenetic patterns. Although some of the observations and interpretations need further verification and evidence before they can be generally accepted, it is nevertheless stimulating to put forward working hypotheses and to find out suitable experimental approaches for testing their validity. Actually this has been stressed in the book which in this regard has succeeded in drawing attention to the need for further analysis of certain not fully understood phenomena.

Waheeb Heneen