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Asplenium obovatum var. protobillotii var. nov. and var. deltoideum var. nov. in Turkey, with remarks on the status of A. billotii

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RÉSUMÉ

DEMIRIZ, H., R. VIANE & T. REICHSTEIN (1990). Asplenium obovatum var. protobillotii var. nov. et var. deltoideum var. nov. en Turquie, avec des remarques sur le statut d'A. billotii. *Candollea* 45: 241-259. En anglais, résumés français et anglais.

Deux nouvelles variétés du diploïde *Asplenium obovatum* Viv. sont décrites pour la Turquie. *A. obovatum* var. *protobillotii* n'est pas distinct par sa morphologie générale (particulièrement par ses segments terminaux dentés) du tétraploïde *A. billotii* F. S. Schultz. Il est cependant diploïde et correspond à *A. obovatum* var. *obovatum* par sa longueur d'exospore, sa taille de cellules stomatales et les écailles de son rhizome. L'autre forme que nous appelons *A. ovobatum* var. *deltoideum* a des frondes larges avec un contour plus ou moins deltoïde. Des formes s'approchant de cette morphologie extrême sans cependant l'atteindre sont également connues en Europe. La découverte de la var. *protobillotii* accroît la possibilité que l'autotétraploïde *A. billotii* puisse avoir pour origine le doublement chromosomique du diploïde *A. obovatum*. Comme dans d'autres cas semblables, le nom *A. billotii* est ramené au rang sous-spécifique dans le nom spécifique plus ancien: *A. obovatum*. Un nom, au rang sous-spécifique est déjà disponible: *A. obovatum* subsp. *lanceolatum* (Fiori) Pinto da Silva (1959: 217), cf. R. Fernandes (1960: 102-103) et le chapitre 5.

ABSTRACT

DEMIRIZ, H., R. VIANE & T. REICHSTEIN (1990). Asplenium obovatum var. protobillotii var. nov. and var. deltoideum var. nov. in Turkey, with remarks on the status of A. billotii. *Candollea* 45: 241-259. In English, French and English abstracts.

Two new varieties of diploid *Asplenium obovatum* Viv. are described from Turkey. *A. obovatum* var. *protobillotii* is in gross morphology (particularly in its dentate ultimate segments) indistinguishable from tetraploid *A. billotii* F. W. Schultz. It is, however, diploid and in its exospore length, size of guard cells (stomata), and rhizome scales it agrees with *A. obovatum* var. *obovatum*. The other form, which we designate as *A. obovatum* var. *deltoideum* has broad fronds with a more or less deltoid outline. Forms approaching this extreme (without reaching it) are known also from Europe. Finding of the var. *protobillotii* enhances the possibility that autotetraploid *A. billotii* could have originated by chromosome doubling in diploid *A. obovatum*. As in other similar cases, the name *A. billotii* is reduced to subspecific rank under the older species name *A. obovatum*. A name on the subspecific level is already available: *A. obovatum* subsp. *lanceolatum* (Fiori) Pinto da Silva (1959: 217), see R. Fernandes (1960: 102-103) and chapter 5.

1. Introduction

During a botanical expedition in Anatolia H. Demiriz showed to T.R. on 7th Oct. 1968 two remarkable forms of *Asplenium obovatum* Viv. We intended to describe them only after some hybridization experiments could be completed. This objective, however, could not be realized,

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owing to lack of time, but as these taxa demonstrate the range of variation in diploid *A. obovatum* particularly well, and as one of them represents the missing link for establishing the correct status for the autotetraploid *A. billotii* F. W. Schultz (see Discussion), we publish them now.

2. Material and methods

2.1. — The collecting of living plants and their cultivation on limefree soil was done as described by RASBACH & al. (1983: 44).

2.2. — For the examination of meiosis, suitable fronds bearing young sori were fixed in glass tubes (tightly closed with plastic stoppers) containing glacial acetic acid: abs. ethanol 1:3 (freshly mixed) kept, as far as possible, at 3°-4°C; after 2 days the liquid was replaced by fresh fixative. If the material was note investigated within 2 days, the glass tubes were transferred to a freezer at ca. —15°C. If this was not possible, the liquid was replaced by 70% aqueous ethanol. In this medium the fixed material keeps reasonably well for several weeks at room temperature. Root tips for studying mitosis were first pretreated in 0.1% aqueous colchicin at 4°-5°C for 12-20 hrs, or, if this was not possible, for 4-6 hours at room temperature. The liquid was drained off and the root tips were quickly dried on blotting paper fixed in acetic-ethanol as above. Before squashing, the root tips were softened by partial hydrolysis in O.1N hydrochloric acid for 20-30 minutes (depending on thickness) at exactly 60°C. Squashing, staining with aceto carmine, and the preparation of permanent slides was carried out as described by MANTON (1950: 295 etc.).

2.3. — For the comparison of spore sizes, the length of the exospore was measured as described by LOVIS (1955: 102). We embedded the spores in artificial "Canada" balsam ("Caedax", Merck by T.R. and "Euparal", via Kosmos service 71, Stuttgart by H.R., "Depex" by R.V.). This leads to slightly lower values than embedding in "gum chloral" as done by LOVIS (1955), but the difference is negligible (SLEEP & REICHSTEIN, 1982: 685). Measurements by H.R. and T.R. were done under the microscope with a calibrated eye piece. In critical cases ca. 50 spores were measured, broken or shrunken ones being ignored. Normally 20 good spores are sufficient, the resulting mean values do not differe significantly. The results are presented in Table 1. The figures given there without brackets give the length of the exospore for at least 90% of the spores of the sample. It corresponds ± with the "range of the mean" inLOVIS (1955). The lower value in brackets is not significant as it is often not possible to decide whether a very small spore is still viable. The highest values in brackets are, on the other hand, rather significant, provided foreign spores (as contaminants) are absent.

R.V. developed a faster, more precise and statistically more correct method, briefly described in RASBACH & al. (1989: 485, line 11-13). It avoids moving slides and turning the eye piece, it also involves less strain for the eyes. He uses a "Wild M-20" microscope with a drawing tube which projects the preparation on a digitalising Summagraphics tablet at the desired enlargement. The two ends of the exospore (or of a guard cell) in the picture are touched with the needle like end of a cursor and thus fed into a "Commodore Personal Computor PC 10-11". A program written in "GWBASIC" (R.V.) then gives the distance in µm, calculates the mean, standard deviation (SD), and coefficient of variation, and prints the results (see figs. 1 and 2) with the lowest value between brackets; the second figure is the mean minus the SD, then comes the mean, followed by the mean plus SD, and finally the highest value (between brackets). The range given by the second and fourth value (i.e., mean minus SD and mean plus SD) includes c. 70% of the observations, as long as these are normally distributed.

2.4. — For measuring guard cells in stomata we used 1 or 2 pinnae of well-developed fronds. They were cleared (by H. Rasbach and T.R.) in chloral hydrate (liquified by addition of 20-25% water) overnight. They were then well washed with water, dried by passing through 50% and 100% ethanol, and mounted in "Euparal" (by H.R.) or in "Caedax" (by T.R.) after further passing through ethanol-xylene mixture and pure xylene. "Euparal" is a balsam which gives no turbidity with the material containing ethanol. The stomata and guard cells are clearly visible under the microscope without staining. Measuring was carried out as for exospores. R.V. made epidermis

Taxon and ploidy level		*Exospore length in µm*	*Guard cells length in µm*	*Rhizome scales length up to*
A. obovatum subsp. *obovatum* var. *obovatum* (2×)	HR	(27-)30-33(-36)	(34-)38-50(-54)	7 mm
	RV	(22-)28-32(-38)	(32-)41-50(-59)	8 mm
A. obovatum subsp. *obovatum* var. *protobillotii* (2×)	HR	(26-)29-33(-37)	(34-)38-48(-52)	7 mm
	RV	(24-)28-32(-40)	(31-)41-49(-60)	8 mm
A. obovatum subsp. *obovatum* var. *deltoideum* (2×)	HR	(25-)26-31(-35)	(35-)40-47(-50)	4 mm
	RV	(23-)25-28(-31)	(32-)41-48(-56)	5 mm
A. obovatum subsp. *lanceolatum* = *A. billotii* (4×)	HR	(30-)33-42(-45)	(50-)54-64(-68)	10 mm
	RV	(28-)33-38(-49)	(40-)54-65(-71)	12 mm

Table 1. — Microcharacters which are useful in distinguishing the diploid subsp. *obovatum* (both varieties) from subsp. *lanceolatum* (details see under 2.3-2.4). HR and RV independent results, partly with different origin.

preparation by boiling, clearing first with 2.5% NaOH, then with ca. 2% NaOCl solution (VIANE, 1985), careful washing, and staining with Ruthenium red ("Merck, art. 12319" or "Fluka, Art. 84071") as described by VIANE & al. (1989).

2.5. — The measurements of microcharacters are summarized in Table 1. From this table, it is evident that measuring the length of guard cells (stomata) is the most reliable method for distinguishing these diploid taxa from the tetraploid ones. The results show very little overlapping and the method has the additional advantage that it can be used when no spores are available. Rhizome scales are also very useful but sometimes more difficult to obtain and their length depends on the size of the plant.

2.6. — Collections used for comparison of gross morphology (Fig. 3) scales (Fig. 5) and SEM (Fig. 9, 10).

A. obovatum subsp. *obovatum* var. *obovatum:* TR-1785-a, Italy, Isola d'Ischia (Napoli), Mt. Caruso (N.W. part of the island) ca. 70 m alt., 26th Sept. 1966, leg. T.R. On this place only diploid subsp. *obovatum* grows (together with *A. onopteris*) but no subsp. *lanceolatum* is present (see MANTON & REICHSTEIN, 1962). — TR-4141. Italy, Sardinia, Isl. of Caprera, northern slope of Mt. Teialone, ca. 1.5 km S. of the north coast, sunny granitic rocks, ca. 150 m alt. relatively scarce, with *Cheilanthes guanchica* Bolle and *Ch. tinaei* Tod., 30th May 1977 H. & K. Rasbach, H.L. & T. Reichstein. Exospore ca. 27-30 µm.

R.V. also used the following 7 samples for measuring micro-characters.

1. Davis & Sutton D 64828 from Italy, Calabria (E.).
2. No name, s.n. from France, Corsica, W. of Ajaccio, rochers de la Parata (BR).
3. Ras-472 27 May 1985 from Italy, Sicily, Monti Peloritani (RAS).
4. VIANE 3736 4 Apr. 1988 from France, Corsica, La Trinité (GENT).
5. VIANE 3738 4 Apr. 1988 from France, Corsica, La Trinité (GENT).
6. VIANE 3739 4 Apr. 1988 from France, Corsica, La Trinité (GENT).
7. VIANE 3746 5 Apr. 1988 from France, Corsica, E. of Porto-Vecchio (GENT).

A. obovatum subsp. *lanceolatum* (= *A. billotii*). TR-4116, Corsica, Madonna della Serra, S.W. of Calvi, granitic rocks ca. 500 m alt. S.W. of the church. Ample material growing together with *Cheilanthes tinaei*, 23rd May 1977, H. & K. Rasbach, H.L. & T. Reichstein. Checked by R.V.

The following additional samples were used by R.V. for measuring micro-characters.

1. J. Bot. Liège (*78/704) France, Corsica, Calvi (GENT).
2. D. Marchetti s.n. (5.12.81), Italy, E. Liguria (T.R.).
3. Pinto da Silva s.n. (Callé 444), Portugal, Beira Alta, Avo, 250 m (GENT).
4. A.E. Salvo s.n. (= TR-7223), Spain, Sierra Nevada (T.R.).
5. TR-1774, 21st Sept. 1966, Italy, Ischia (T.R.).
6. TR-5315a, 20th Apr. 1981, Spain, Cádiz, Miel valley, ca. 90 m alt. (T.R.).
7. TR-5352, 26th Apr. 1981, Spain, Cádiz, Miel valley, ca. 80 m alt. (T.R.).
8. RV 3053, 10 July 1985, Madeira, Curral das Freiras, 650 m (GENT).

9. RV 3084, 13 July 1985, Madeira, P. Joao do Prado, 1200 m (GENT).
10. RV 3175, 12 July 1985, Madeira, Machico (GENT).
11. RV 3318, 12 Sept. 1986, Spain, Asturias, Cudillero, 30 m (GENT).
12. RV 3325, 12 Sept. 1986, Spain, Asturias, S. or Tineo (GENT).
13. RV 3745, 15 Apr. 1988, France, Corsica, Col d'Illarato (GENT).
14. RV 3814, 20 Apr. 1988, Spain, Cádiz prov., Sierra de la Luna (GENT).
15. RV 3866, 24 Apr. 1988, Spain, N. of Madrid, Sierra del Hoyo, 900 m (GENT).
16. RV s.n., 7 Sept. 1983, England, Wales ca. 10 m alt. (GENT).

3. Asplenium obovatum Viv. var. **protobillotii** Demiriz, Viane & Reichst. **var. nov.**

Typus: H. Demiriz, B. Tutel, A. Aydın & P. Koktay, 16th Apr. 1968. **Holotypus** (whole pressed plant) ISTF 22947. **Isotypus** (one frond) Z.

Locus. — Turkey, Istanbul A 2 (A). Prov. Istanbul, Distr. Kartal, Yakacık dağı (rocks above the village Yakacık, ca. 22 km E. of Istanbul City, above Ayazma, a natural fountain with fine masonry), 250 m alt. Publ. under No. 26194 in DEMIRIZ & al. (1969: 160).

Derivatio. — Denoting our conviction that this diploid variety is the true ancestor of autotetraploid *A. obovatum* Viv. subsp. *lanceolatum* (Fiori) Pinto da Silva (= *A. billotii* F. W. Schultz).

Diagnosis. — Convenit characteribus morphologiae macrospicae cum subspecie *lanceolatum*, tetraploidea, sed cum subspecie *obovatum* (var. *obovatum*), diploidea, numero chromosomico ($n = 36^{II}$), magnitudine sporarum (longitudo exosporii circ. 28-32 µm), longitudine cellularum occludentium stomata (circ. 38-48 µm), atque longitudine squamarum rhizomatis.

Description. — Var. *protobillotii* cannot be distinguished from tetraploid subsp. *lanceolatum* (= *A. billotii*) by the naked eye. It can best be distinguished by the chromosome number or by comparison of microcharacters (see Table 1). It has therefore so far been confused with subsp. *lanceolatum.* The population at the locus classicus in 1968 consisted of ca. 30-40 plants with fronds up to ca. 15 cm long but often smaller, probably owing to rather dry conditions. A little higher up the hill a few small plants of var. *obovatum* were found. In Anatolia this is a rare species, only five localities are known, two of which are on the islands in the Marmara Sea (see Appendix). Of the plants above Yakacık only a few survived until 1988 (see paratypes). Var. *protobillotii* has, however, now been found in Europe where it can reach an even larger size and is still more pronouncedly dentate (see RASBACH & al., 1990).

Topotypes. — All from the same locality.

H. Demiriz, 13th Nov. 1966, ISTF 21749. Publ. under No. 25009 by DEMIRIZ & al. (1969: 160).

TR-2331, 7th Oct. 1968, leg. H. Demiriz & T. Reichstein, cult. in Basel, diploid ($n = 36^{II}$, det. J. D. Lovis, in litt. 16th March. 1969. Photogr. of a pressed frond, see Fig. 3).

TR-3593, 20th June 1973, leg. A. & C. Nieschalk, obtained living in Basel on 16th Aug. 1973 and cult.

R. Viane 3887, 14th July 1988, leg. H. Demiriz & R. Viane. At this date only one single plant could still be detected. Four fronds pressed, including a few rhizome scales.

Remarks. — The teeth and incision of the ultimate segments were slightly more pronounced in these topotypes than in the holotype. Unfortunately we had not pressed an entire plant from these specimens.

4. Asplenium obovatum Viv. var. **deltoideum** Demiriz, Viane & Reichst. **var. nov.**

Typus: R. Viane 3886 (= TR-7234 A), 14th July 1988, leg. H. Demiriz and R. Viane. **Holotype** GENT. **Isotype (small plant) G.**

Locus. — Turkey, Istanbul (A): Maltepe, Cevizli, Dragos tepesi (a low hill), in shade of crevices in S. exposed siliceous rocks at ca. 100 m alt., ca. 18 km E. of Istanbul City, close to relatively

modern houses and litter. Together with *A. onopteris* L., *Polypodium australe* Fée, *Quercus coccifera, Paliurus spina-christi, Erica arborea, Phillyrea latifolia.*

Derivatio. — Designating the deltoid outline of the lamina.

Diagnosis. — Recedit a varietate *obovatum* circumscriptione laminae deltoides notabili; par infimum pinnarum secundo insigniter majus.

Description. — The shape of the fronds of this variety is reminiscent of *A. cuneifolium* Viv., but the ultimate segments are roundish. Forms of *A. obovatum* approaching var. *deltoideum* are not rare in Europe but are usually less extreme. The length of the guard cells corresponds to var. *obovatum* and var. *protobillotii,* spores and rhizomes scales were slightly smaller (Table 1), perispore architecture is not significantly different (Fig. 10) but we had only few samples.

Topotypes. — All from the same locality.

H. Demiriz as ISTF 21747. One large plant, but less pronouncedly *deltoid* than TR-2330 (Fig. 7), 13th Nov. 1966. Publ. under ISTF 25007 in DEMIRIZ et al. (1969: 160).

TR-2330. H. Demiriz & T. Reichst. 7th Oct. 1968. Five fronds and one living plant collected. Diploid (det. J. D. Lovis in litt. 16th March 1969). Two good fronds were pressed in Oct. 1969 (see Fig. 7).

RV 3886 B and C small sister plants of type specimen, collected living and plant B cult. in Gent, plant C in Basel as TR-7234C. A root fixing taken 12th June 1989 was diploid, $2n$ = ca. 72 (det. H. Rasbach in litt. 14th June 1989), sporangia of plant B gave $n = 36^{II}$.

Remark. — At the time when ISTF 21747 and TR-2330 were collected (1968) the place was already endangered by building activities, but still in much better condition than in 1988 when the type specimen and its sister plants were collected.

5. Discussion and nomenclature

Opinions about the appropriate status and naming of the two main members of the *A. obovatum* group have changed during the last two centuries. The plant which is known today to be tetraploid (MANTON, 1950: 98-109) was first described as *Asplenium lanceolatum* Hudson (1778 Fl. Angl. II: 454). This name was used by CHRISTENSEN (1905: 117) who incorrectly quoted the first ed. (1762) of Hudson's flora. As pointed out by BECHERER (1929: 26-29) and by FIORI (1943: 171 footnote 1), the name *A. lanceolatum* Hudson appeared only in the second edition (1778) and is therefore illegitimate, being a later homonym of *A. lanceolatum* Forsskål (1775). The correct name at specific level is *A. billotii* F. W. Schultz (1845), described first under *A. cuneatum* F. W. Schultz (1844). On the other hand, MANTON & REICHSTEIN (1962) have shown that *A. obovatum* Viv. s.str. (1824: 68) is diploid and therefore obviously an ancestral species in this group. The different ploidy level together with different gross morphology seemed to be sufficient to advocate treatment of *A. obovatum* and *A. billotii* as distinct species (MANTON & REICHSTEIN, 1962: 87). Another reason for separating these two taxa were the cytological results obtained by SHIVAS for a specimen from the Balearic Islands which had been misidentified by Alston as *"Asplenium lanceolatum"* Hudson (= *"A. billotii"*) and which we now know to be *A. balearicum* SHIVAS (1969: 75). Hybridisation experiments involving this material by Shivas misled MANTON (1961) to assume that *A. billotii* (under the name of *A. lanceolatum*) is an allotetraploid from *A. obovatum* (2*x*) and *A. onopteris.*

Formerly some authors treated both taxa as one aggregate species, e.g., as *A. obovatum* Viv. sensu lato (1804) or as *A. obovatum* Viv. emend. BECHERER (1929: 29), while others distinguished them at a lower level. GRENIER & GODRON (1855) treated the diploid as *A. lanceolatum* var. *obovatum* and CHRIST (1900: 13) as *A. lanceolatum* subsp. *obovatum.* Many authors, including ROUY (1913: 438-439) and GUÉTROT (1928: 88), followed them, assuming that var. or subsp. *obovatum* had evolved as a geographical race from subsp. *lanceolatum.* For nomenclatural reasons BECHERER had to reverse the order of the names and created the name *A. obovatum* Viv. emend.

Becherer var. *billotii* (F. W. Schultz) Becherer (1929) for the tetraploid. This agrees better with the biogenesis. FIORI (1921: 3; 1923: 26; 1943: 171-173) with his very broad species concept treated the two taxa as varieties of *A. fontanum* (L.) Bernhardi.

When SLEEP (1966: 130-134; 1983: 17-18) proved that *A. billotii* was not only a tetraploid but an *auto*tetraploid taxon, she discussed the possibility that it might have arisen by chromosome doubling in the diploid *A. obovatum* and concluded that this must indeed be so in spite of the differences in gross morphology. Autotetraploidy was known to occur in Aspleniaceae, in the following five aggregate species: *Ceterach officinarum* Willd.; *A. petrarchae* (Guérin) DC.; *A. ruta-muraria* L.; *A. septentrionale* (L.) Hoffm. and in *A. trichomanes* L. in addition to *"A. billotii"*. In these five cases the diploid and the tetraploid cytotype are at present usually recognised at the subspecific level. In all these cases the two cytotypes usually cannot be differentiated by gross morphology (e.g. with the naked eye). *A. billotii* and *A. obovatum* seem to be an exception as they do show slightly divergent morphology. SLEEP (1983: 18) formulated this apparent contradiction as follows: "We may thus conclude that, although they do look different, *A. billotii* has nevertheless arisen by chromosome doubling from *A. obovatum* or a form with chromosomes homologous to it". We believe this form to be represented by *A. obovatum* var. *protobillotii*. Doubling of its chromosomes must be a rather rare event in diploid *A. obovatum* in view of the existence of so many countries (the whole Mediterranean area east of Italy) where diploid *A. obovatum* is well known (see maps 88 and 89 in JALAS & SUOMINEN, 1972 [which today are partly out of date] and DERRICK & al., 1987: 3-11) but no *"A. billotii"* has ever been found. Since var. *protobillotii* is now known not only from Turkey but also from Spain (see RASBACH & al., 1990) there is good reason to assume that the tetraploid *"A. billotii"* (distributed on the Atlantic Islands, throughout Atlantic Europe and the Western Mediterranean) has arisen within that broad area from *A. obovatum* var. *protobillotii*.

We therefore think it appropriate to reduce once again the status of *"A. billotii"* to a subspecies of *A. obovatum* Viv. An appropriate name is already available, published as *A. obovatum* Viv. emend. Becherer subsp. *lanceolatum* (Huds.) PINTO DA SILVA (1959: 217) as a new combination. As pointed out by Rosetta FERNANDES (1960: 102-103), it is a correct name, but being based on the illegitimate *A. lanceolatum* Hudson (1778: 454), non *A. lanceolatum* Forsskål (1775: 185) must, according to Art. 72 of the ICBN, be treated as a new name (P. da Silva 1959) and written without (Hudson) in brackets, and *A. lanceolatum* Hudson must not be cited as basionym. According to Art. 7.11 of the ICBN (1988) it is nevertheless based on HUDSON's (1778) description and type. We asked Professor W. Greuter how to proceed in order to stay in agreement with the ICBN (1988). In his opinion, which we accept, the tetraploid taxon should probably best be treated as *A. obovatum* Viv. subsp. *lanceolatum* (FIORI, 1921: 3, quoted from FIORI, 1943: 171) PINTO DA SILVA (1959: 217) because FIORI (1921: 3; see also FIORI, 1923: 26) created the name *A. fontanum* Bernh. var. *lanceolatum* Fiori. As far was we could ascertain, this is the oldest legitimate and homotypic name bearing the same epitheton. The type of *A. lanceolatum* Hudson was destroyed (burnt) but A. C. Jermy (BM) promised to select a neotype, with checked cytology, from Cornish material.

Remark. — The present rules of the ICBN (1988) for cases like *A. obovatum* subsp. *lanceolatum* are contradictory and illogical. We hope that they will be corrected at the next possible occasion. In our opinion the best solution would be to follow Recommendation 72A (p. 72) and not allow the use of illegitimate names at all. Then in this case the more satisfactory name *A. obovatum* subsp. *billotii* could be created. If such a rule is not possible, we believe that illegitimate names on lower than species level, should be fully accepted and their authors given in brackets, if the combination is based on the same type.

6. Appendix

List of the 8 specimens of *Asplenium obovatum* Viv. from Turkey deposited in ISTF (till Jan. 1989). The squares given as A 1 (A) etc. are those given in DAVIS (1965: 2). The first numbers are those of ISTF.

1. 22608. A 1 (A). Prov. Balıkesir, Distr. Erdek, Marmara adası, westlich: Hänge hinter dem Strandkasino Manastir. Auf Felsen 17.VIII.1967 leg. A. Aydın. One small plant. Publ. under No. ISTF 25817 in DEMIRIZ & al. (1969: 160).

2. 22592. A 1 (A). Prov. Balıkesir, Distr. Erdek, Marmara adası, Altınsuyu menbaı (Quelle). Auf Felsen 13.VIII. 1967, leg. A. Aydın. One plant. Publ. under No. ISTF 25802 in DEMIRIZ & al. (1969: 160).

3. 31029. A 2 (A). Prov Istanbul, Distr. Adalar, Büyükada (= Prinkipo Island): Viranbağ (Paliambelo). Auf Felsen, 10 m alt. 17.VIII.1977, leg. H. Demiriz, B. Tutel & A. Aydın. One large plant with fronds up to 20 cm long. Ultimate segments slightly incised. Publ. under No. ISTF 31029 in DEMIRIZ & al. (1977: 76).

4. 21689. A 2 (A). Prov. Istanbul, Distr. Adalar, Büyükada (= Prinkipo Island): Aya Yorgi tepesi (Yüce tepe), östlich, unter Felsen und Gestein. 150 m alt. 23.X.1966, leg. H. Demiriz. One relatively large plant. Publ. under No. Demiriz 6135 in DEMIRIZ et al. (1969: 160).

5. 21747. A 2 (A). Prov. Istanbul, Distr. Kartal, Maltepe Dragos tepesi. Auf Felsen, 50 m alt. 13.XI.1966, leg. H. Demiriz. One large plant of var. *deltoideum* but less pronouncedly *deltoid* than the type and topotype specimens. Publ. under No. ISTF 25007 in DEMIRIZ & al. (1969: 160).

6. 21749. A 2 (A). Prov. Istanbul, Distr. Kartal, Yakacık: Yakacık dağı, südl. Hänge auf Felsen, 250 m alt. 13.XI.1966, leg. H. Demiriz. Two fragments of two fronds of good var. *protobillotii.* Publ. under No. 25009 in DEMIRIZ & al. (1969: 160).

7. 22447. See under *A. obovatum* var. *protobillotii* typus. One good large frond but ultimate segments less deeply incised than in **6.**

8. 26792. A 2 (A). Prov. Istanbul, Distr. Kartal, Yakacık: Aydos dağı, N.W. Hänge auf Felsen. 400 m alt. 28.X.1972, leg. I. Delice. Plant of var. *obovatum* with fronds up to 9 cm long.

HENDERSON in DAVIS (1965: 51) quotes an old collection of Aznavour on Prinkipo (Büyükada).

Voucher	Taxon	Locality		Rhizome Scales LPA	Stomata LSTO			Exospore LEXO		
VOUCHER	SSP	COUNTRY LOCALITY	HERB	LPA	LSTO			LEXO		
Davis & Sutton D. 64828	ob-ob	Italy Calabria	E		36	41	46	27	29	30
No coll. sn.	ob-ob	France Corsica, Ajaccio	BR		43	47	51	27	29	31
TR-1785 a	ob-ob	Italy Ischia	T.R.	7	42	46	49	25	28	30
Viane 3736	ob-ob	France Corsica, La Trinité	GENT					29	31	33
Viane 3738	ob-ob	France Corsica, La Trinité	GENT	6				27	29	31
Viane 3739	ob-ob	France Corsica, La Trinité	GENT	7				29	31	33
Viane 3746	ob-ob	France Corsica, E. of Porto-Vech	GENT	5				28	31	33

Fig. 1. — Outprint for 7 specimens of *A. obovatum* subsp. *obovatum* giving mean for rhizome scales, mean and range for stomata and exospore. LPA = length of scales in mm, LSTO = length of guard cells in µm, LEXO = length of exospore in µm (R.V.).

Voucher	Taxon	Locality		Rhizome Scales LPA	Stomata LSTO			Exospore LEXO		
J. Bot. Liège (*78/704)	ob-lanc	France Corsica, Calvi	GENT		55	**61**	67	33	**36**	39
Marchetti sn. (5.12.81)	(TR-ob-lanc	Italy E. Liguria	T.R.					34	**37**	41
TR-1774	ob-lanc	Italy Ischia	T.R.	10	54	**59**	64	35	**37**	40
TR-5315a	ob-lanc	Spain Cadiz prov., Miel valley	T.R.		52	**56**	60	32	**35**	38
TR-5315a (sheet 2)	ob-lanc	Spain Cadiz prov., Miel valley	T.R.					29	**32**	35
TR-5352	ob-lanc	Spain Cadiz prov., Miel valley	T.R.		50	**54**	58			
Viane 3053	ob-lanc	Madeira	GENT		58	**63**	68	32	**33**	35
Viane 3084	ob-lanc	Madeira	GENT					34	**37**	39
Viane 3175	ob-lanc	Madeira	GENT		55	**60**	65	33	36	40
Viane 3318	ob-lanc	Spain Asturias, Cudillero	GENT	10	56	**61**	65	34	**37**	40
Viane 3745	ob-lanc	France Corsica, Col d'Illarato	GENT					34	**36**	39
Viane sn.	ob-lanc	England Wales	GENT		50	**54**	58	31	35	39

Fig. 2. — Outprint for 12 specimens of *A. obovatum* subsp. *lanceolatum* (tetraploid) = *A. billotii.* Denotations and abbreviations as in Fig. 1.

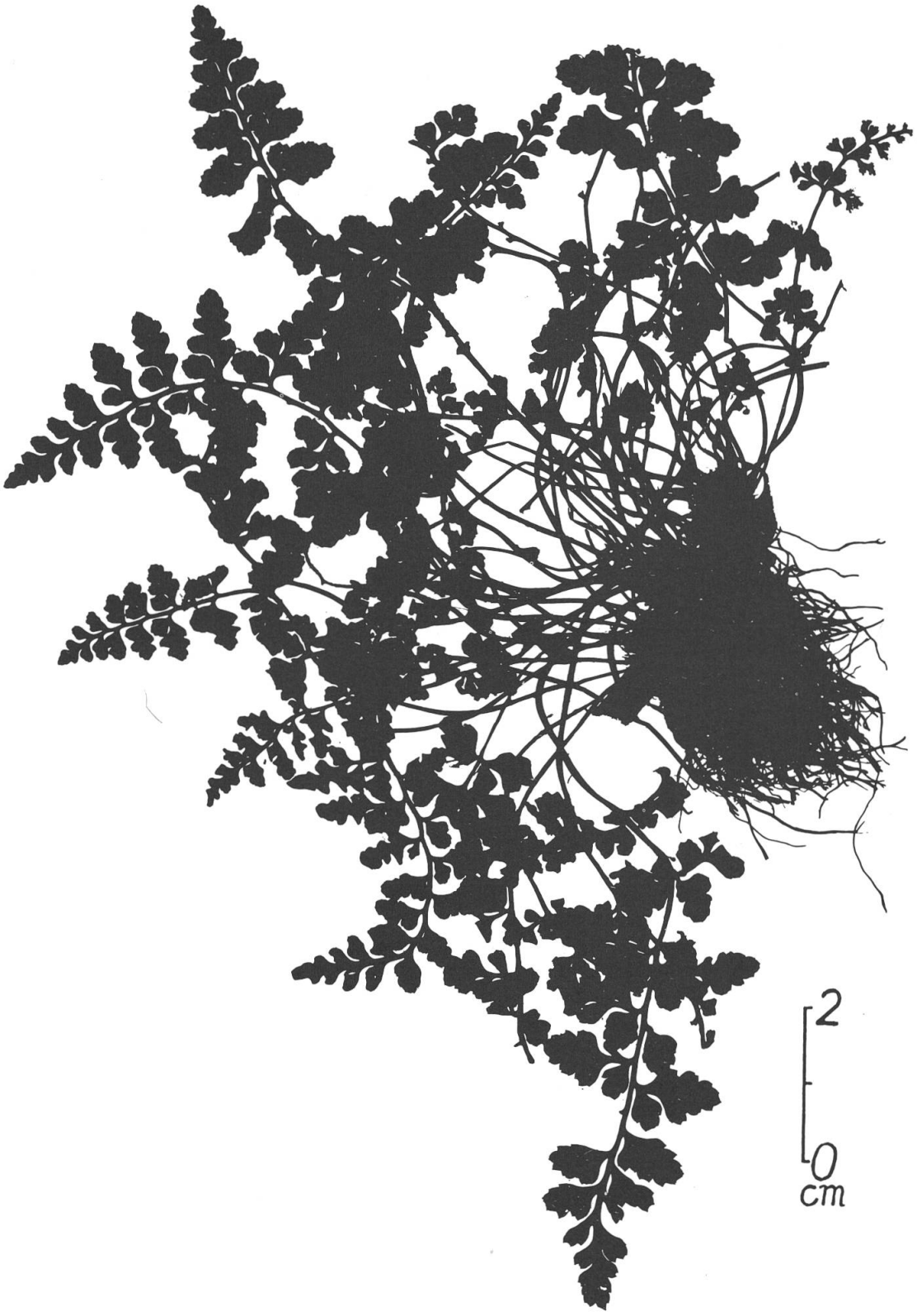

Fig. 3. — *Asplenium obovatum* var. *protobillotii.* Photograph (silhouette) of type specimen ISTF 22947 (Phot. P. Eglin, Basel).

Fig. 4. — Silhouette of pressed frond TR-2331 = topotype of *A. obovatum* var. *protobillotii* pressed 7th Mar. 1970. The arrows on this and figure 5 indicate the approximate limit between dark and green colour on the stipe or rachis, full line on upper (adaxial) side, broken line on lower (abaxial) side (Phot. P. Eglin, Basel).

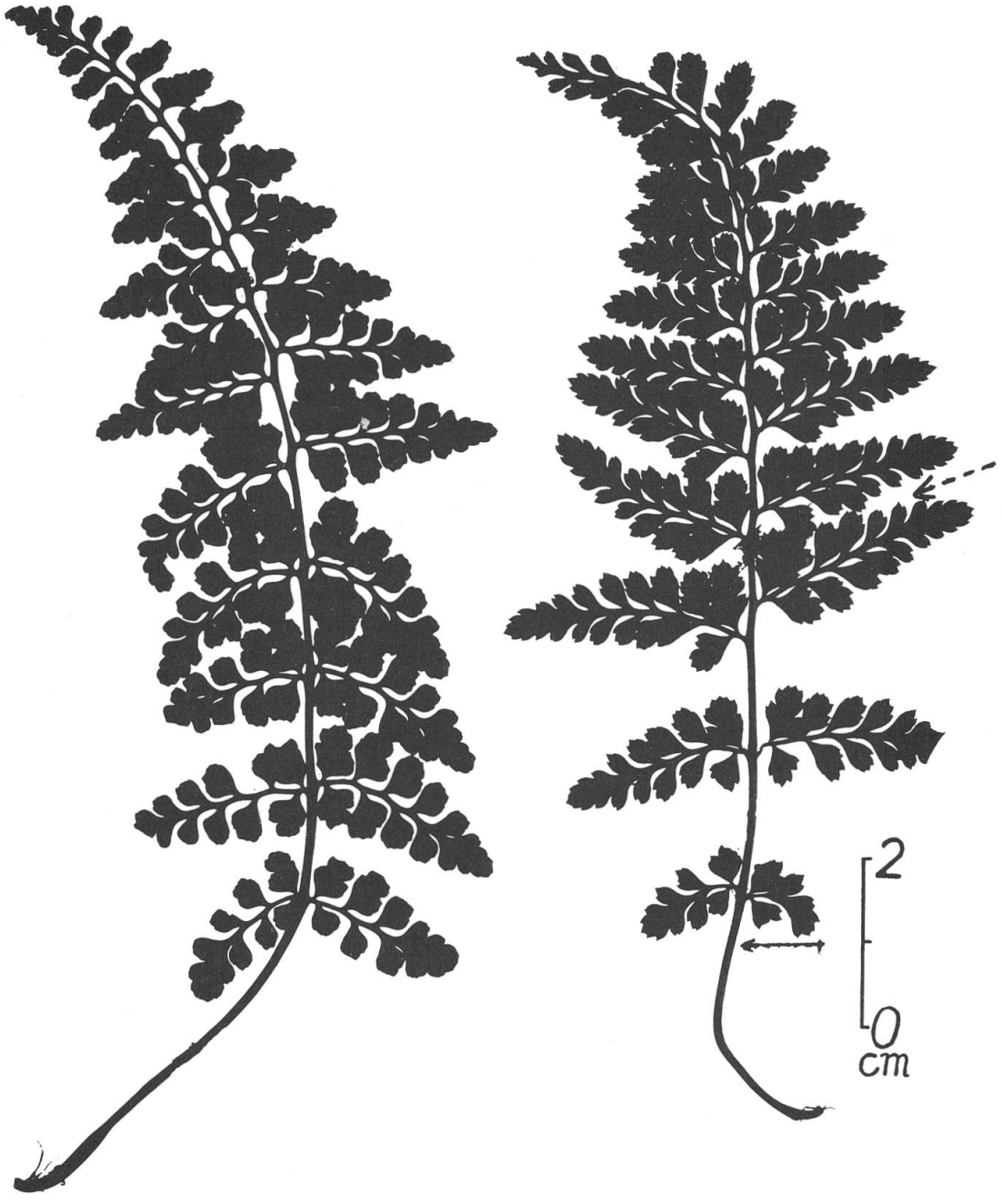

Fig. 5. — Silhouettes of fronds. **5.1** = TR-4141 = *A. obovatum* subsp. *obovatum* from Caprera Island, Sardinia; **5.2** = TR-4116 = *A. obovatum* subsp. *lanceolatum* from Corsica (Phot. P. Eglin, Basel).

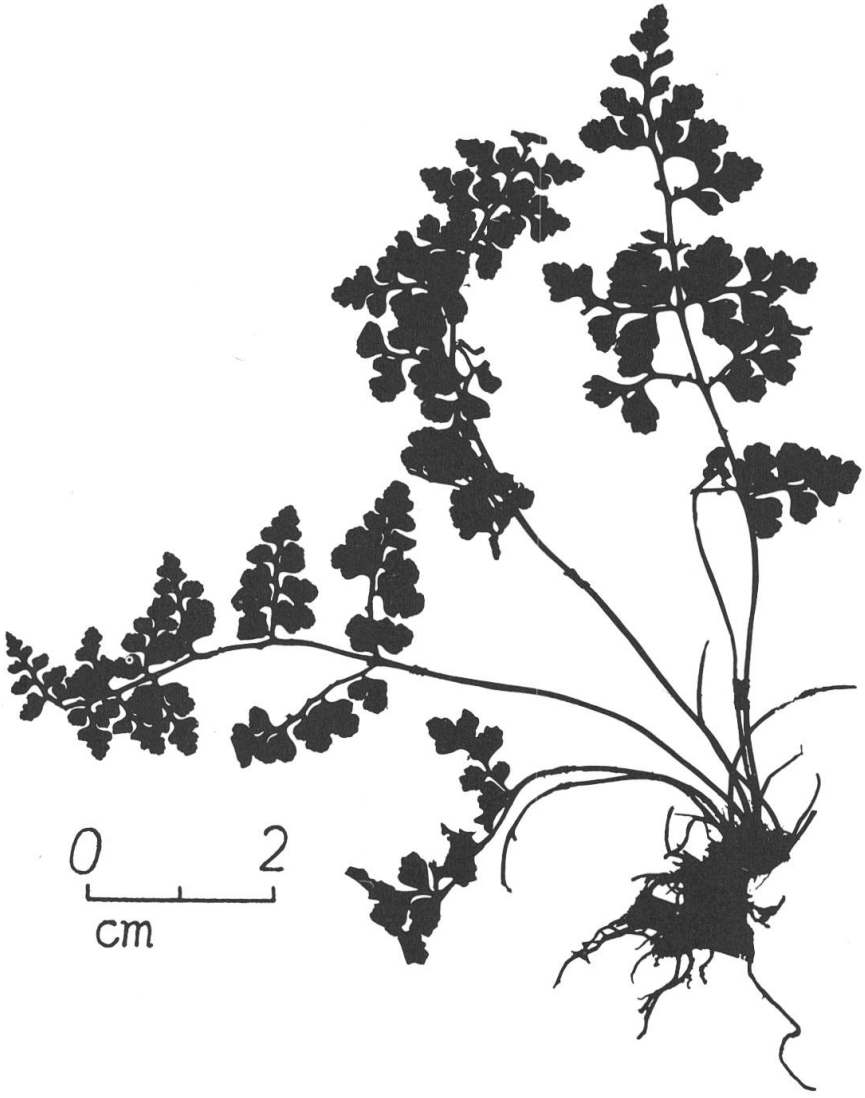

Fig. 6. — *Asplenium obovatum* var. *deltoideum*. Photograph (silhouette) of type specimen RV 3886 = TR-7234 A, small plant (Phot. P. Eglin, Basel).

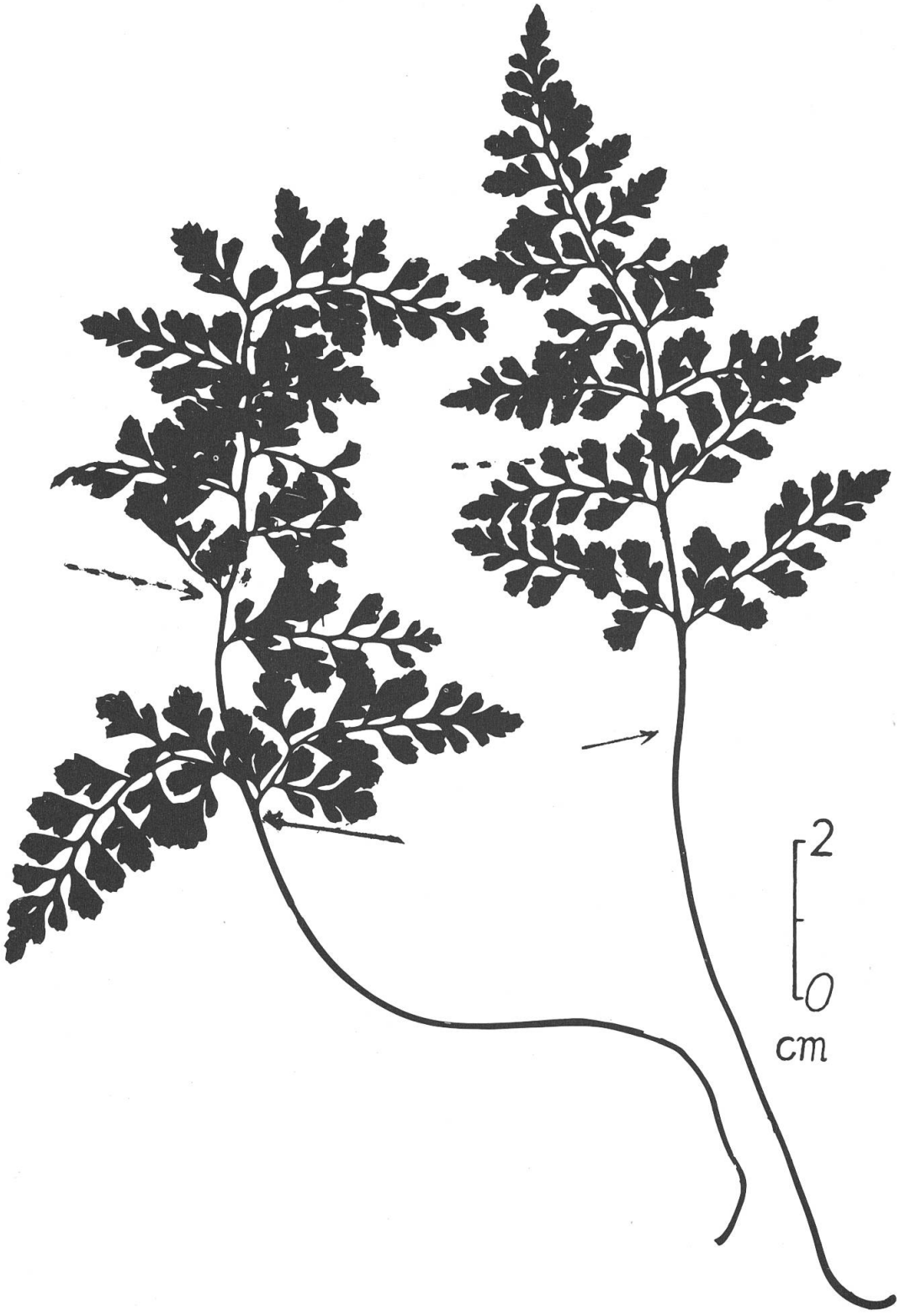

Fig. 7. — *Asplenium obovatum* var. *deltoideum*. Photograph (silhouettes) of topotype, TR-2330 after cultivation, pressed in Oct. 1969 (Phot. P. Eglin, Basel).

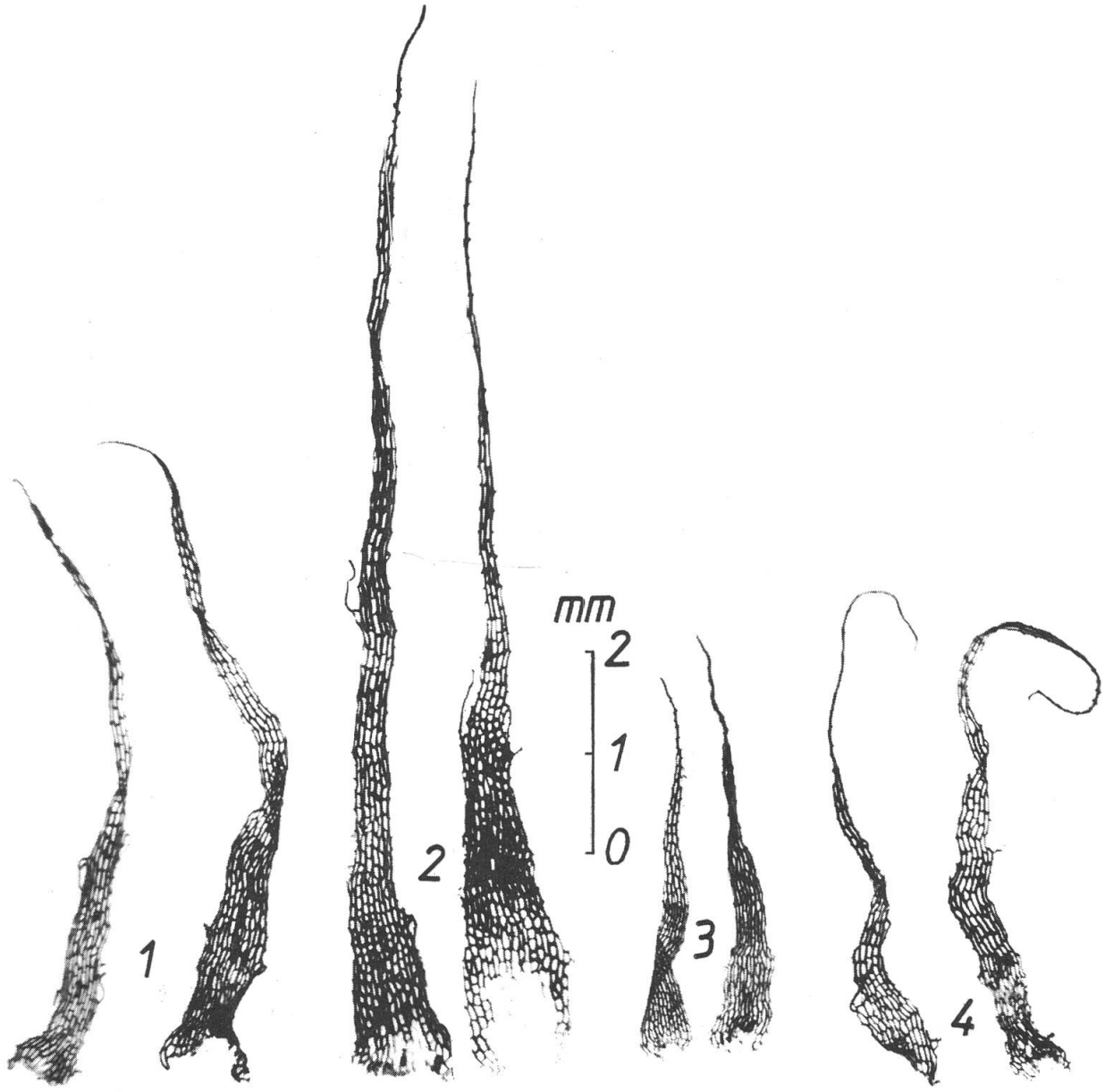

Fig. 8. — Rhizome scales of **1** = *A. obovatum* subsp. *obovatum* var. *obovatum* (TR-1785a from Ischia, Napoli, Italy); **2** = *A. obovatum* subsp. *lanceolatum* (RV 3318 from Spain); **3** = *A. obovatum* var. *deltoideum* (RV 3886-B = TR-7234 B) from Dragos (Turkey); **4** = *A. obovatum* var. *protobillotii* (RV 3887 from Yakacık, Turkey) (Prep. R.V.; Phot. P. Eglin, Basel).

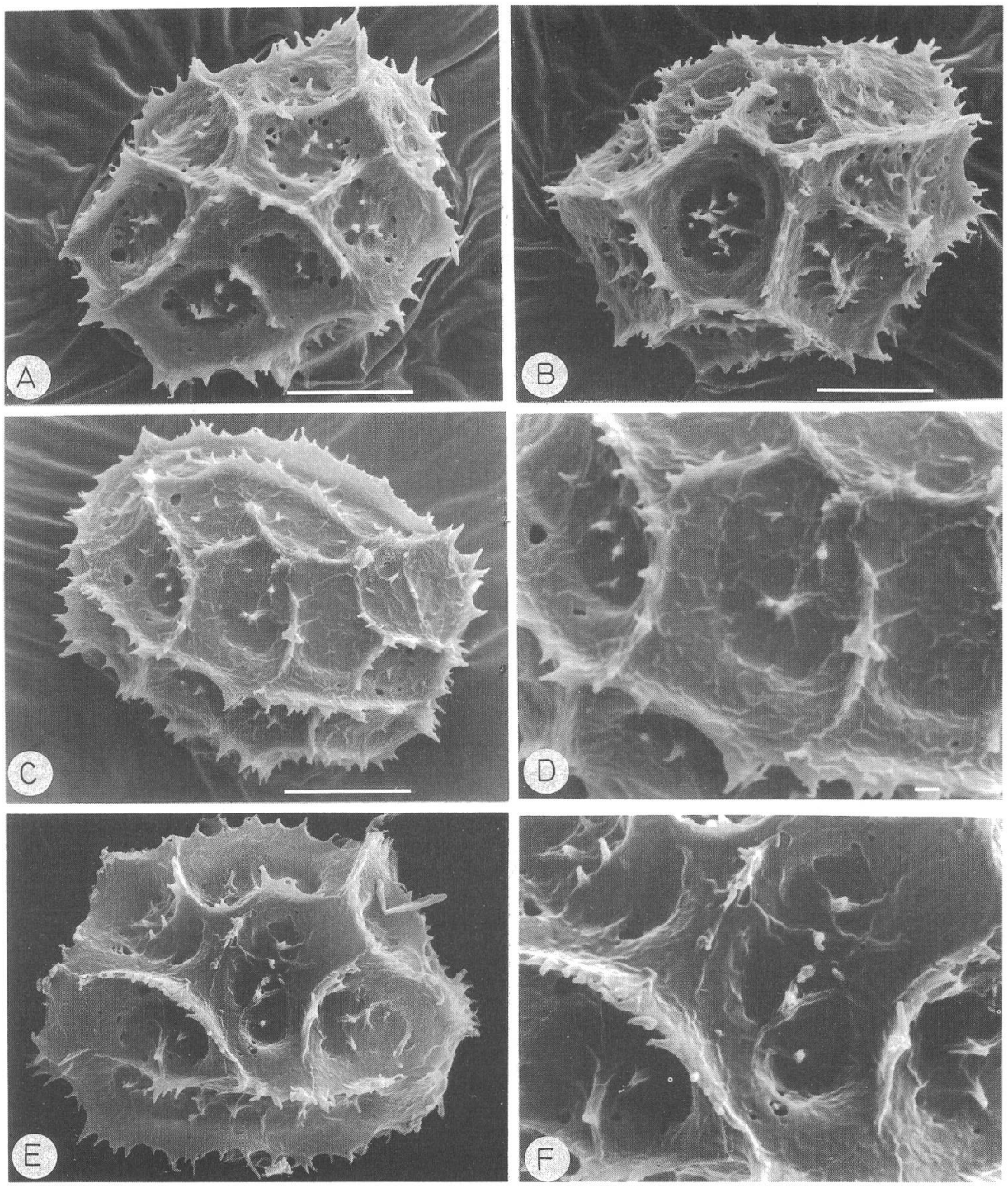

Fig. 9. — Scanning electron microscope photographs (SEM) of spores of: **A, B** = *A. obovatum* subsp. *obovatum* var. *protobillotii,* RV 3887 from Yakacık, Turkey. **C, D** = *A. obovatum* subsp. *obovatum* var. *deltoideum,* RV 3886 C (= TR-7234 C) from Dragos, Turkey. **E, F** = *A. obovatum* subsp. *obovatum* var. *obovatum,* TR-1785 a from Ischia, Italy. Bar = 10 µm; in Fig. D = 1 µm (Prep. and phot. R. Viane).

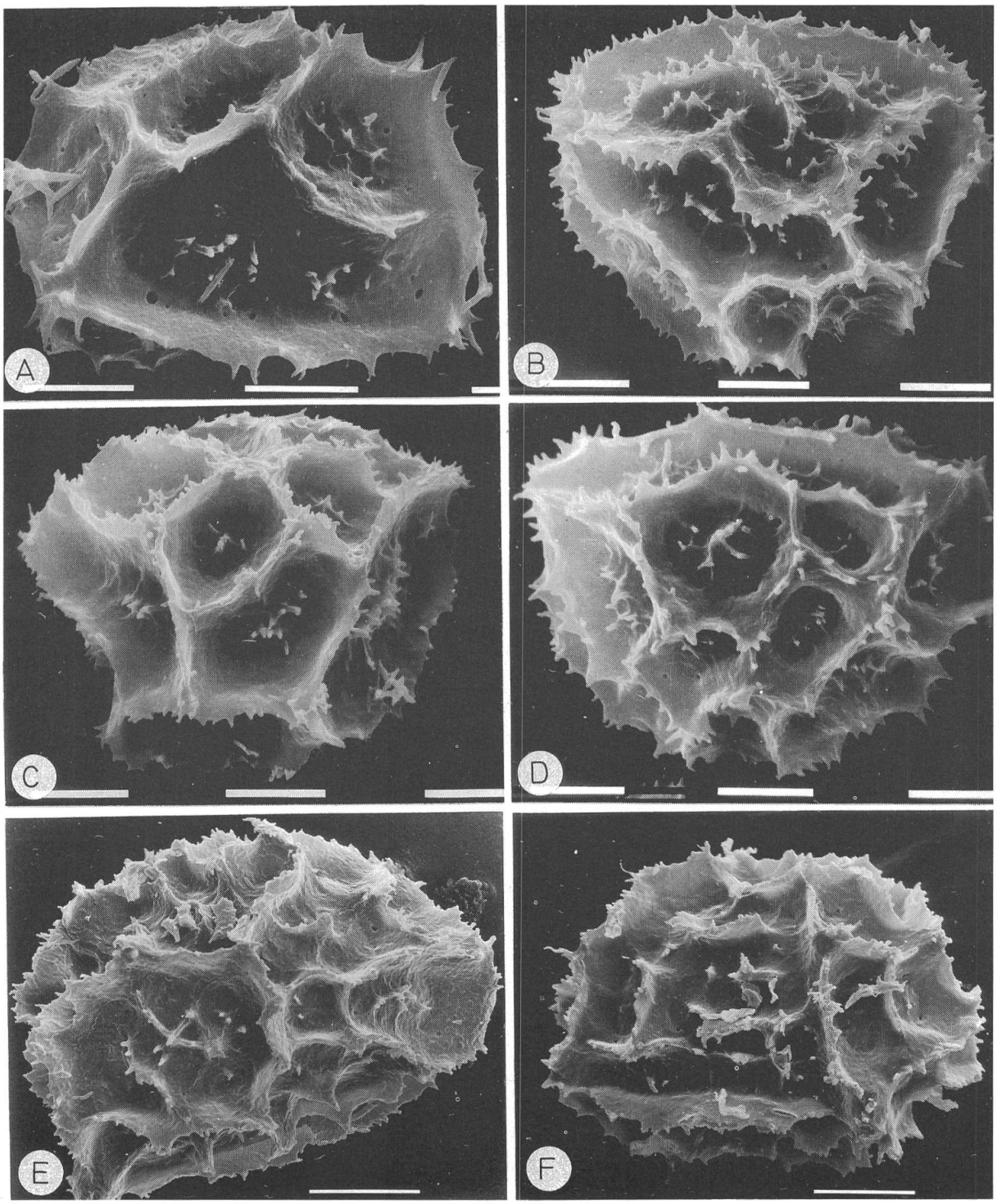

Fig. 10. — Scanning electron microscope photographs (SEM) of spores of: *A. obovatum* subsp. *lanceolatum* (= *A. billotii*), all in lateral view. **A** = RV 3084 from Madeira; **B** = RV 3175 from Madeira; **C** = RV 3053 from Madeira; **D** = RV 3318 from N. Spain; **E, F** = TR-5352 from S. Spain, Miel Valley. **Bar** = 10 µm (Prep. and phot. R. Viane).

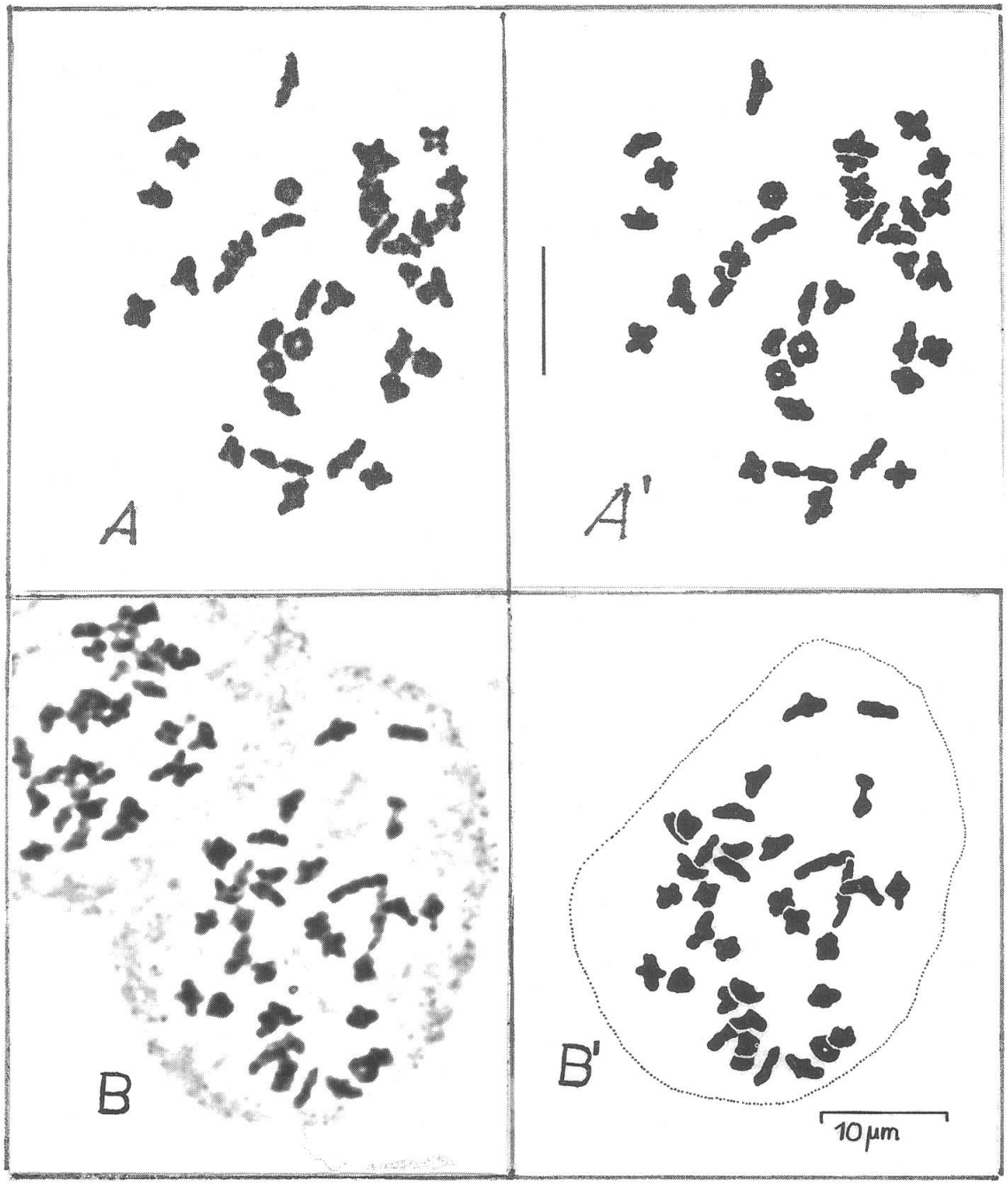

Fig. 11. — Cytology: **A, B** = photographs, **A', B'** = explanatory diagrams. **A, A'** = *A. obovatum* subsp. *obovatum* var. *protobillotii* (TR-2331 cult.), spore mother cell in meiosis (diakinesis), showing $n = 36^{II}$ (det. and phot. J. D. Lovis). **B, B'** = *A. obovatum* subsp. *obovatum* var. *deltoideum* (TR-7234 B 1 = RV 3886 B 1, after cultivation), spore mother cell in meiosis (diakinesis), showing $n = 36^{II}$, above this cell part of another cell is visible (upper corner left) which also showed 36 pairs (det. and phot. H. Rasbach).

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