VOLUME II

A FIELD APPRAISAL OF THE ROLE OF PLANT OPAL IN THE AUSTRALIAN ENVIRONMENT

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1. SEM micrographs have a scale bar in the bottom right-hand corner, the length of which is noted in the caption.
2. On the captions of photographs of thin sections and plant opal taken under a petrological microscope the following descriptors are used:
   PPL Plain Polarised Light
   XPL Crossed Polarised Light
3. MU numbers refer to the photographed sample's number in the samples held in the Macquarie University Museum.
4. Soil Profile numbers are given where necessary. A full description of each profile is to be found in Appendix D.

PLATE 1

SEM micrographs

A MU 50482	bilobate	planar view, sediment from A2, solodized solonetz, site 8, Pilliga, scale is 1 um
B MU 50519	bilobate	side view, sediment from A1, site 12, Pilliga, scale is 10 um
C MU 50517	polylobate	top view, sediment from A1, site 8, Pilliga, scale is 10 um
D MU 50481	polylobate or rod?	sediment from A2, site 8, Pilliga, scale is 1 um
E MU 50483	cross	planar view, sediment from B1, site 8, Pilliga, scale is 1 um
F MU 50496	cross	top view, sediment from A1, Botanic Gardens, Sydney, scale is 1 um
G MU 50484	saddle	top view, sediment from B2, site 8, Pilliga, scale is 1 um
H MU 50503	double outline	top view, carton from termite's nest site 8, Pilliga, scale is 1 um

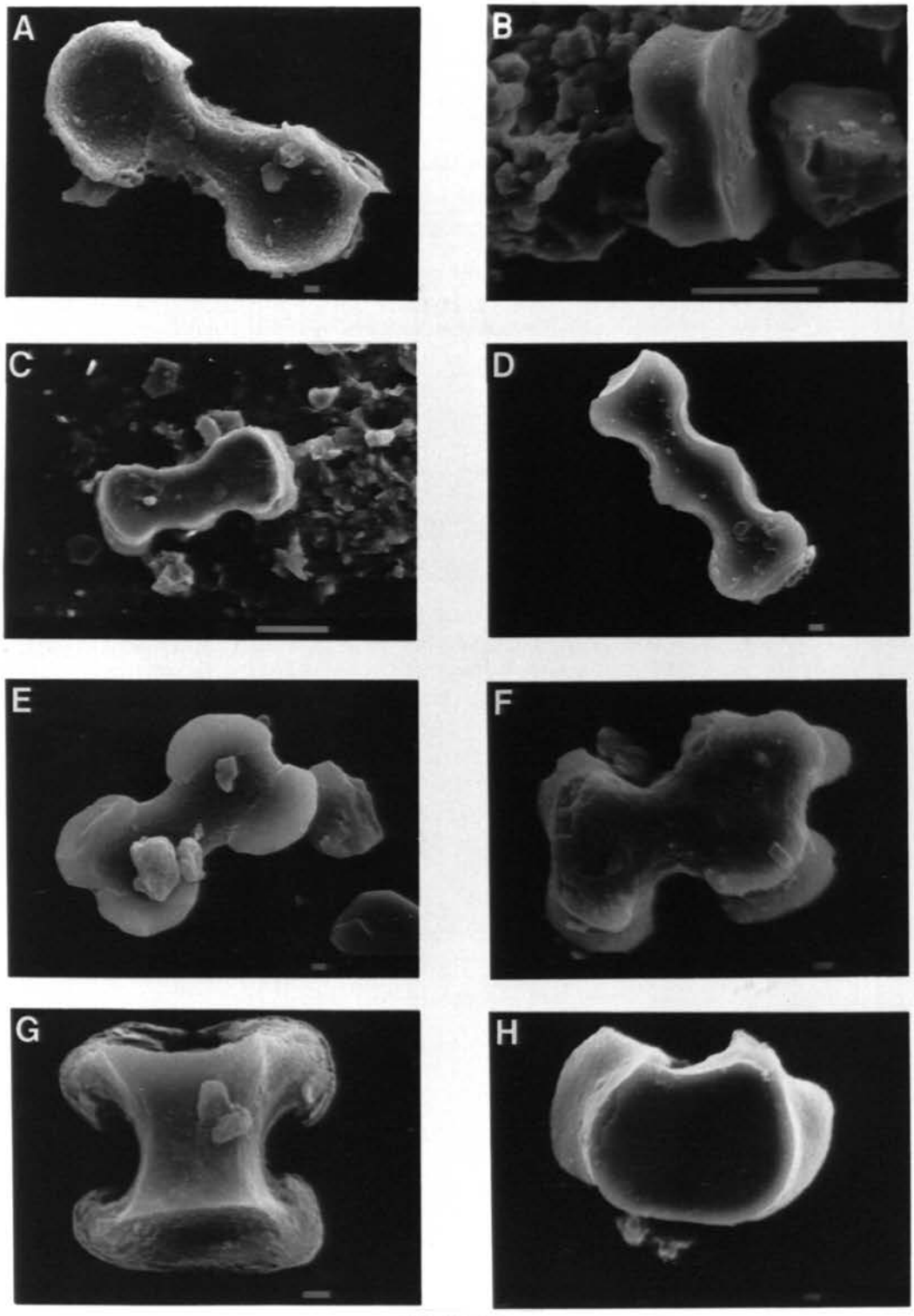


PLATE 1

PLATE 2
SEM micrographs

A MU 50499	cone	from leaves and stem, *Stipa sp.* scale is 10 um, side and top views.
B MU 50497	cone	sediment from A1, Botanic Gardens, Sydney, scale is 1 um Top view.
C MU 50500	cone	from leaves, *Stipa sp.* scale is 10 um, side and top view.
D MU 50492	rod, thin and cones	spiked (top of micrograph) various views. from *Stipa* sp., Pilliga, scale is 10 um
E MU 50487	rod, thick	smooth from *Pteridium esculentum* roots, Oxford Falls, Sydney, scale is 10 um, side view.
F MU 50492	rod, thick	spiked from *Stipa sp.* Pilliga, scale is 10 um
G MU 50501	rod, thin	spiked from root of *Stipa sp.* scale is 10 um
H MU 50483	rod, thick	jigsaw, sediment from B_1, site 8, Pilliga, scale is 10 um, top view.

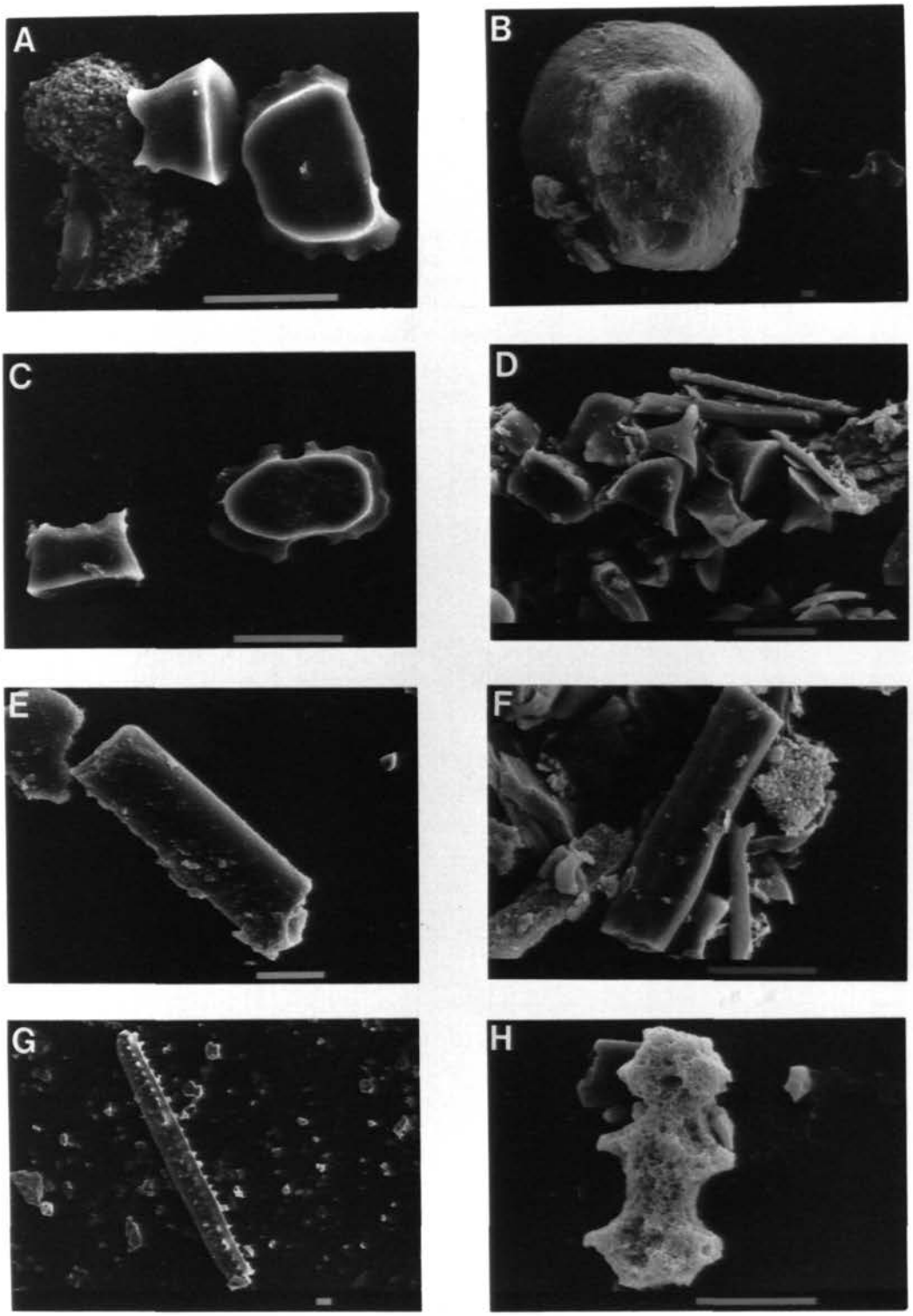


PLATE 2

PLATE 3
SEM micrographs

A MU 50483	rod, thick	jigsaw sediment from B1, site 8, Pilliga, scale is 1 um, top view.
B MU 50521	rod, platey	jigsaw, sediment from A1, site 3, Ecology Reserve, scale is 10 um, top view.
C MU 50502	rod, platey	jigsaw, leaves and stem from *Stipa sp.*, scale is 10 um top view.
D MU 50490	rod, platey	jigsaw, from *Stipa sp.* Pilliga, scale is 10 um top view.
E MU 50486	rod, thick	ridged, sediment from organic pan podzol, Narrabeen, scale is 1 um
F MU 50481	rod, thick	ridged, sediment from domes, site 8, Pilliga, scale is 10 um
G MU 50486	rod, thick	rough, sediment from the organic pan, podzol, Narrabeen, scale is 10 um
H MU 50477	sheet 2D irregular	honeycomb, from *Banksia asplenifolia* leaves, Oxford Falls, scale is 10 um top view

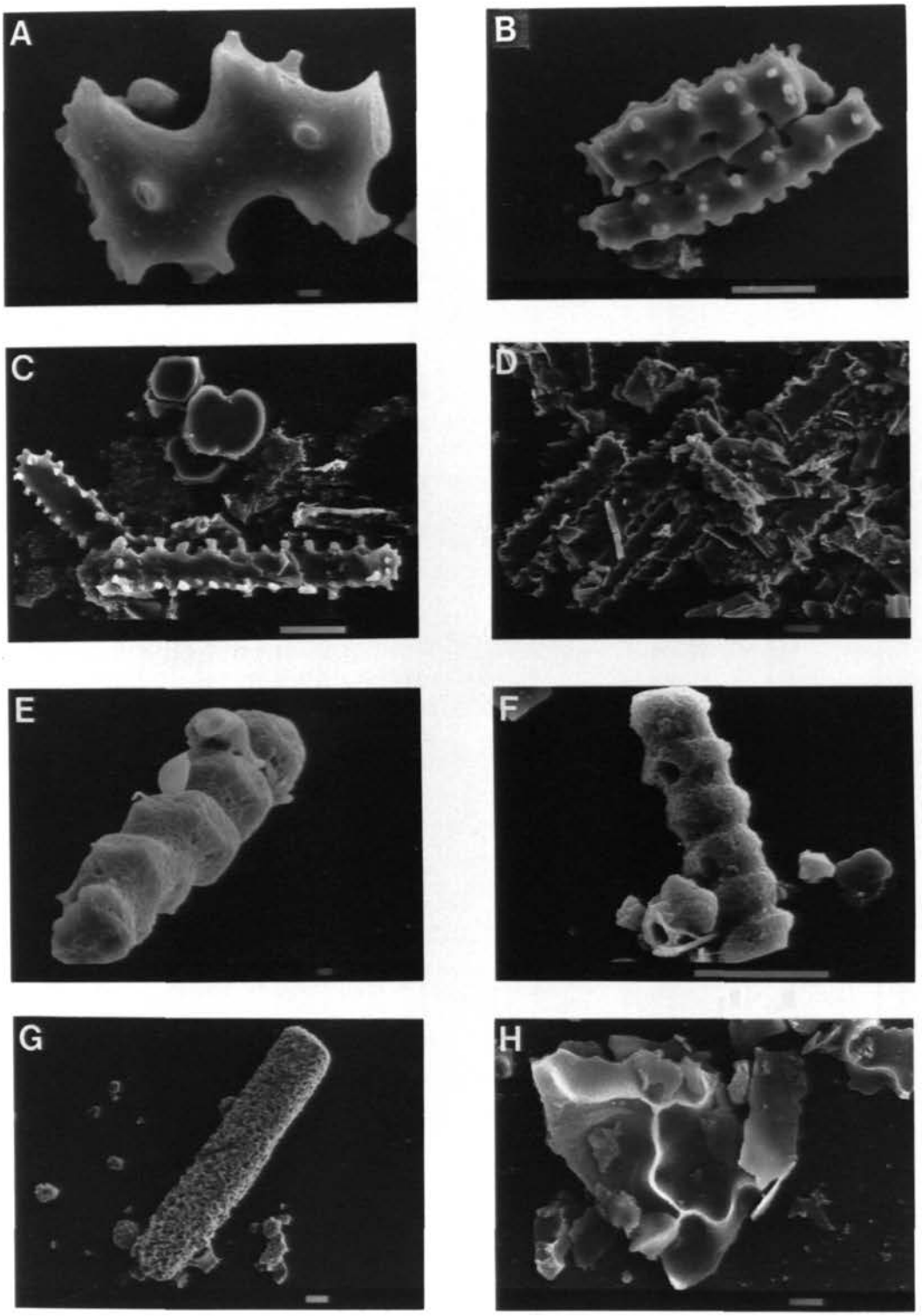


PLATE 3

Plate 4
SEM micrographs

A MU 50494	sheet 2D irregular	plain, from *Dodonaea vicosa ssp. cuneata* leaves, site 8, Pilliga, scale is 10 um
B MU 50493	sheet 2D irregular	perforated, from *Calytrix tetragona* site 2, Pilliga, scale is 1 um
C MU 50523	sheet 2D regular	bulbous, multicelled, from Ecology Reserve ash scale is 10 um, top view
D MU 50522	sheet 2D regular	multicelled, from Ecology Reserve ash, scale is 10 um Contains several morphologies in growth position.
E MU 50483	sheet 2D irregular	honeycomb, sediment from B1, site 8, Pilliga scale is 10 um
F MU 50518	sheet 3D regular	smooth, sediment from A1, Pilliga site 8 scale is 10 um, top view
G MU 50503	sheet 3D regular	rough, carton from termite's nest, site 8, Pilliga, scale is 10 um top view
H MU 50498	sheet 3D regular	rough, sediment from A1, Gardens, Sydney scale is 10 um, top view

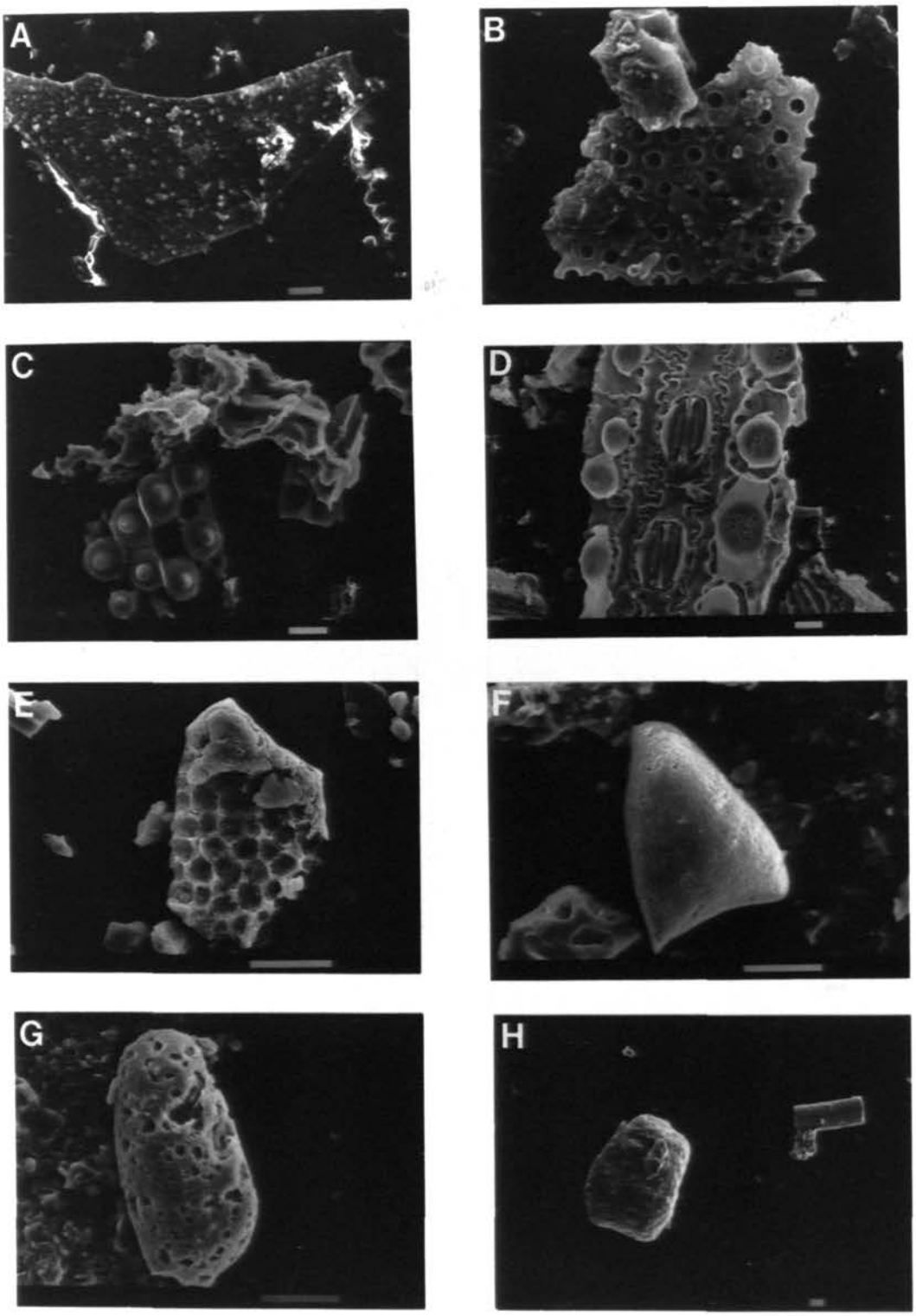


PLATE 4

Plate 5
SEM micrographs

A MU 50517	sheet 3D regular	verrucose, sediment from A1, site 8, Pilliga. scale is 10 um
B MU 50523	sheet 3D irregular	multicelled, from Ecology Reserve ash, scale is 10 um top view
C MU 50495	sheet 3D irregular	multicelled, from leaves of *Dodonaea viscosa spp. cuneata*, site 8, Pilliga scale is 10 um top and side views
D MU 50521	prickle, long	multicelled, from Ecology Reserve ash, scale is 10 um
E MU 50521	prickle, long,	from Ecology Reserve ash scale is 10 um
F MU 50516	prickle, long	sediment from A1, site 7, Pilliga, scale is 10 um
G MU 50517	prickle, long	sediment from A1, site 8, Pilliga, sclae is 10 um
H MU 50485	prickle, short	sediment from the organic pan, podzol, Narrabeen scale is 1 um

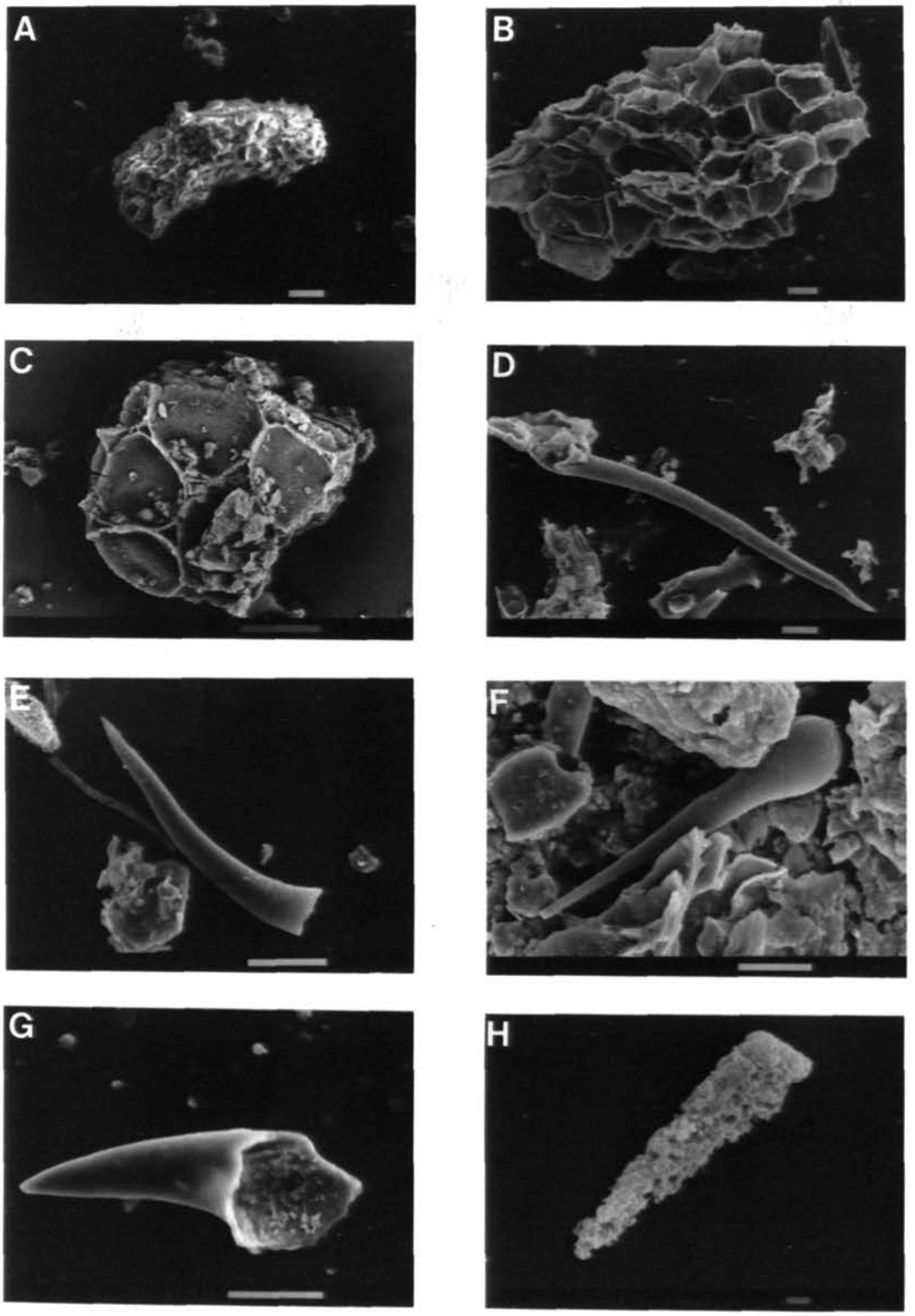


PLATE 5

Plate 6
SEM micrographs

A prickle, gourd-shaped sediment from A1, site 9,
MU 50519 Pilliga, scale is 10 um

B sphere, single smooth, sediment from domes,
MU 50482 Pilliga site 8
scale is 1 um

C sphere, single spiked, sediment from A1, site 8,
MU 50518 Pilliga, scale is 1 um

D sphere, single rough, sediment from A1, site 7,
MU 50515 Pilliga, scale is 1 um

C and D are possibly chrysophyte tests

E sphere, single perforated, from *Unk sp.1*,
MU 50488 Oxford Falls
scale is 10 um

F sphere, compound, smooth, from leaves *Melaleuca*
MU 50490 *uncinata*, site 1, Pilliga
scale is 1 um

G sphere, compound, smooth, from leaves of
MU 50489 *Eucalyptus gummifera*,
Oxford Falls
scale is 1 um

H sphere, verrucose, sediment from A1, site 8,
MU 50517 Pilliga, scale is 10 um

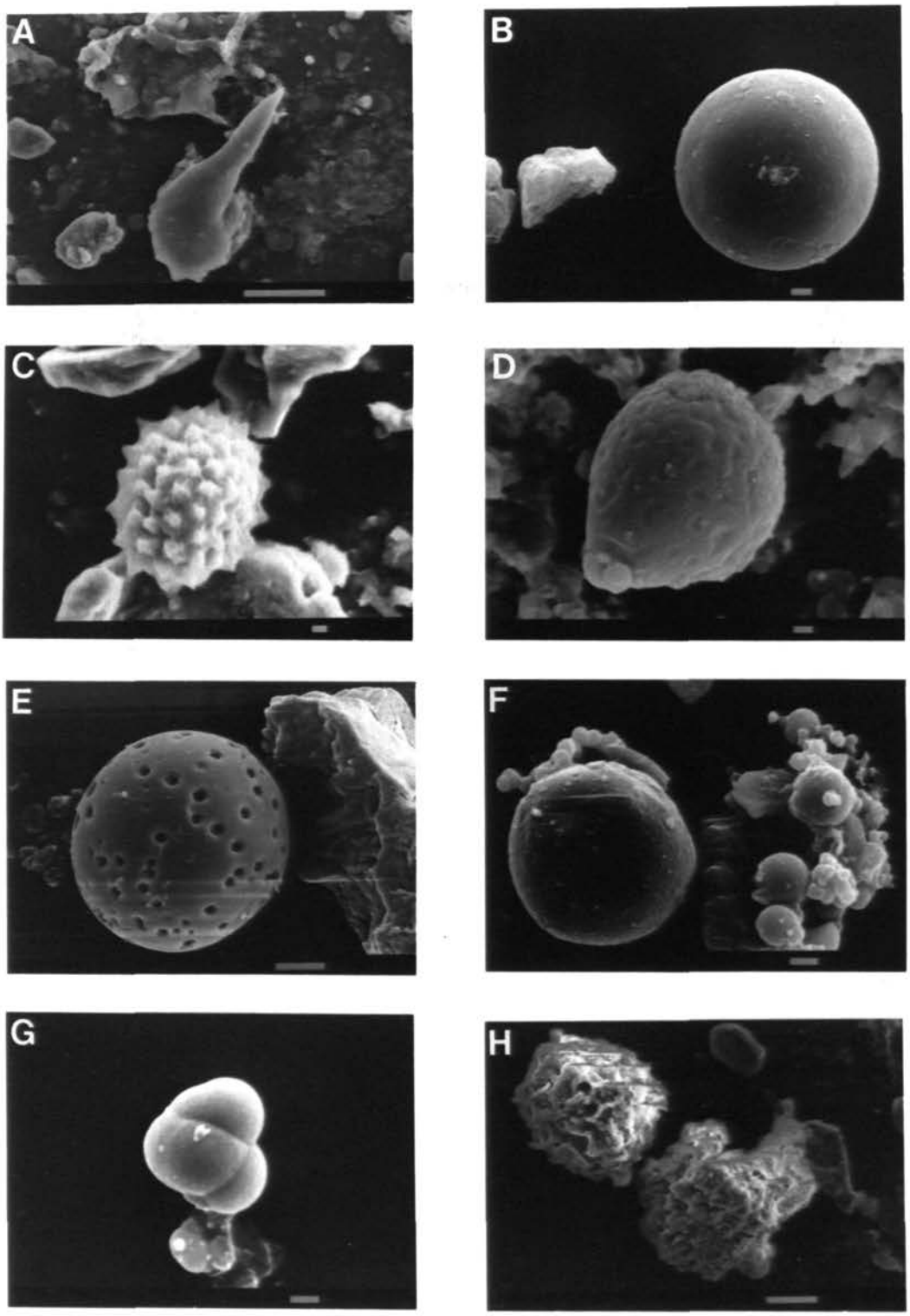


PLATE 6

Plate 7
SEM micrographs

A sphere, compound, rough, sediment from
MU 50520 Ecology Reserve ash
scale is 10 um

B diatom (centrale) sediment from B1, site 8,
MU 50483 Pilliga, scale is 1 um

C diatom (centrale) sediment from A1, site 7,
MU 50516 Pilliga, scale is 10 um

D diatom (centrale) sediment from organic
MU 50486 pan, podzol, Narrabeen
scale is 1 um

E diatom (pinnale) sediment from domes,
MU 50481 Pilliga site 8
scale is 10 um

F chrysophyte? carton, site 8, Pilliga
MU 50503 scale is 10 um

G chrysophyte sediment from A1, site
MU 50515 12, Pilliga
scale is 10 um

H sponge spicule sediment from A1, site 7,
MU 50516 Pilliga, scale is 10 um

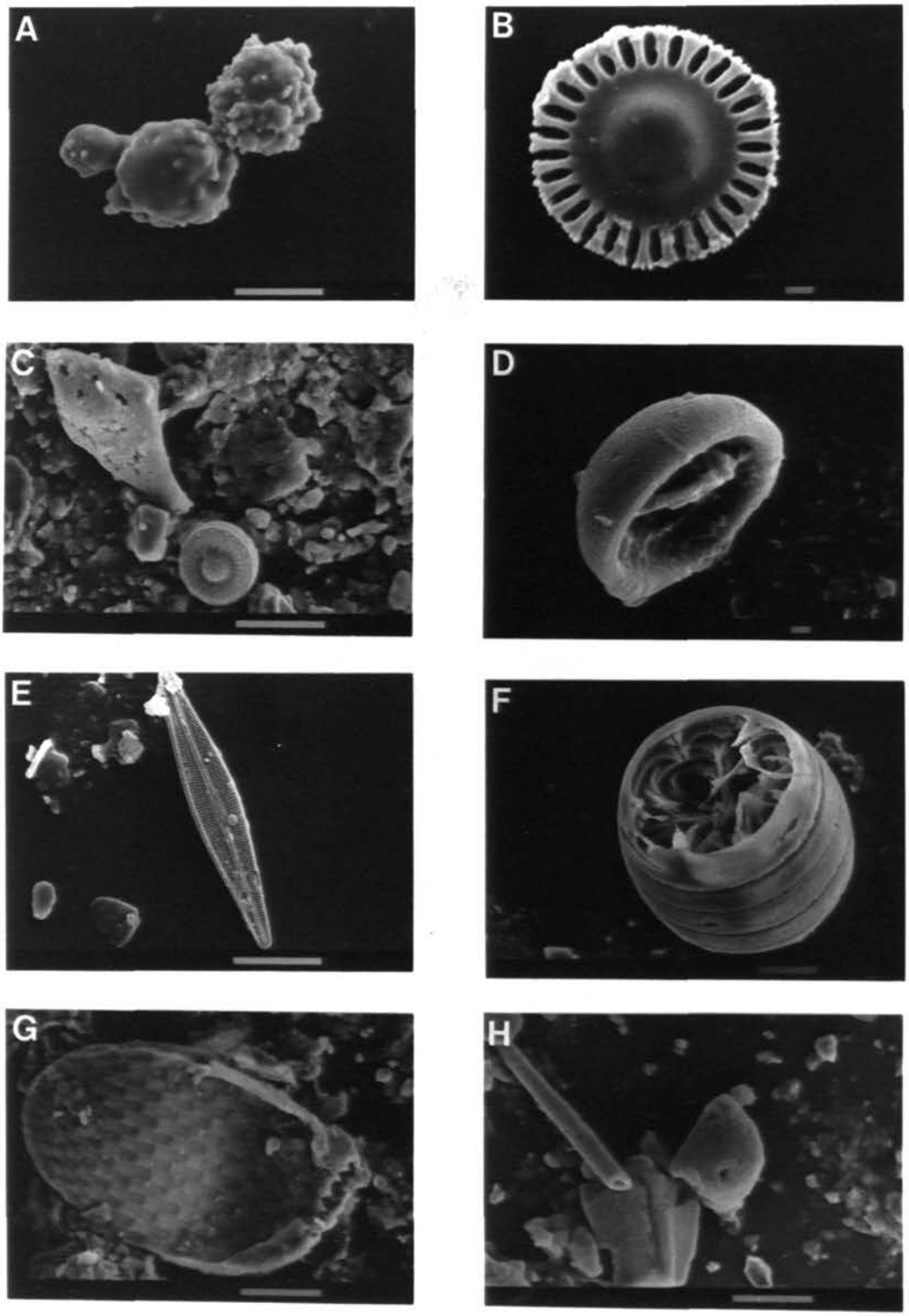


PLATE 7

PLATE 8
SEM micrographs

Scale is 10 um unless otherwise stated.

Plant opal separated from Oxford Falls swamp Core OFC2. MU# 50478

A Sand-sized plant opal. Mainly thick sheets and multicelled material. Scale is 100 um.

B Sand-sized plant opal. Close up of the right-hand group in A. May exhibit some welding together of grains by re-crystalization.

C Sphere, single, rough.

D Group of multicelled platey material including silicified stomatal cells.

E Thick, jigsawed rod.

F Thick rod, spiked.

Cyperaceae-type phytolith from *Acacia* species in the Piliiga State Forests.

G MU# 50510 *Acacia calamifolia.* Contains a few of the phytolith, mainly in single cones.

H MU# 50511 *A. spectabilis.* The bulbous variant is common and appears single only.

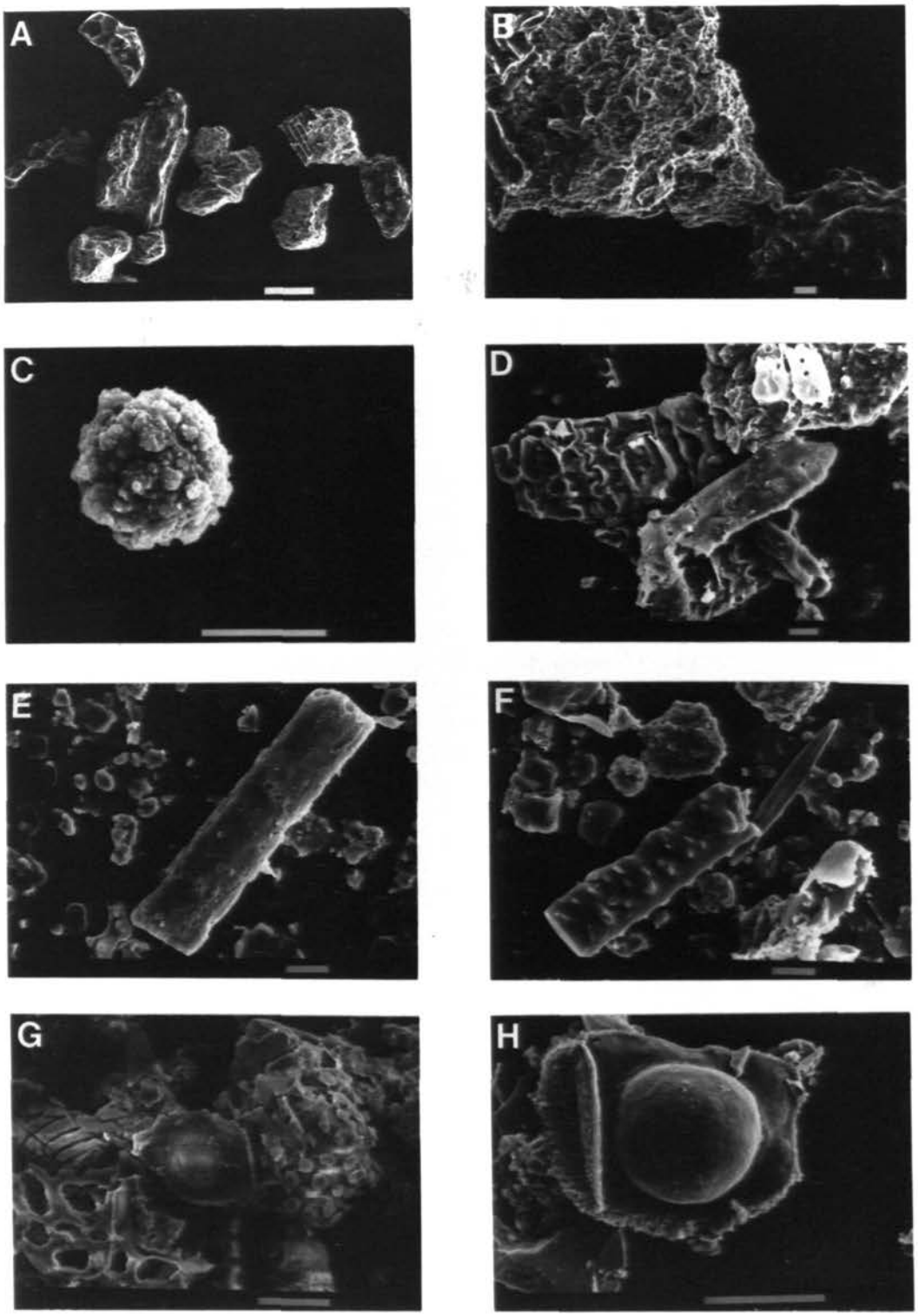


PLATE 8

PLATE 9

SEM micrographs

Scale is 10 um unless otherwise stated.

Cyperaceae-type phytolith from *Acacia* species in the Piliiga State Forests.

A MU# 50511	*A. spectabilis.* A group of bulbous phytoliths.
B-D MU# 50513	*A. lineata.* Rows of cones with some satellites.
E MU# 50512	*Acacia deanei ssp. deanei.* Single conical body on plate.
F-G MU# 50512	*A. deanei ssp. deanei.* Rows of conical bodies with satellites.
H MU# 50514	*A. triptera.* A row of conical bodies with satellites.

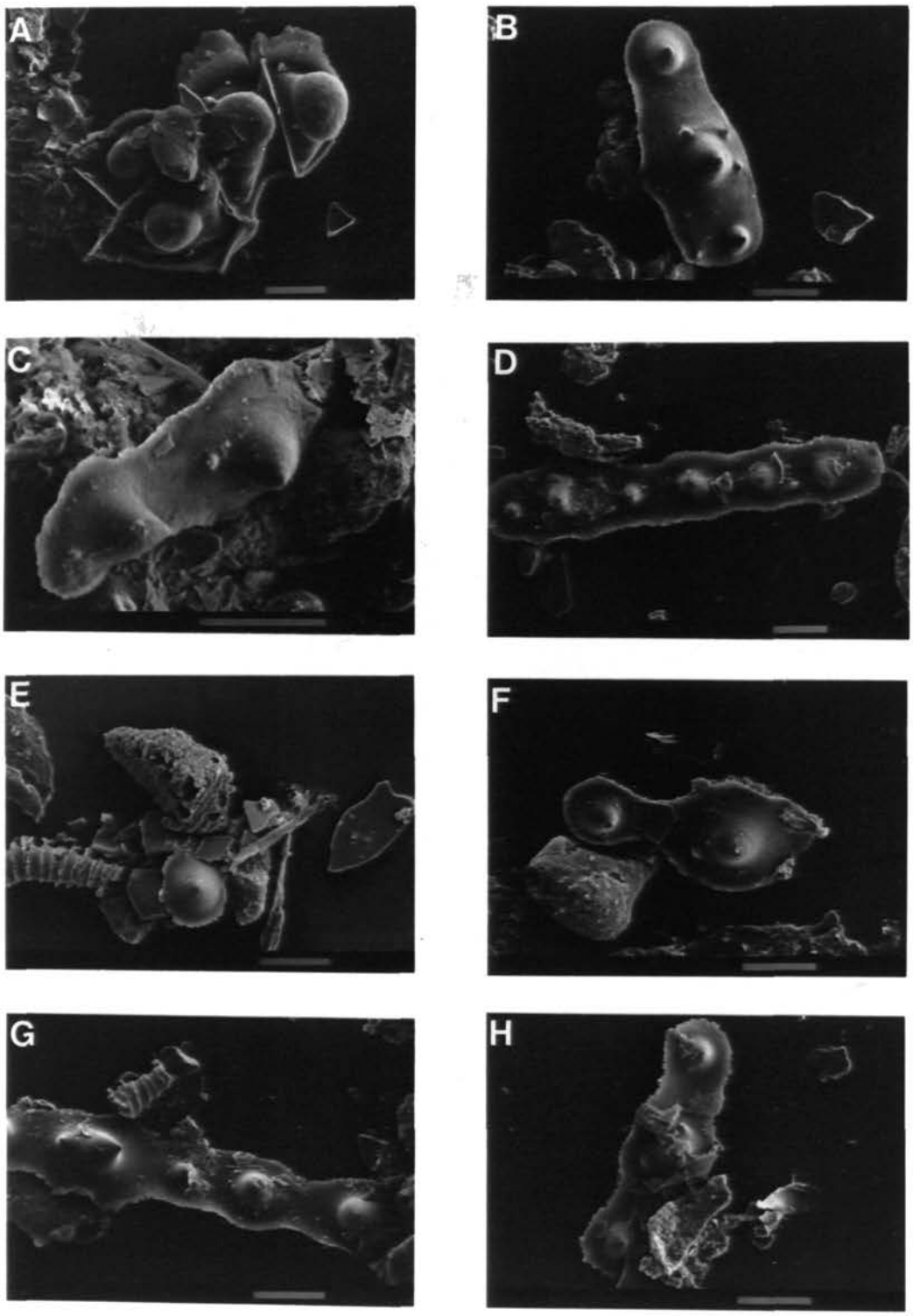


PLATE 9

PLATE 10
SEM micrographs

Plant opal from the Oxford Falls podzol,
Soil Profile #OF2.

A
MU# 50504 — A rough sphere from the A1 (0-50 mm). Scale is 10 um.

B
MU# 50506 — A thick, ridged rod from the A2 (150-200 mm). Scale is 10 um.

C
MU# 50507 — A pitted thick rod from the organic pan (400-450 mm). Scale is 1 um.

D
MU# 50507 — Part of a thick, ridged rod from the organic pan (400-450 mm). Scale is 10 um.

Site 8, mallee, Soil Profile 8iv.

E
MU# 50509 — The very dark lining of the faunal channels. This is comprised of faecal pellets pressed together. Scale is 100 um.

F
MU# 50509 — A faecal pellet from within the faunal channels, B horizon. Scale is 1 mm.

Plant opal from carton, Pilliga Forests,
Site 8. MU# 50503

G — Sheet, 3D, regular, from termite carton. Scale is 10 um.

H — Plant opal from termite carton. Scale is 10 um.

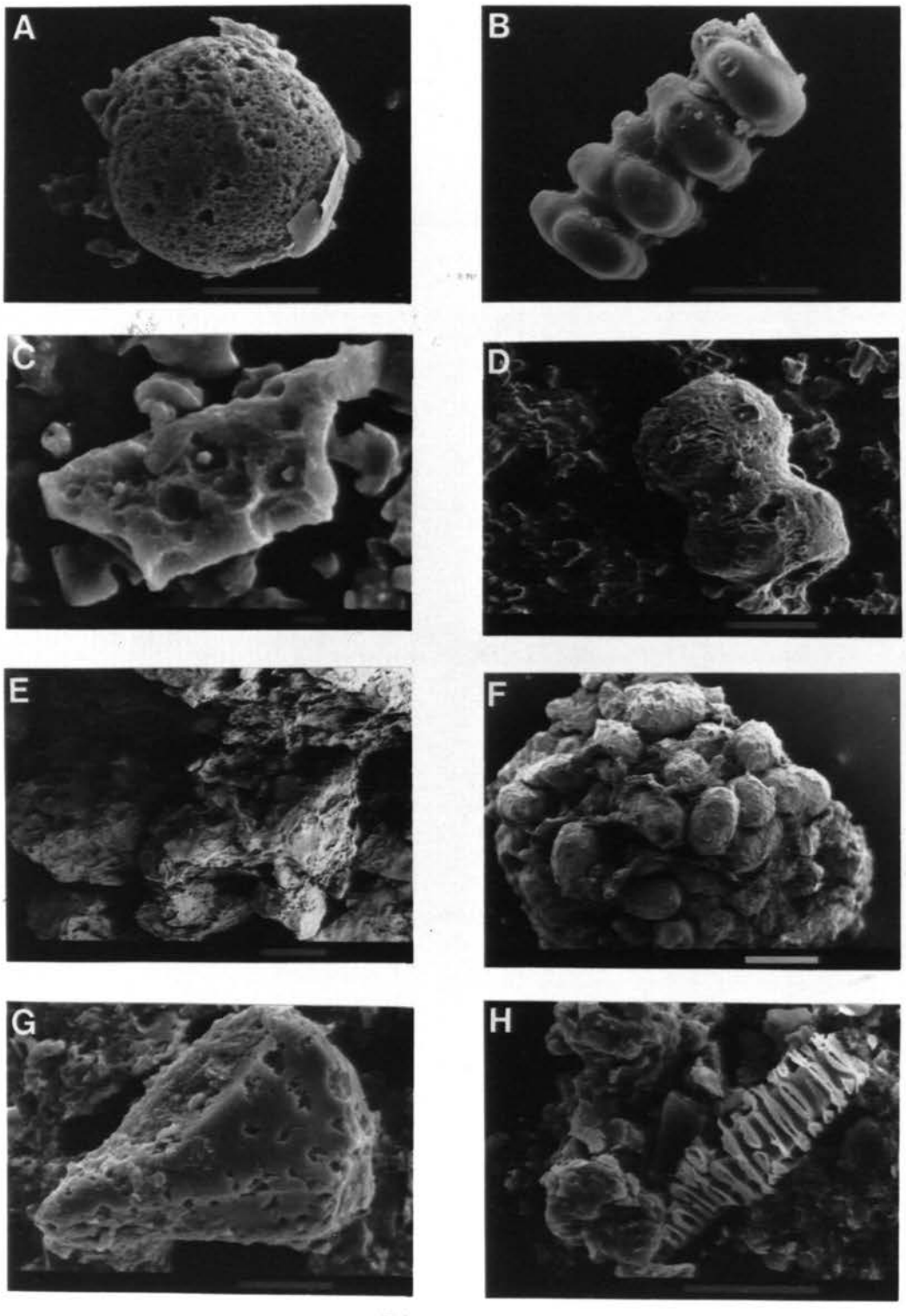


PLATE 10

Plate 11

The boundary between Site 7 (upper broom plain) and Site 8 (mallee) is very sharp. This photograph, taken from the middle of the road looking west through both sites from the broom plain, shows the abrupt change in both species and vegetation height. There are numerous ant nests in the road, which has been slightly built up and is better drained than the surrounding broom plain.

PLATE 11

PLATE 12

Detail of the mallee (Site 8) vegetation.
The many stemmed Eucalyptus is *E. viridis*.
The low, bright green shrub is *Dodonaea viscosa ssp cuneata* or hop bush.

PLATE 12

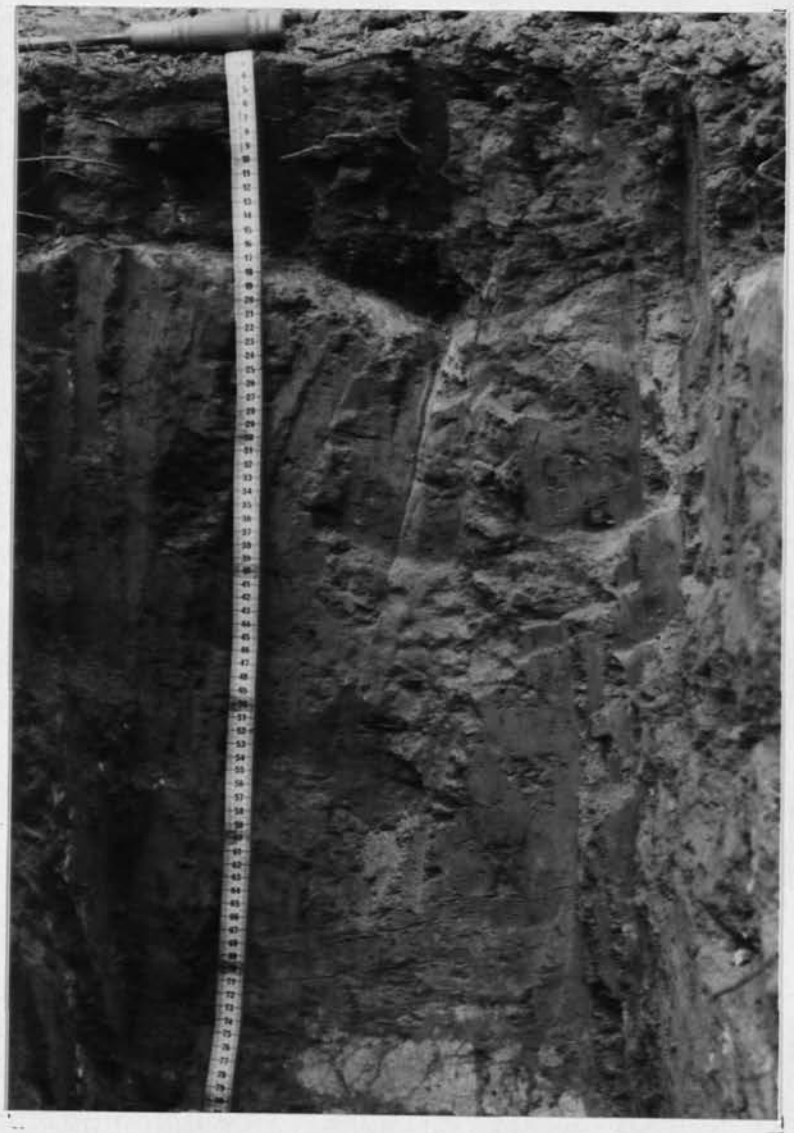
PLATE 13

Soil pit, Site 8 (mallee), soil profile #PF8iv. Tape is in cm. Each 10th cm is darkened.

A View of the pit (to over 1 m). The soil is a Dy4.41 (Northcote, 1974).

B 750 - 1000 mm+ The Pilliga Sandstone forms the substrate for this soil. The sandstone is white/cream with many lenses of darker clay in it.

A



B

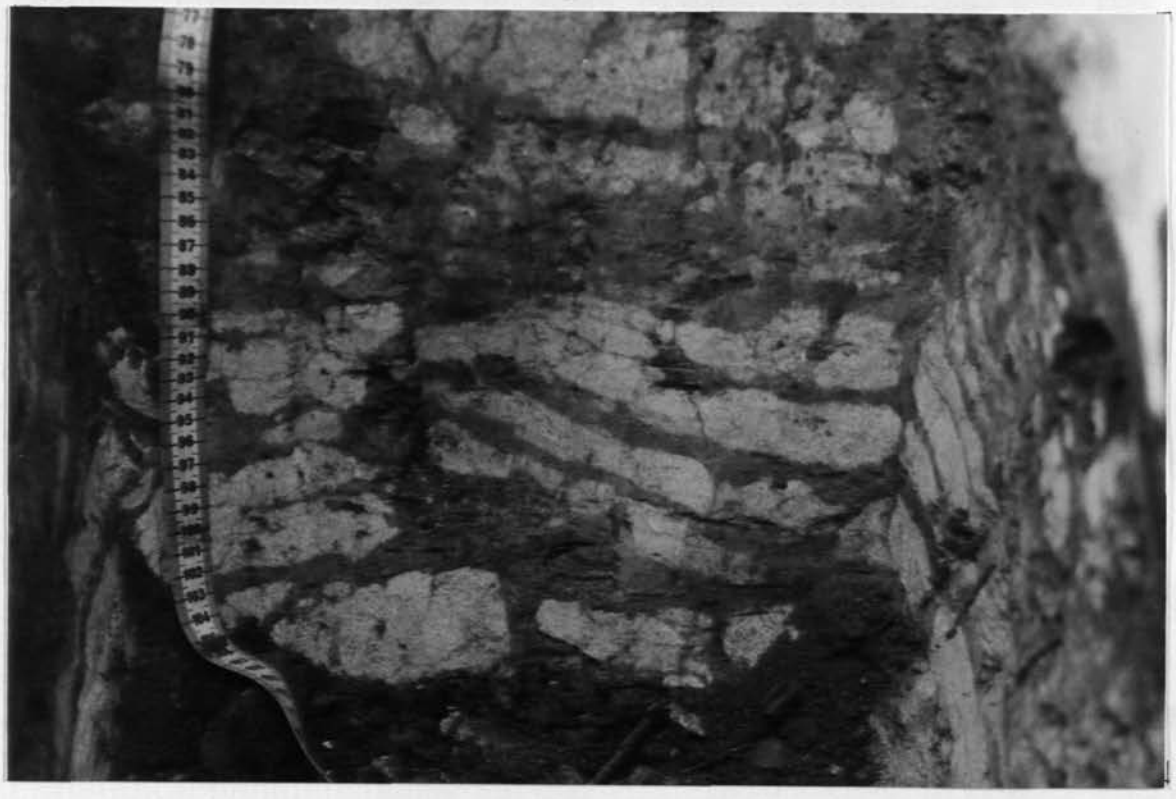


PLATE 13

PLATE 14

Soil pit, Site 8 (mallee), soil profile #PF8iv. Tape is in cm. Each 10th cm is darkened.

A The A1 (0-180 mm) of loamy sand, which overlies the domes and penetrates down the sides of each. The cement-like tops of the domes are exposed.

B A closer view of the dome tops. These are penetrated by a few, large faunal channels.

A

B

PLATE 14

PLATE 15

The lower broom plain (Site 9) looking towards the forest (Site 12). This boundary is also very abrupt. Photograph is taken looking west.

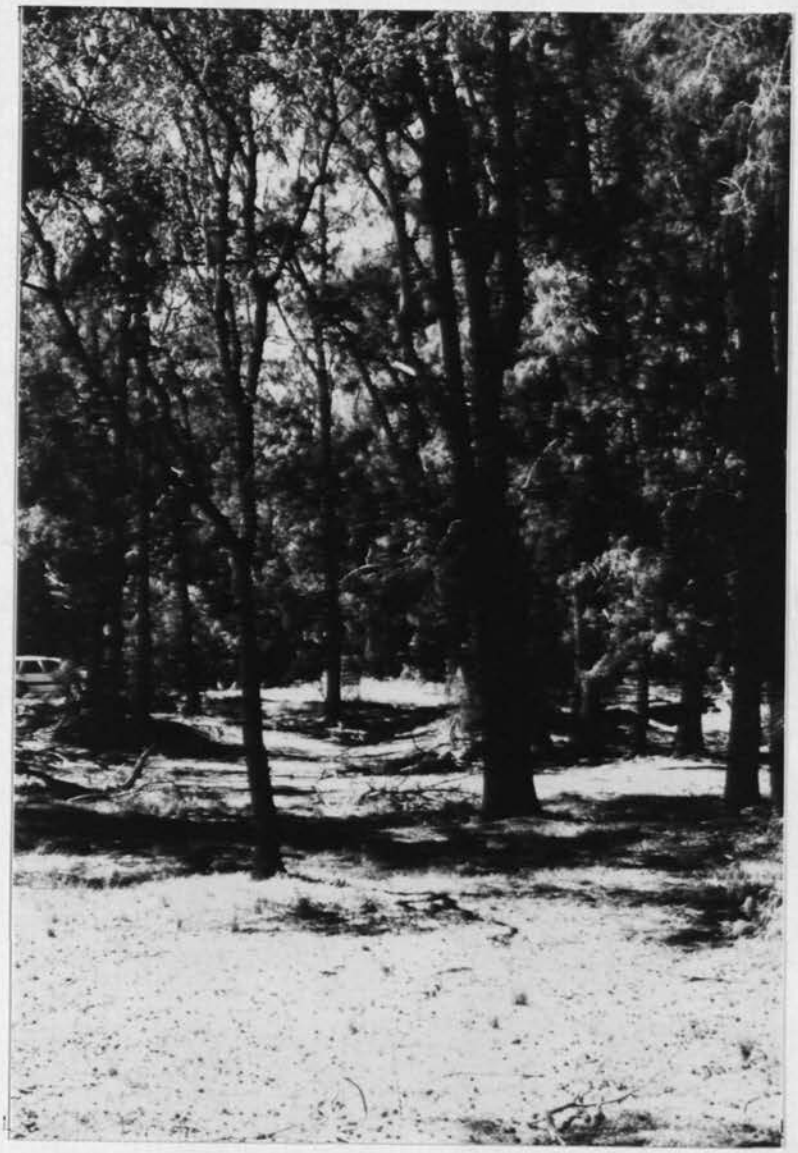
PLATE 15

PLATE 16

A The gilgai area (Site 11). The trees are *Casuarina cristata*. Note the hollow and humock appearance of the ground. Relief is around 2 m.

B The "sand monkey", Site 10. Vegetation comprises *Callitris glaucophylla* and *E. chloroclada*, with *Xanthorrhoea glauca* ssp. *angushfolia* in the shrub layer.

A



B

PLATE 16

PLATE 17

A litter tray located in the mallee (Site 8). The trays measured 50 cm x 50 cm and were constructed of plastic electrical conduit and terylene curtain material.

PLATE 17

PLATE 18

In these photographs the chisel handle is 10 cm long.

A Site 8, mallee. This photograph shows the surface of the site, which can range from bare soil where animals or ants have their runs, to a thick cover of litter.

B Site 8, mallee. Around the bases of the *E. viridis* are halos of bark and litter in which termites build their nests. The ground around the trees is very spongy due to the network of channels under the surface.

A

B

PLATE 18

PLATE 19

In these photographs the chisel handle is 10 cm long.

A Site 8, mallee. The termites also build nests around dead material on the mallee floor. This mound is about 40 cm in diameter and very common in this area.

B Site 8, mallee. The underneath of a fallen log has been packed with a mixture of faecal pellets and soil (sheeting) by the termites. They are then able to work their way into the wood.

A

B

PLATE 19

PLATE 20

In these photographs the chisel handle is 10 cm long.

A Site 8, mallee. A log broken open to show the packing of sheeting within it.

B Site 8, mallee. Around 40-50 mm of material has been packed under and around this log. A large amount of soil is bought to the surface and deposited in such areas. Scale is in cm.

A

B

PLATE 20

PLATE 21

In these photographs the chisel handle is 10 cm long.

A Site 8, mallee. A closer view of the sheeting, showing the packing fabric and the channels along which the termites move.

B Site 8, mallee. A fragment of a mound broken off to show the incorporation of litter within it. The termites bury the litter before eating it, and thus are responsible for the incorporation of much of the litter layer into the soil before it is broken up or decomposed. Scale is in cm.

A

B

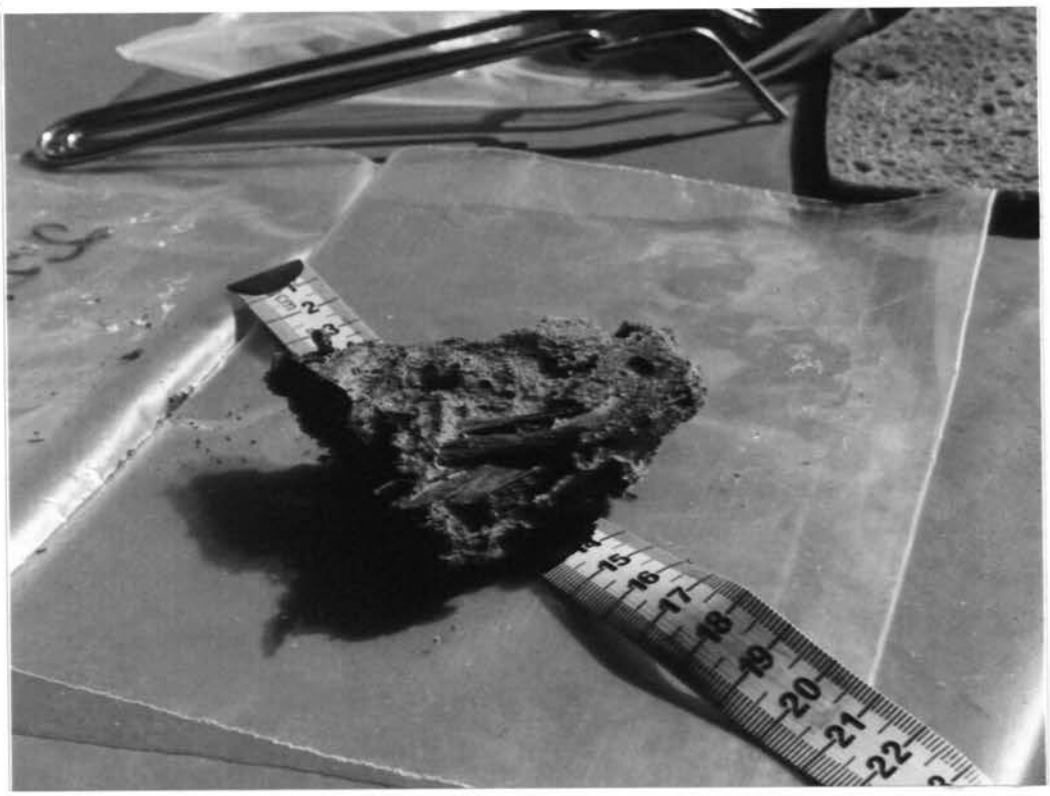


PLATE 21

Plate 22

A Mesh bag used to contain litter in litter decomposition experiment. A large amount of soil is adhering to the outside; this is the side of the mesh bag which was exposed on the surface and the soil has been deposited by termites.

B Rocky Creek, to the south of the field site after rain. The creeks in the area are sandy.

A

B

PLATE 22

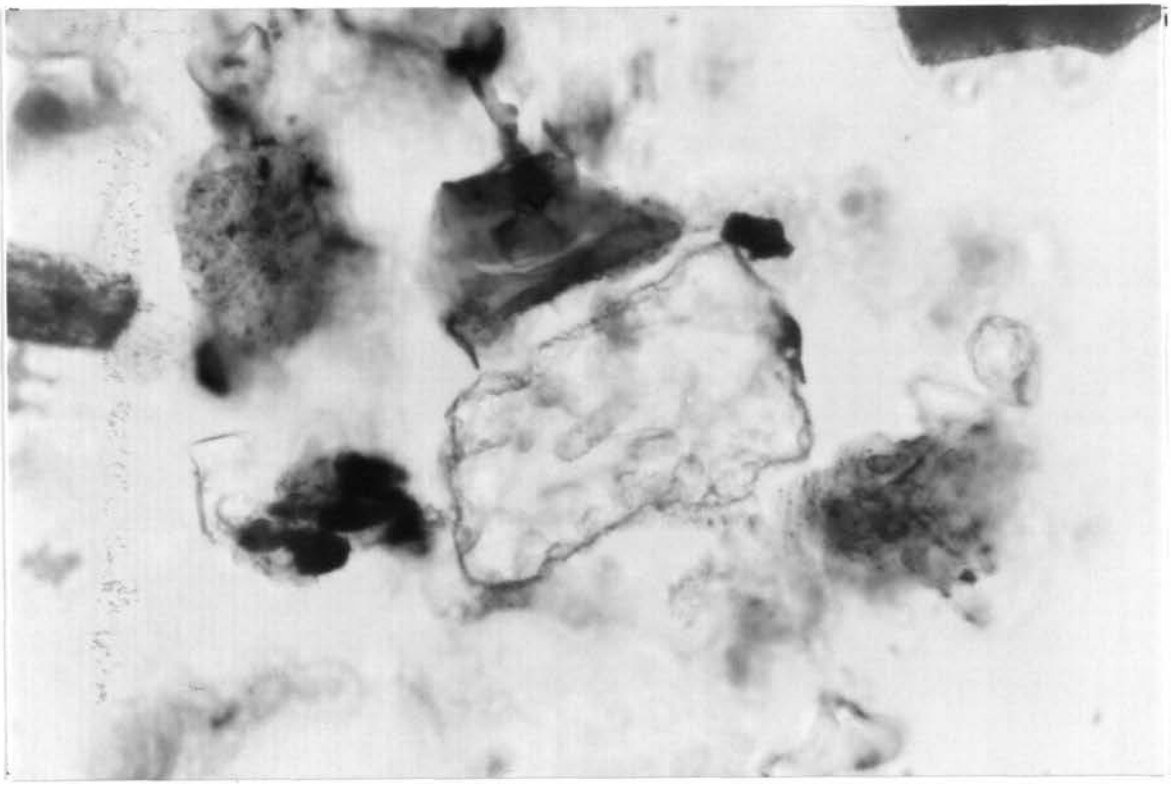
Plate 23

Photographs taken of petrological slides.

A MU 50613: Site 7, upper broom plain pinch sample 7b2. Sheet, 3D, rough-surfaced and pitted. PPL.

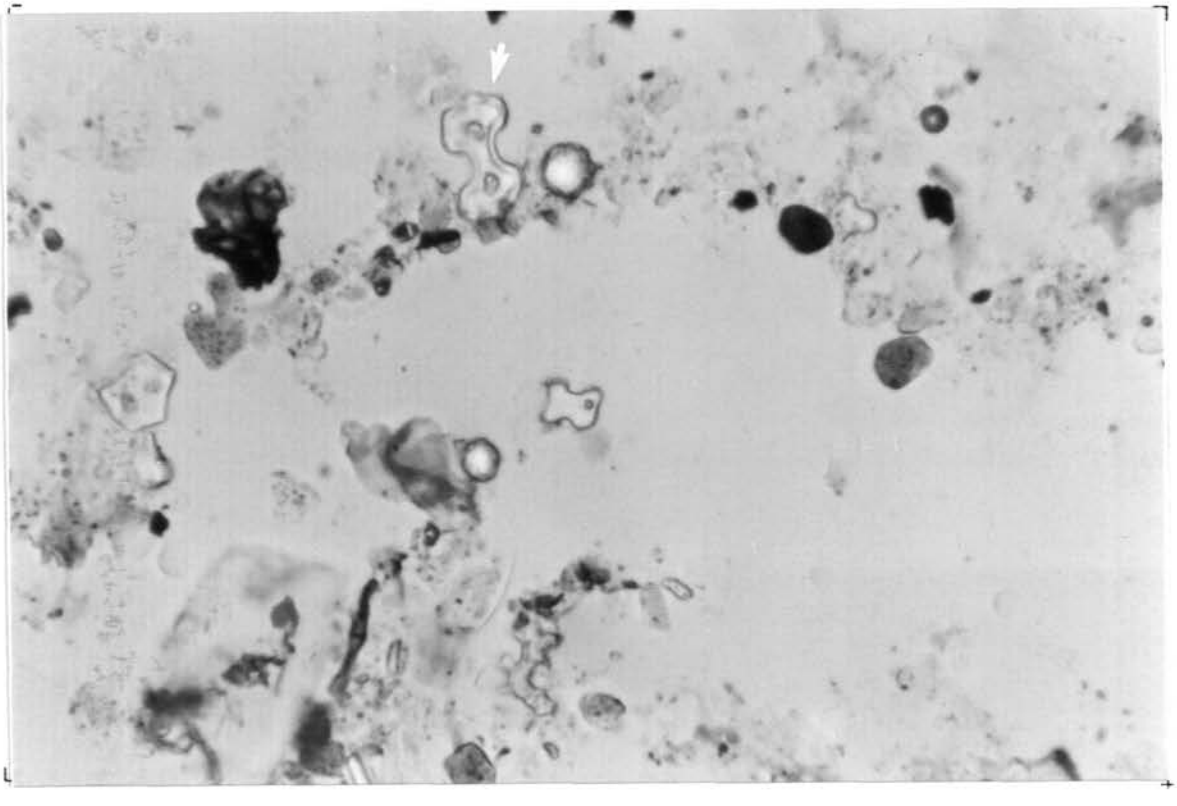
B MU 50615: Site 9, lower broom plain pinch sample 9a1. Note the lobates (arrow). PPL.

A



0 µm 50

B



0 µm 50

PLATE 23

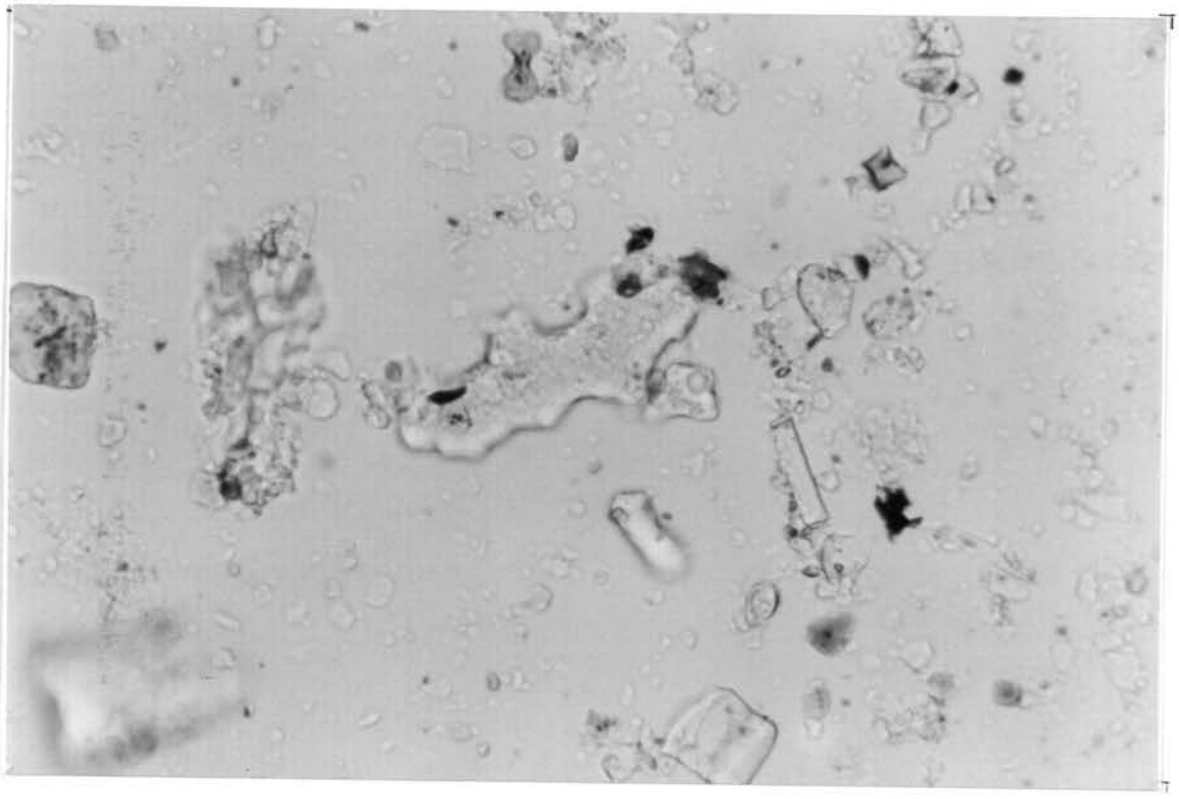
Plate 24

Photographs taken of petrological slides.

A MU 50608: Site 2 broom plain pinch sample 2/1. Contains many rough surfaced 3D sheets. PPL.

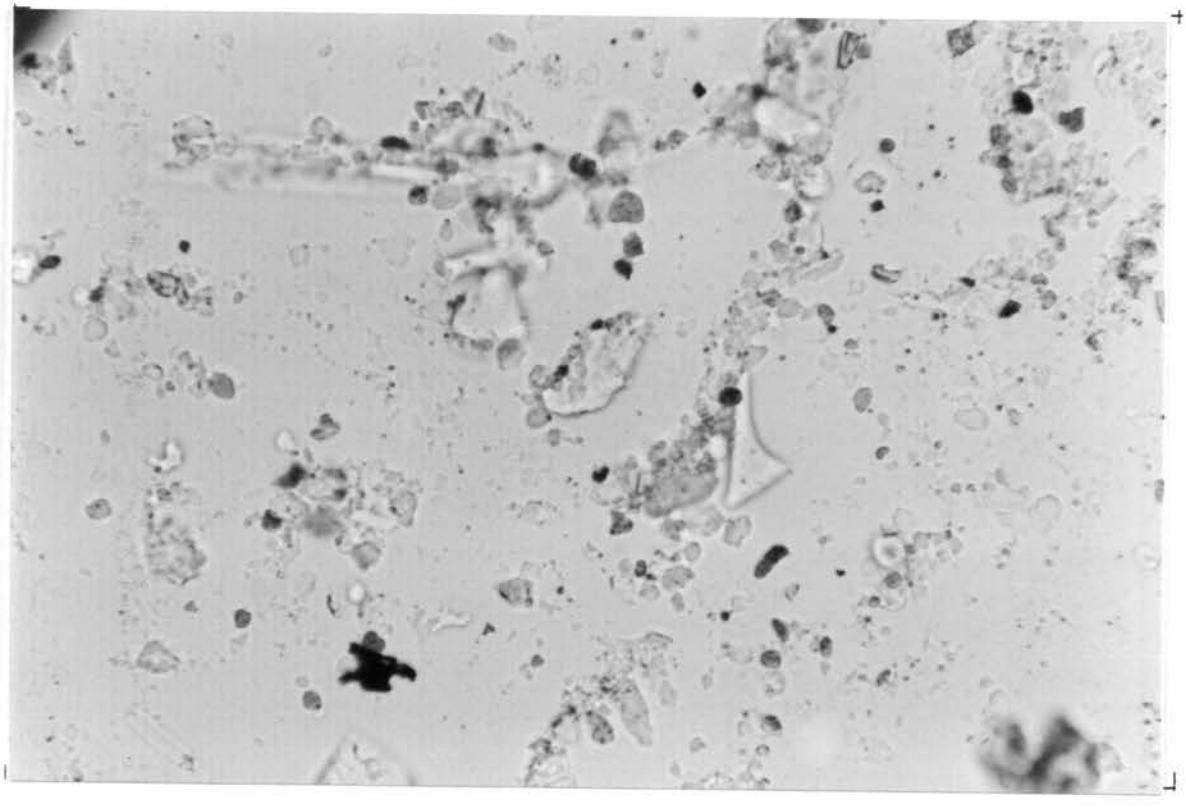
B MU 50610: Site 6 broom plain pinch sample 6/1. Contains many rough surfaced 3D sheets. PPL.

A



0 μm 100

B



0 μm 100

PLATE 24

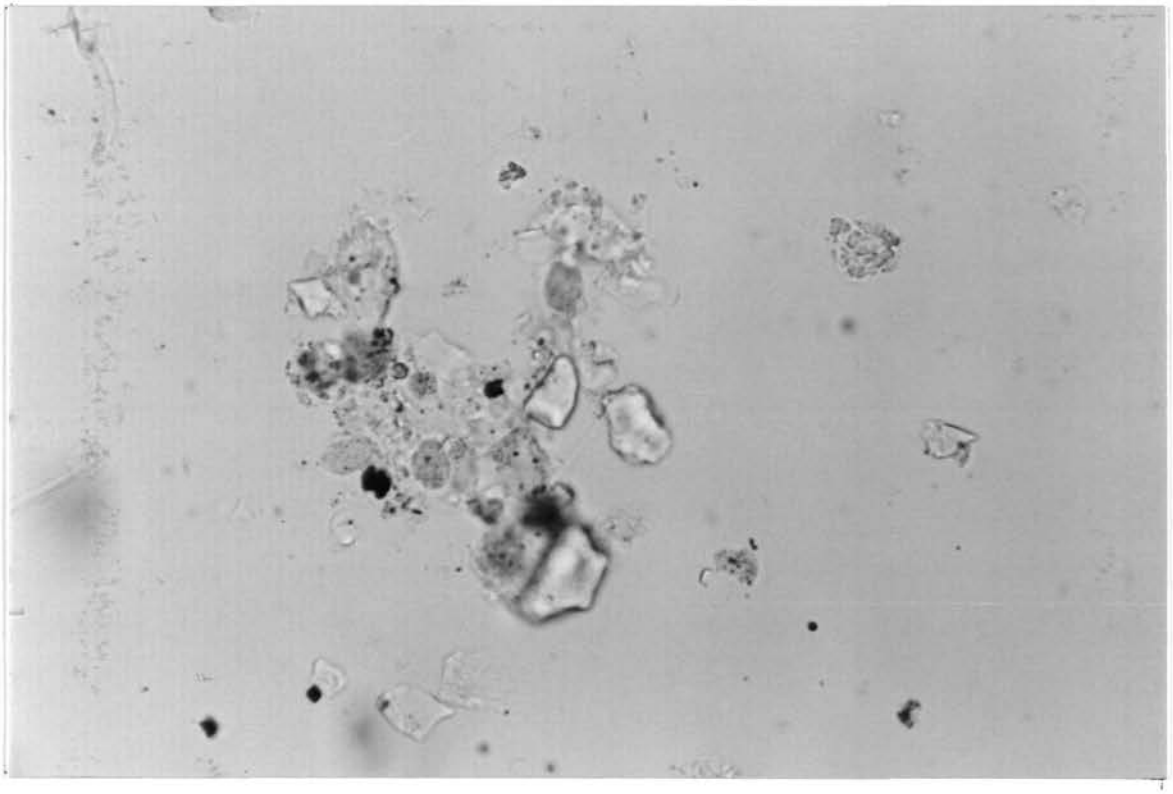
Plate 25

Photographs taken of petrological slides.

A MU 50542: *Acacia lineata.* Pilliga State Forests. Plant opal comprises mainly smooth surfaced bodies. PPL.

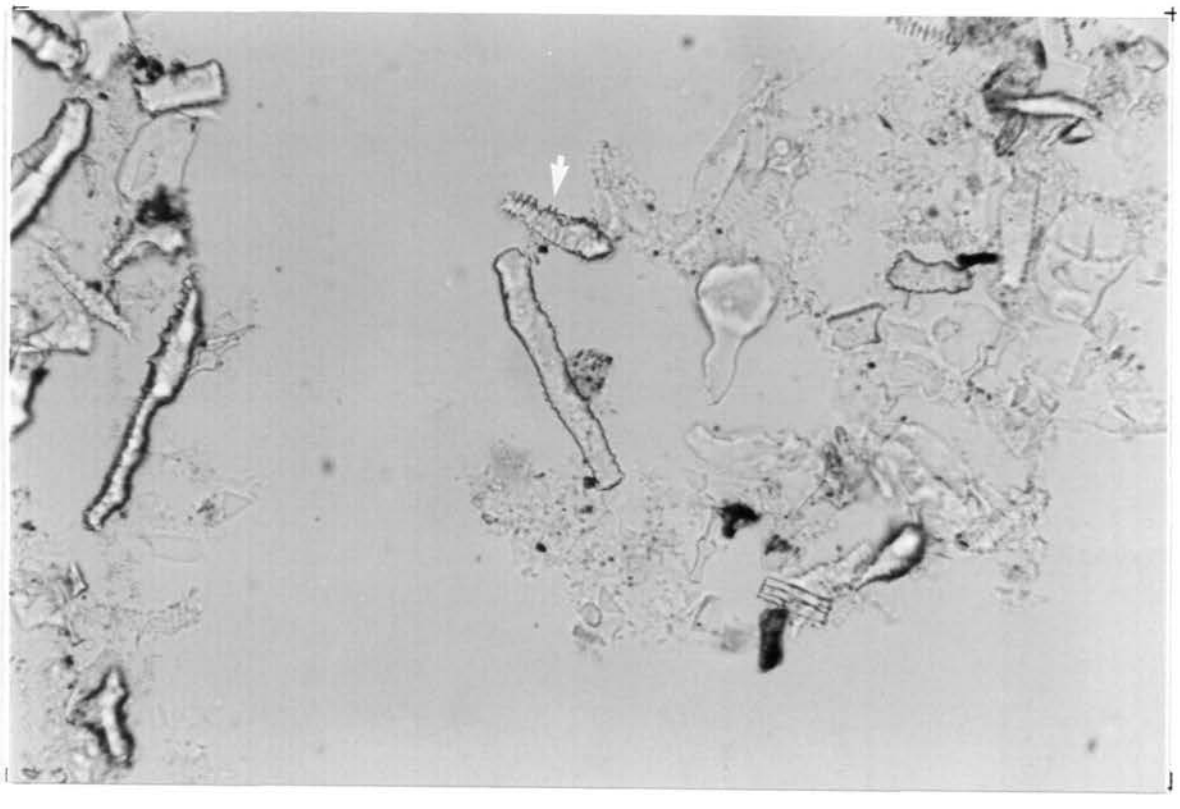
B MU 50536: *A. tindaleae.* Pilliga State Forests. A large proportion of the plant opal from this species is ridged (arrow). PPL.

A



0 µm 100

B



0 µm 100

PLATE 25

Plate 26

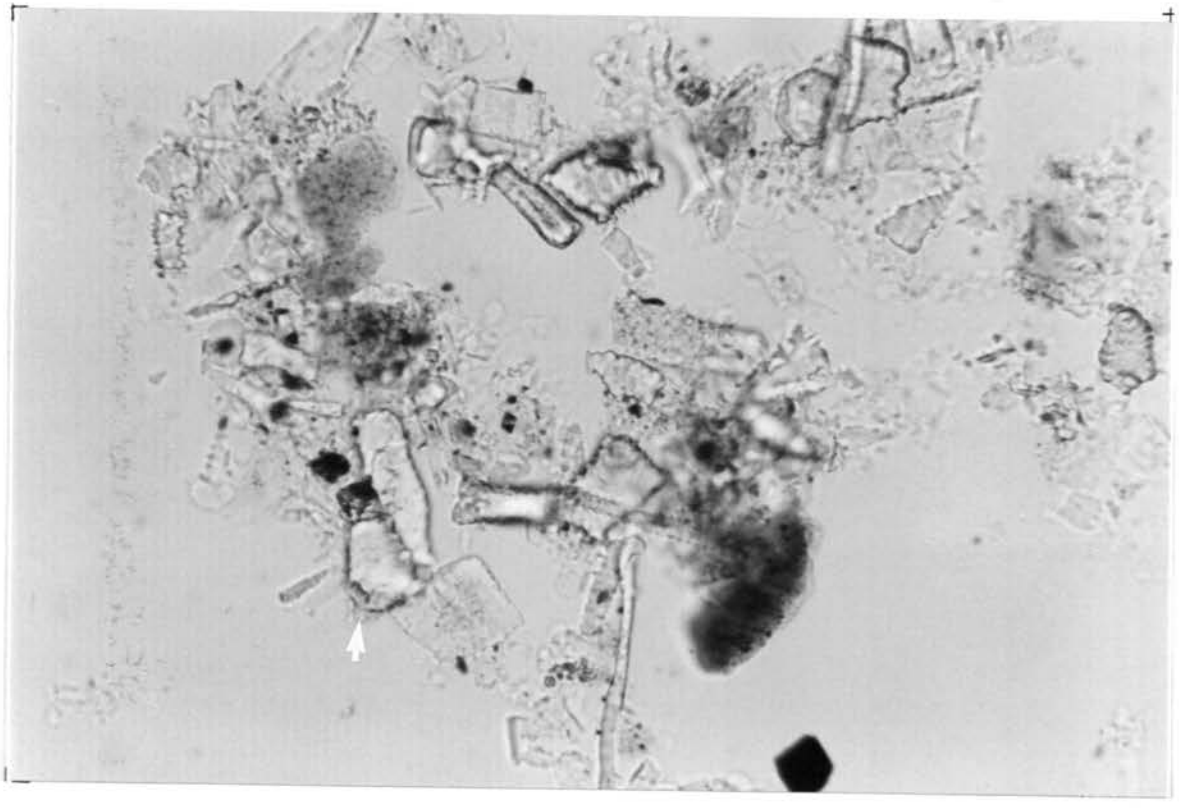
Photographs taken of petrologial slides.

A-B MU 50543: *A. triptera*. Pilliga State Forests. Most of the plant opal is highly ridged, including rods (arrow in A) and 3D sheets. PPL.

A

0 µm 100

B



0 µm 100

PLATE · 26

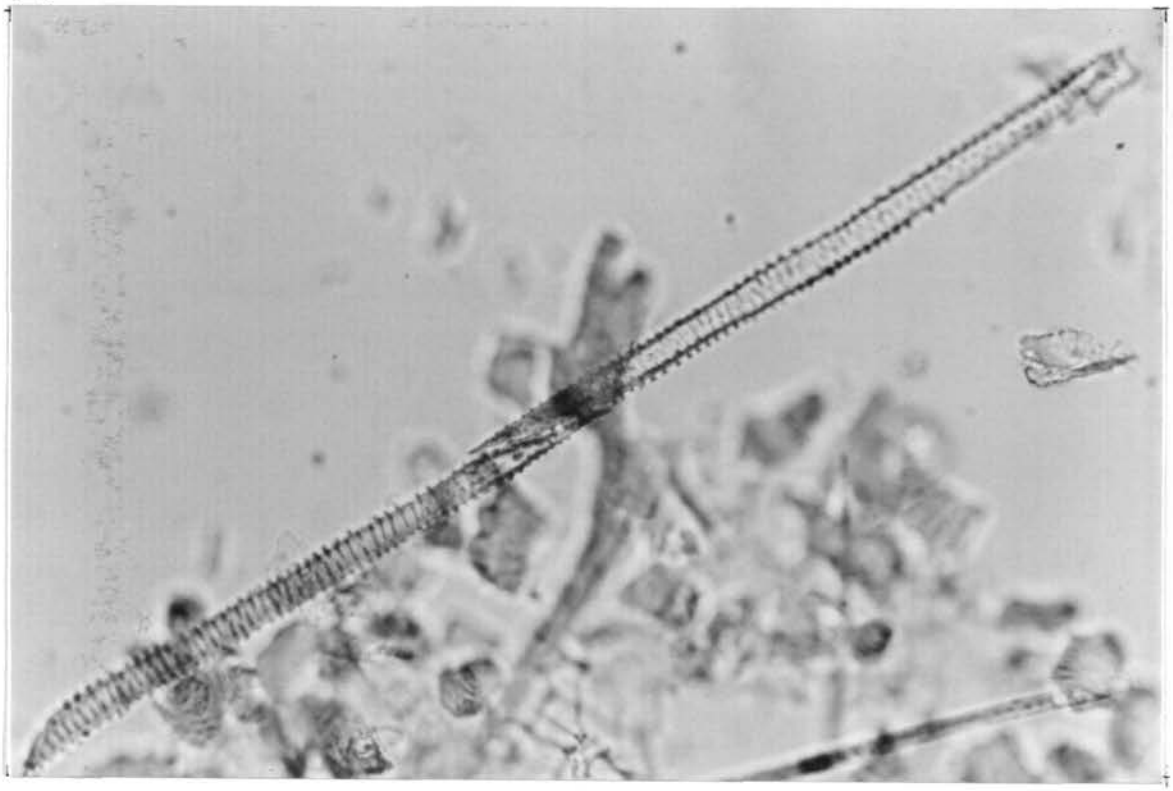
Plate 27

Photographs taken of petrological slides.

A MU 50538: *A. calamifolia.* Pilliga State Forests. Many very long ridged rods in this species. PPL.

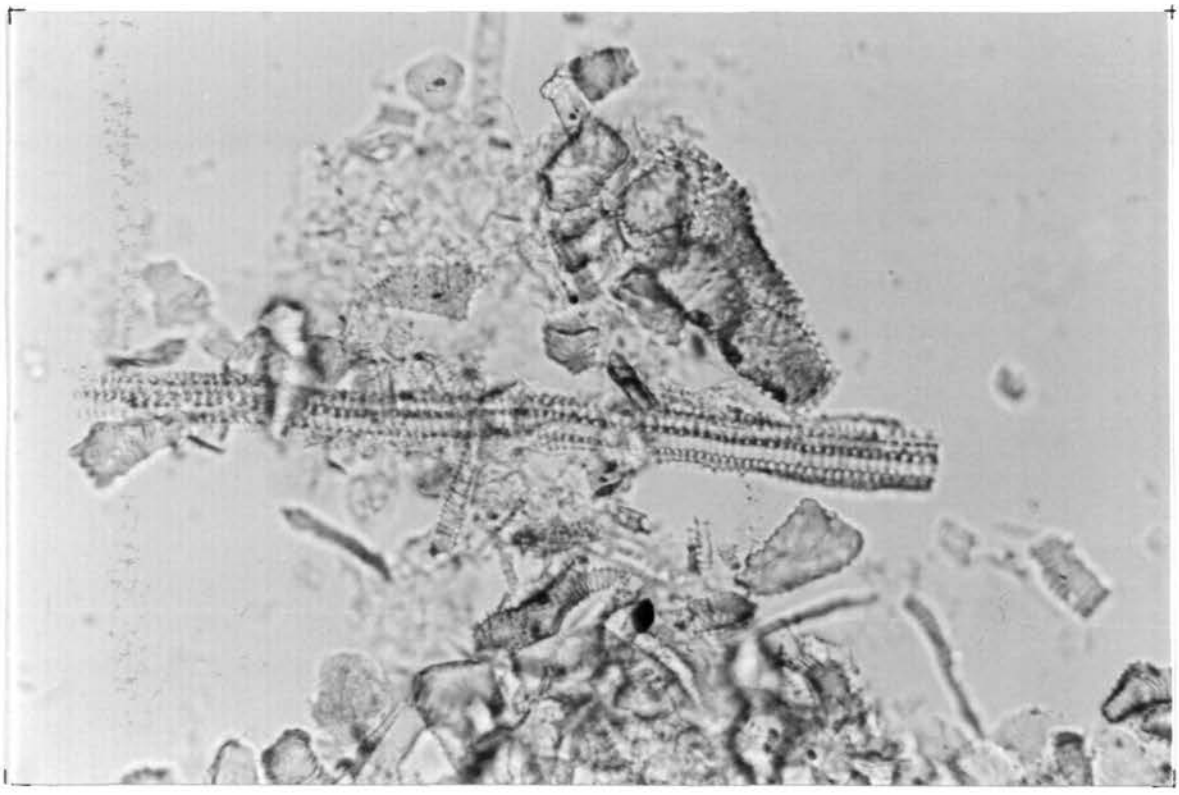
B MU 50538: *A. calamifolia.* Pilliga State Forests. Sheets are also heavily ornamented. PPL.

A



0 µm 100

B



0 µm 100

PLATE 27

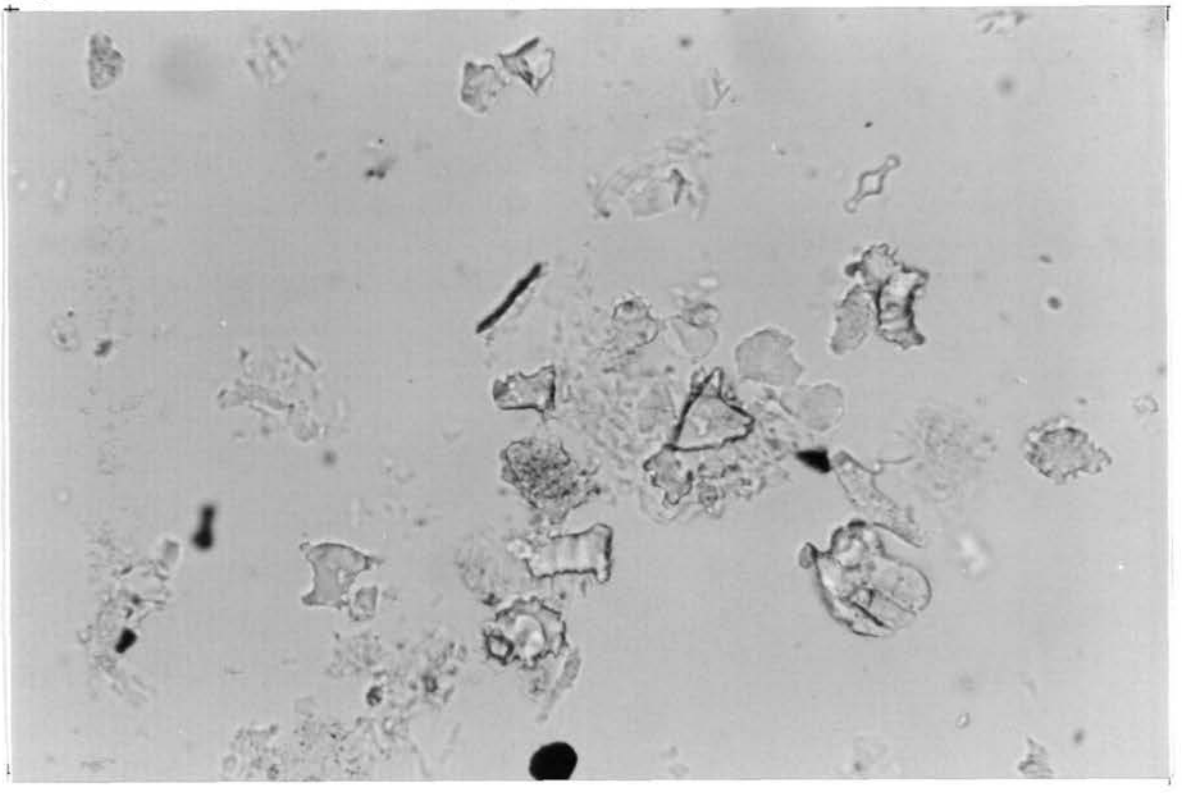
Plate 28

Photographs taken of petrological slides.

A MU 50537: *A. burrowii.* Pilliga State Forests. Plant opal comprises many ridged 3D sheets. PPL.

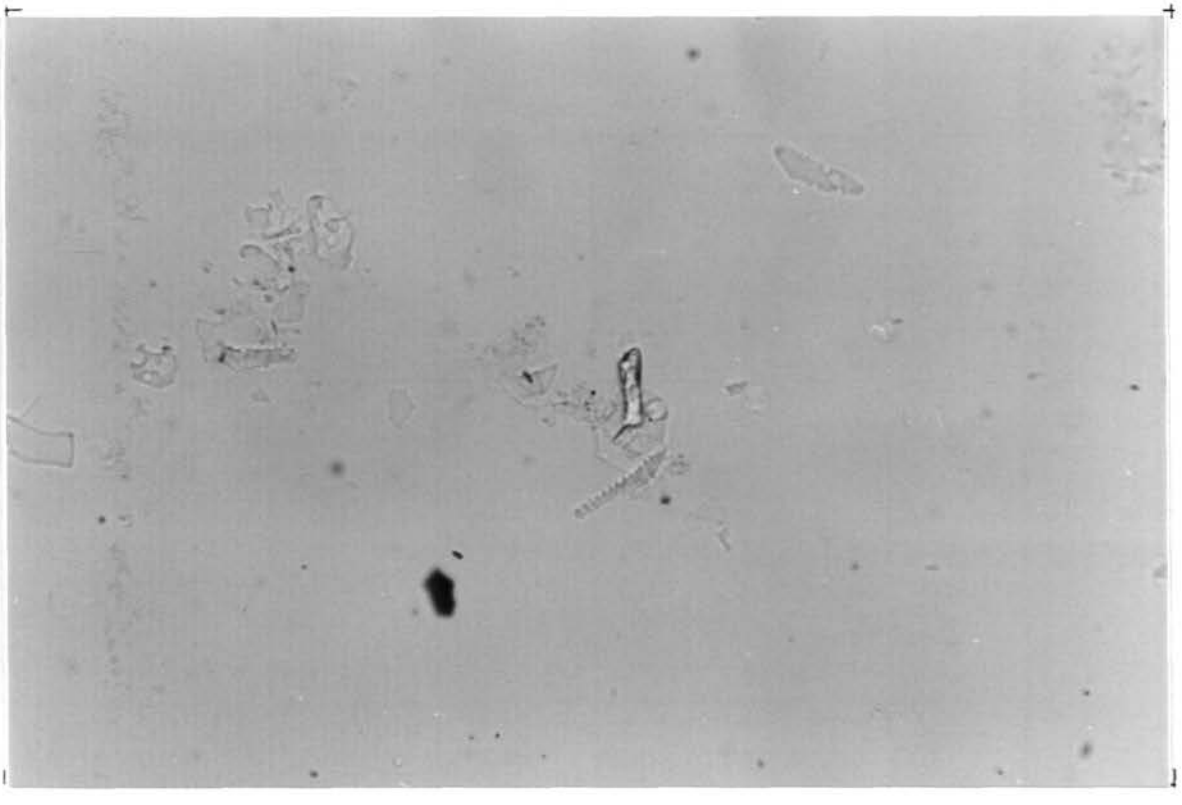
B MU 50541: *A. deanei* ssp *deanei.* Pilliga State Forests. Ridged rods are common in this species. PPL.

A



0 µm 100

B



0 µm 100

PLATE 28

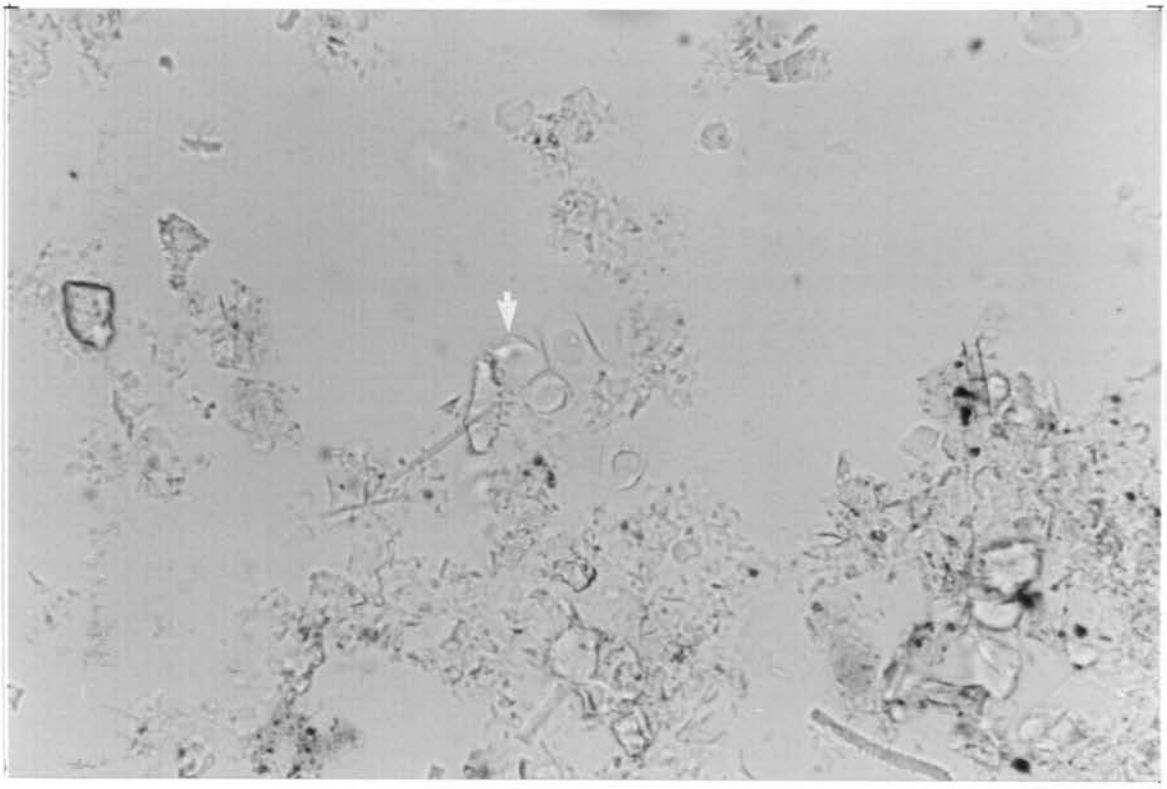
Plate 29

Photographs taken of petrological slides.

A *MU 50539: A. spectabilis.* Pilliga State Forests. A few ridged sheets and rods. Note the bulbous "cyperaceae-type" phytoliths (arrow), beside ridged material. PPL.

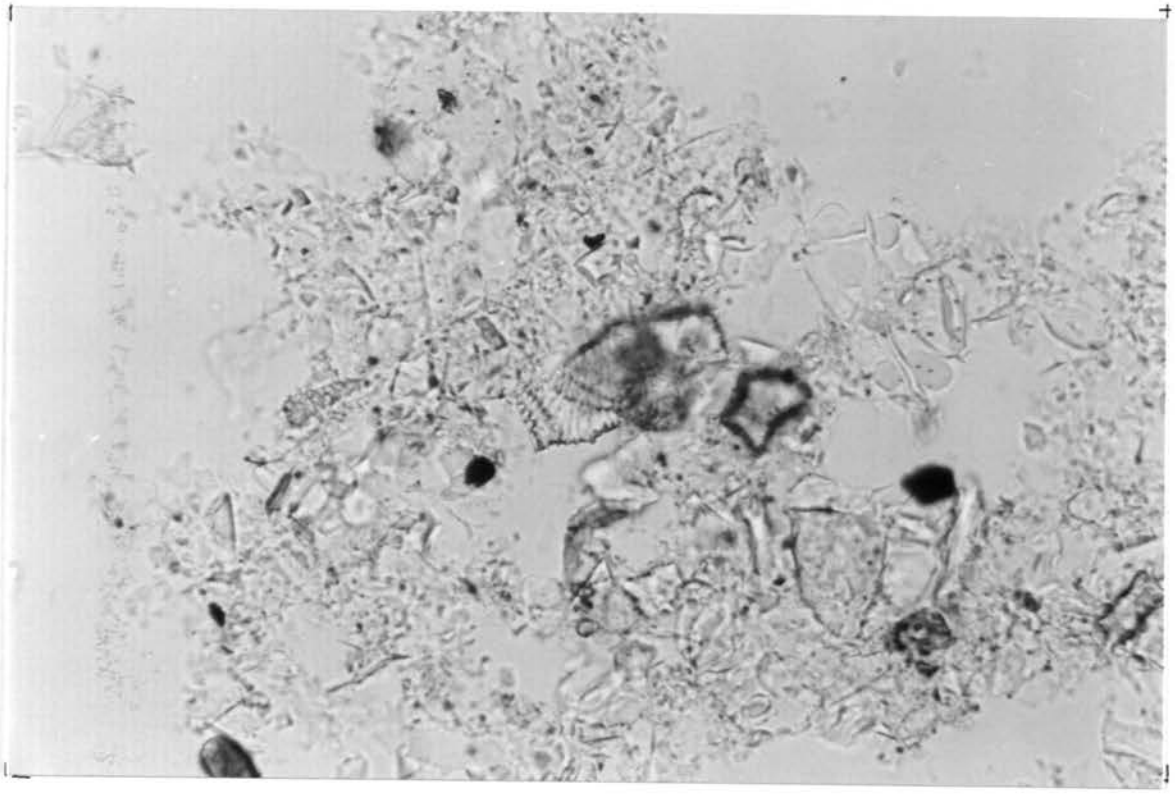
B MU 50539: *A. spectabilis.* Pilliga State Forests. Both smooth and ridged 3D sheets. PPL.

A



0 µm 100

B



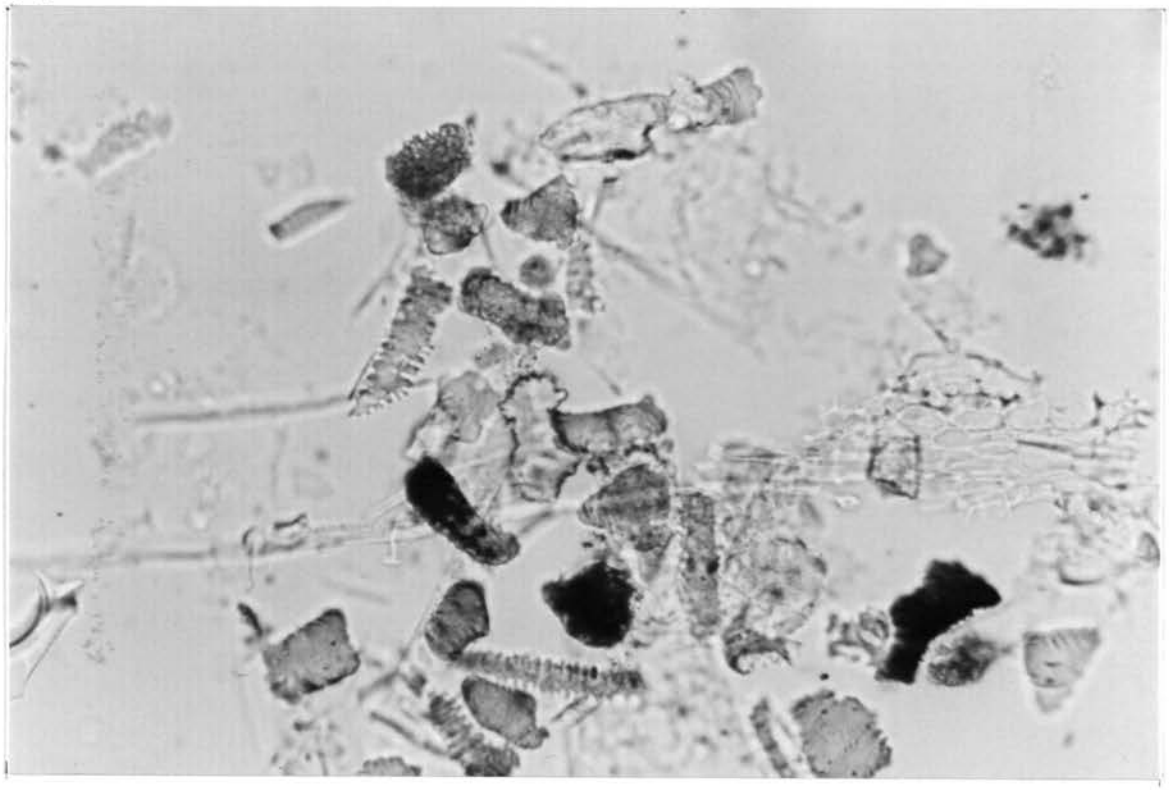
0 µm 100

PLATE 29

Plate 30

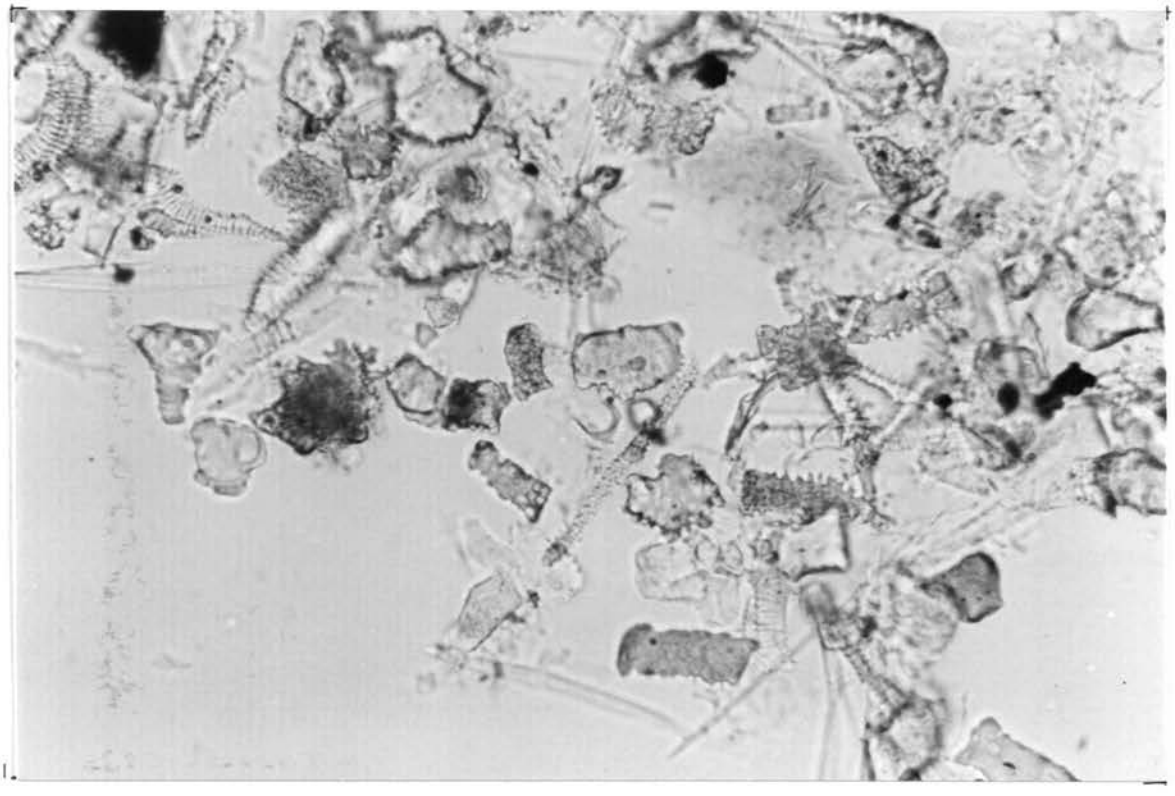
A-B MU 50540: *A. dorotoxylon*. Pilliga State Forests. Photographs show the large number of ridged sheet and rods in this species. PPL.

A



0 µm 100

B



0 µm 100

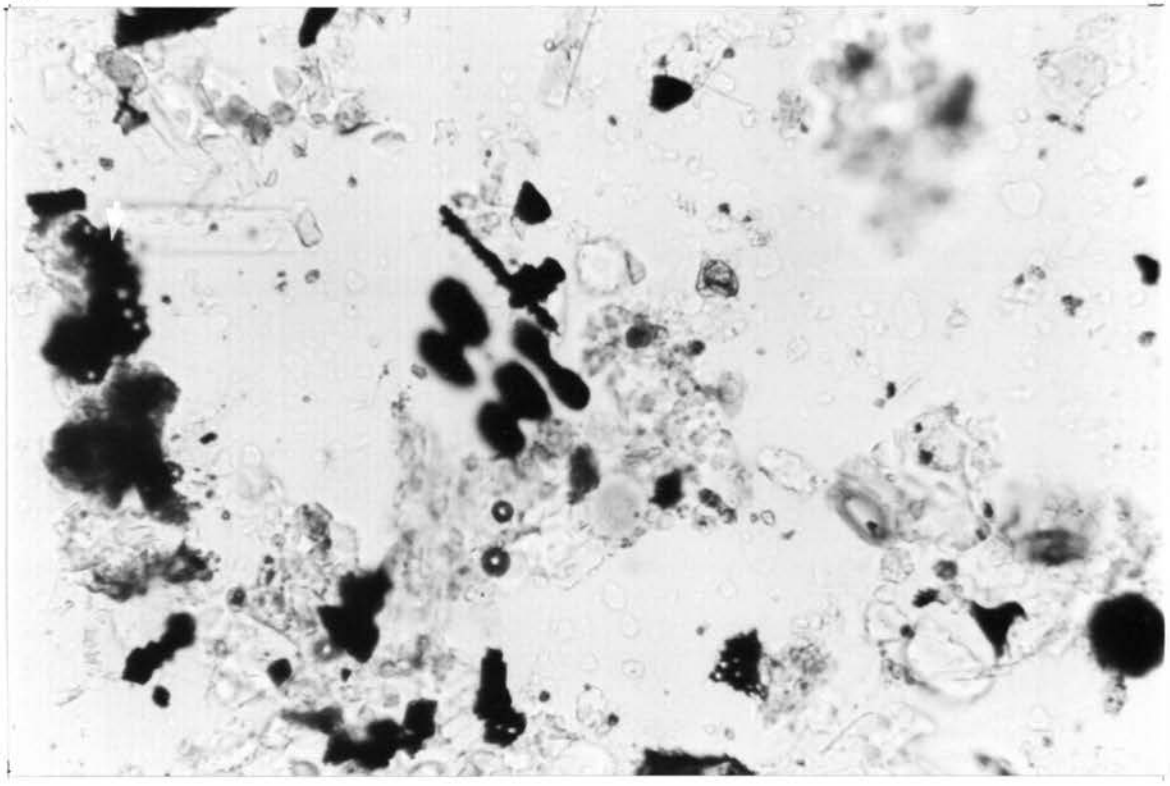
PLATE 30

Plate 31

A MU 50591: Plant opal from the topsoil, 0 - 50mm, Ecology Reserve site 1. Sample E1. A large amount of opal coated with charcoal is present (arrow, LHS of photograph), as well as opal containing occluded material and appearing darker. PPL.

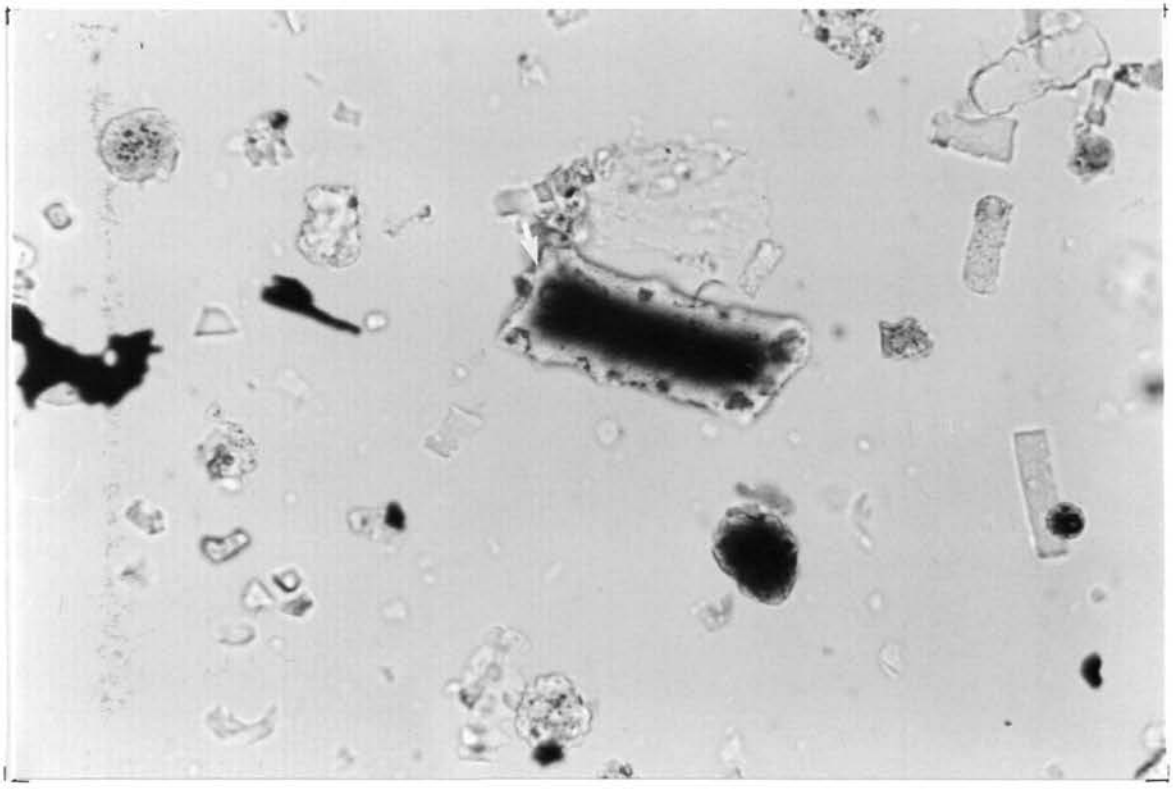
B MU 50593: Plant opal from the topsoil, 0 - 50mm, Ecology Reserve, site 2. Sample E3. Some charcoal coated plant opal, but the majority of darker pieces contain occluded elements (arrow). PPL.

A



0 µm 100

B



0 µm 100

PLATE 31

Plate 32

A MU 50626: Plant opal separated at a Specific Gravity of 1.7. This comprises large pieces of charcoal within which can be seen plant opal (arrow). PPL.

B MU 50626: Plant opal separated at a Specific Gravity of 1.7. A rod coated in charcoal (arrow). PPL.

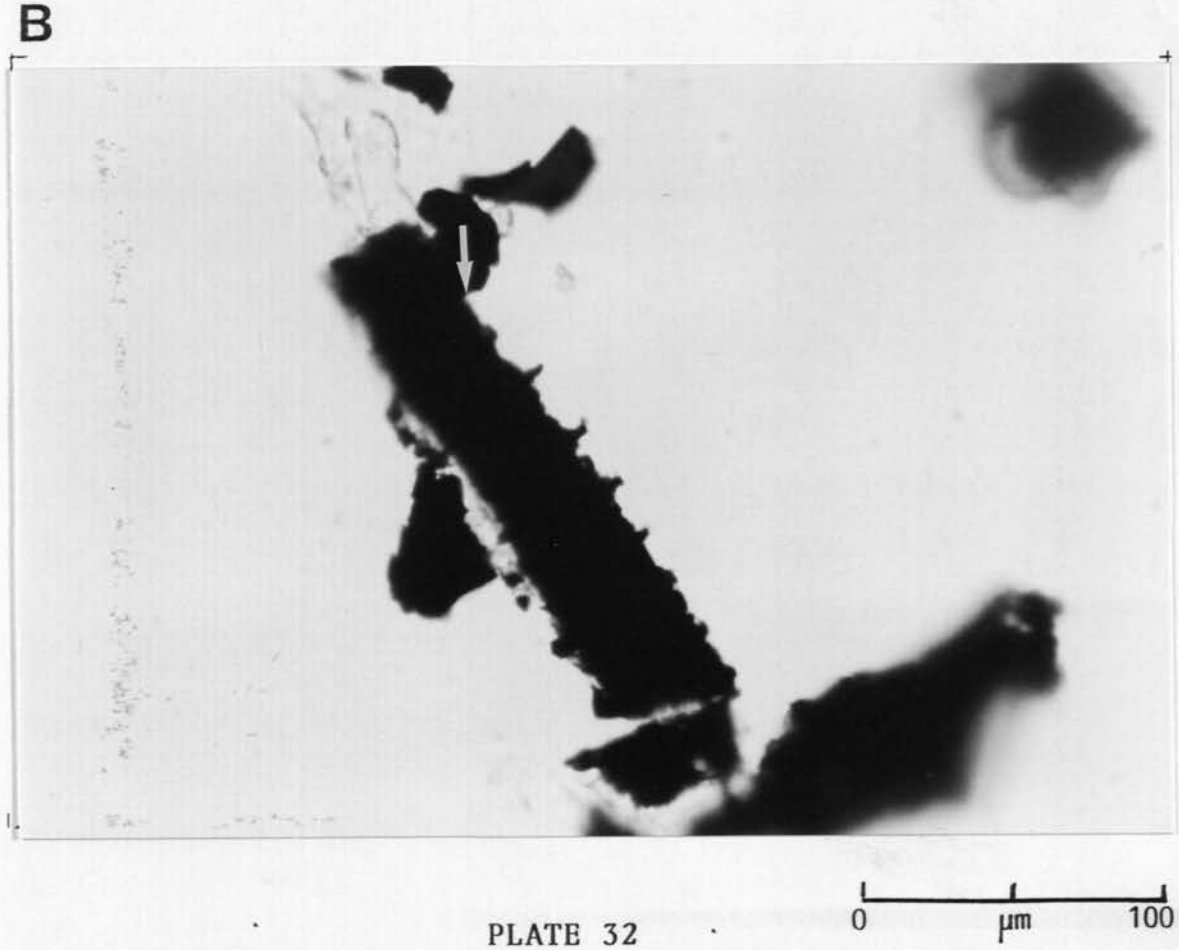


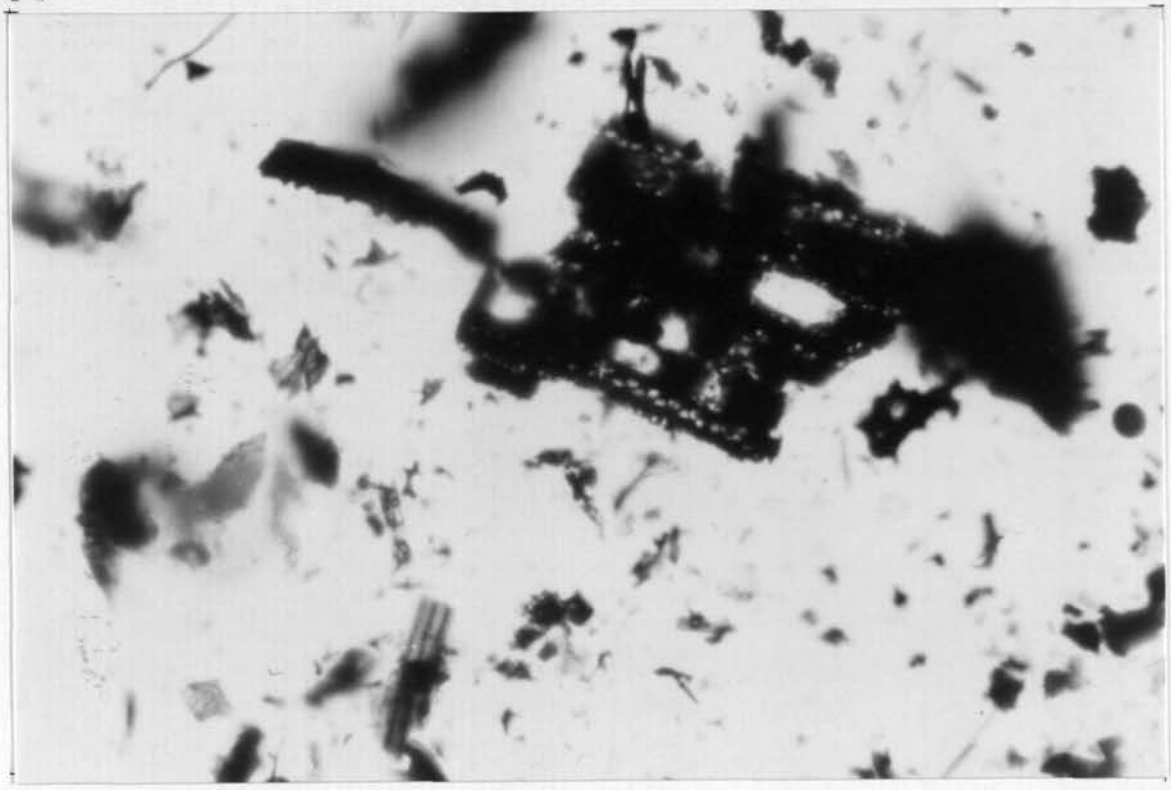
PLATE 32

Plate 33

A MU 50627: Ash from the Ecology Reserve fire. This material has not been treated in any way. It comprises much exposed plant opal, and a great amount of plant opal still encased in charcoal. PPL.

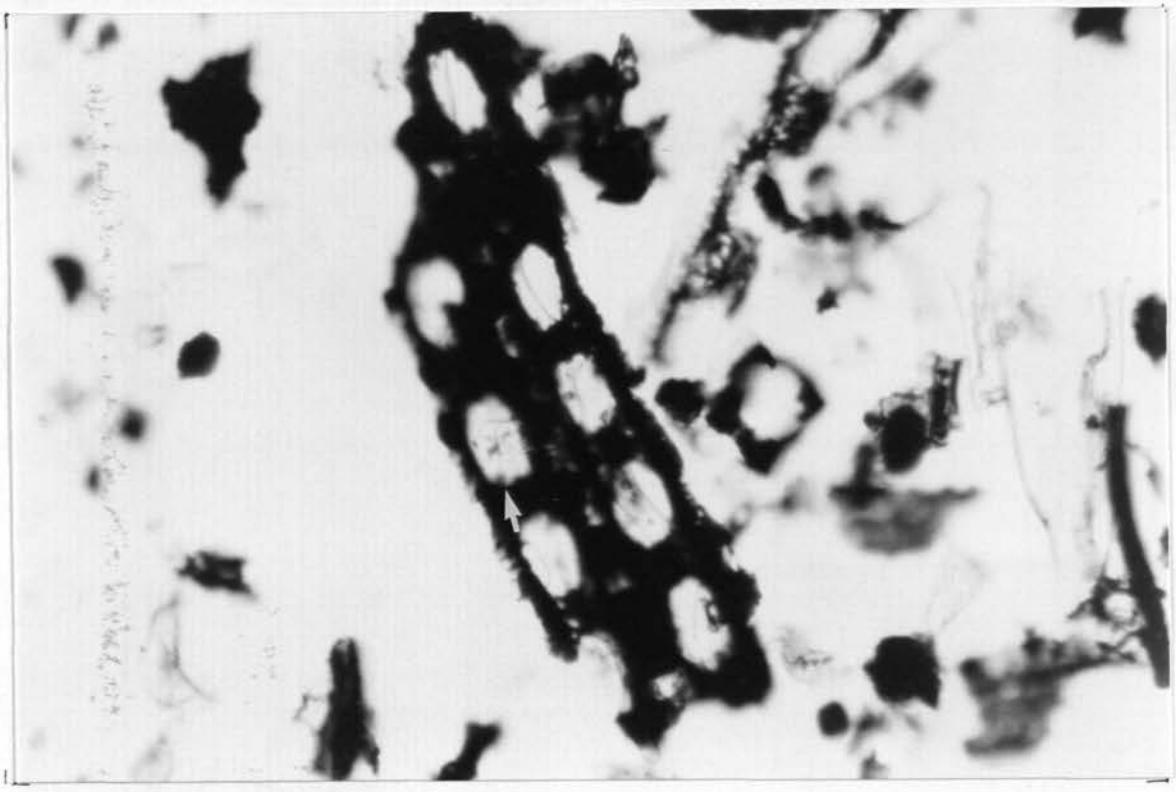
B MU 50628: Material from the Ecology Reserve fire. In this case an attempt has been made to separate the ash from the plant opal, with very little success. Note the large multicelled plate containing silicified stomata, some of which have been exposed (arrow). PPL.

A



0 µm 100

B



0 µm 100

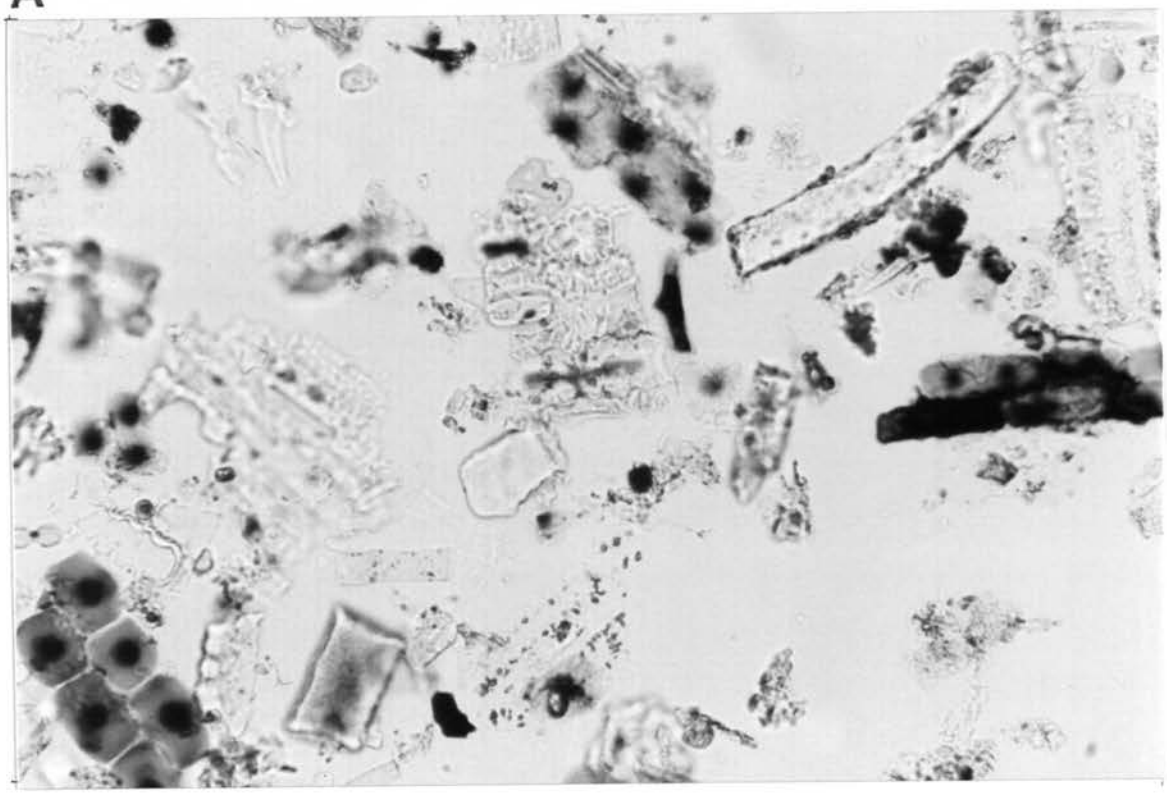
PLATE 33

Plate 34

A MU 50617: Ash from the Ecology Reserve fire which has been heated in a muffle oven to remove most of the charcoal. Despite this, a little charcoal remains, and the platey material in particular is very dark. It appears that the carbon is either fused to the silica surface, or the opal is more able to incorporate carbon during a fire. It is noticable that this darker material is removed rapidly after the fire. Note the large amount of big, multicelled sheets present (arrow). Ash from the day 2 sample: sample 2a. PPL.

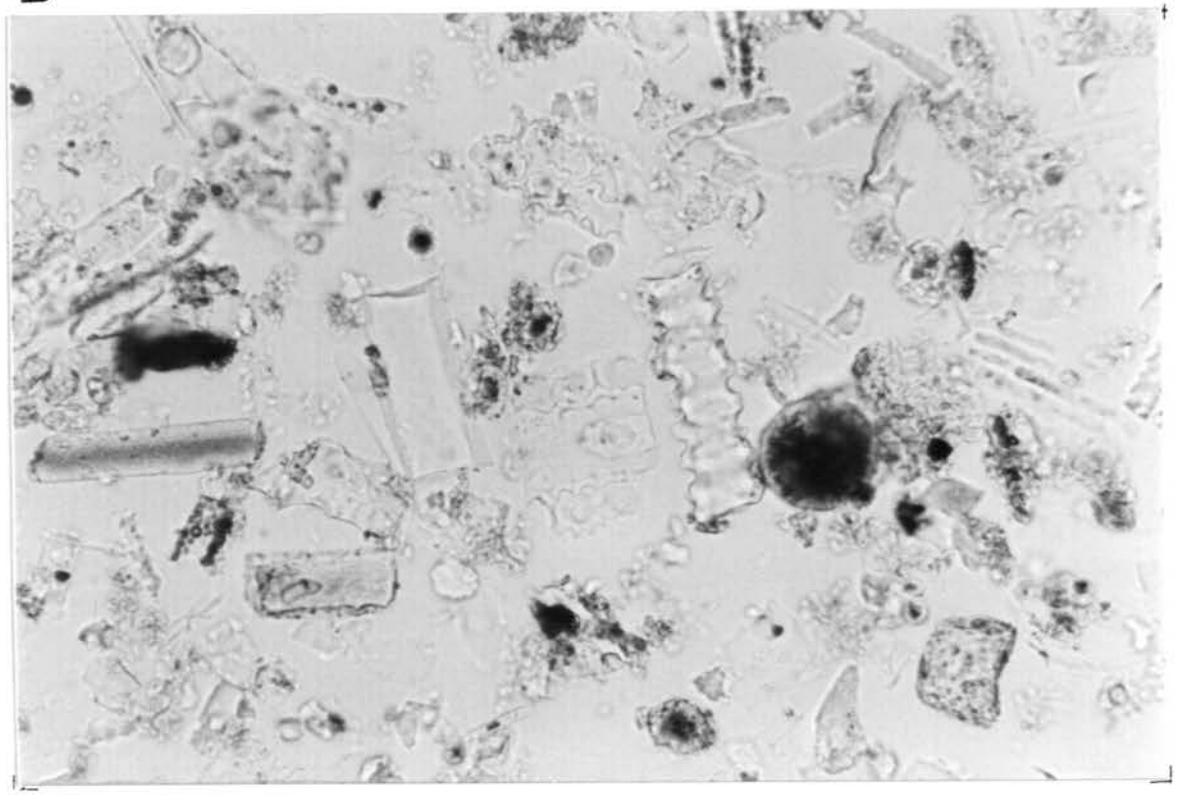
B MU 50618: This material is from the day 14 sample (sample 5a). It has been heated and separated from sediment. There are fewer dark pieces of plant opal, and very little charcoal encased opal remaining. The platey, multicelled material is also less and smaller. PPL.

A



0 µm 100

B



0 µm 100

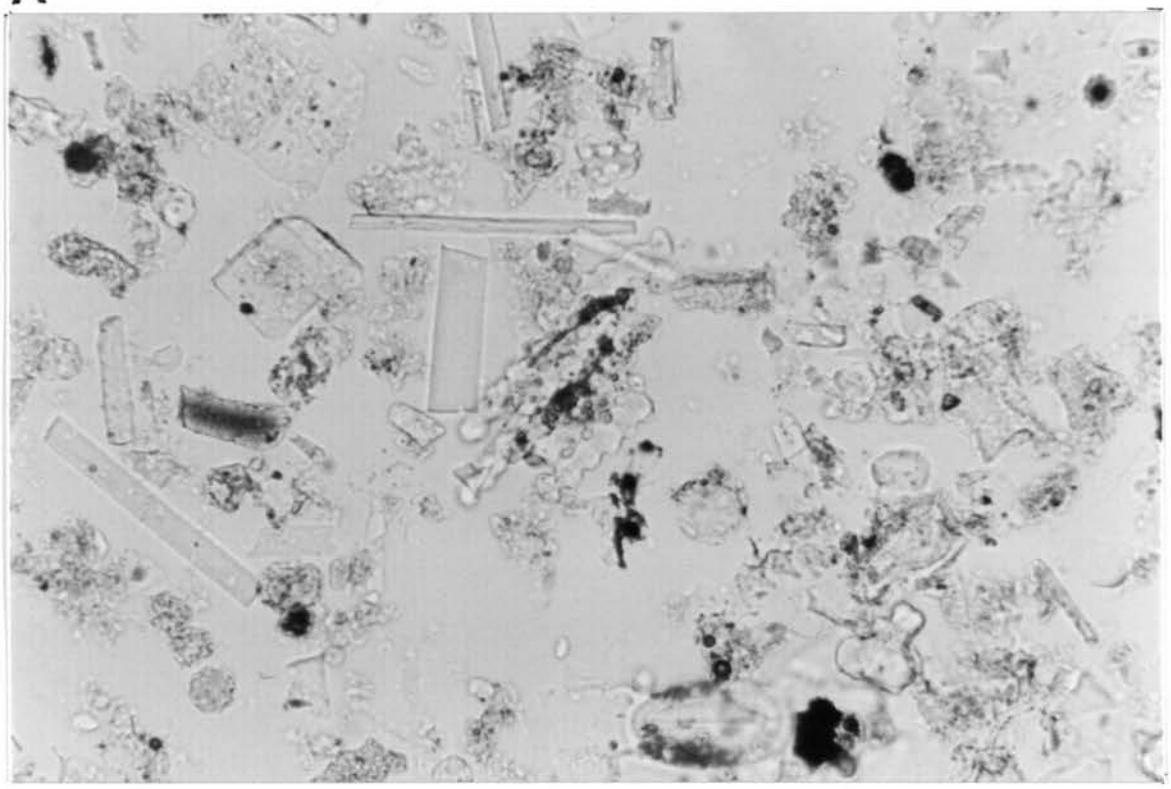
PLATE 34

Plate 35

A MU 50618: Ecology Reserve fire. This material is from the day 14 sample (sample 5a). It has been heated and separated from sediment. Again it shows fewer dark pieces of plant opal and very little charcoal encased opal or multicelled material. PPL.

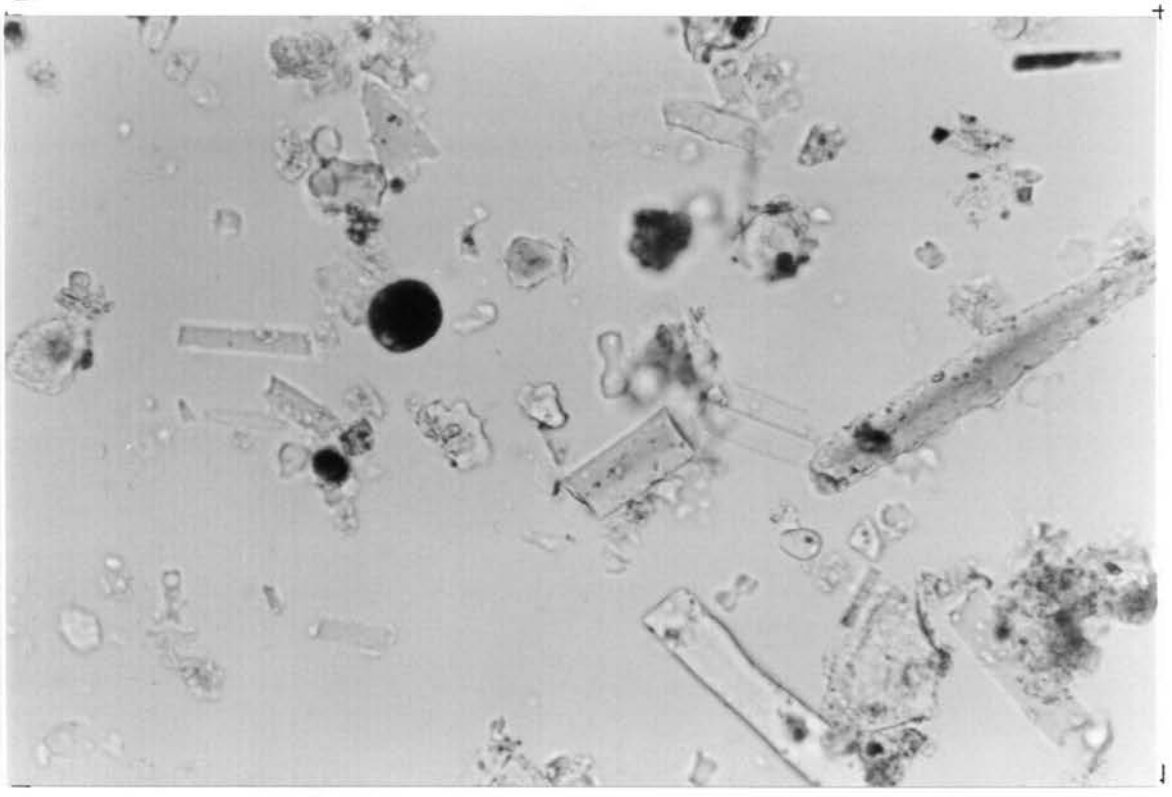
B MU 50619: Material from the day 30 sample (sample 8a). Mainly composed of more robust morphologies. Very little charcoal remains in the sample, and very few multicelled sheets. PPL.

A



0 µm 100

B



0 µm 100

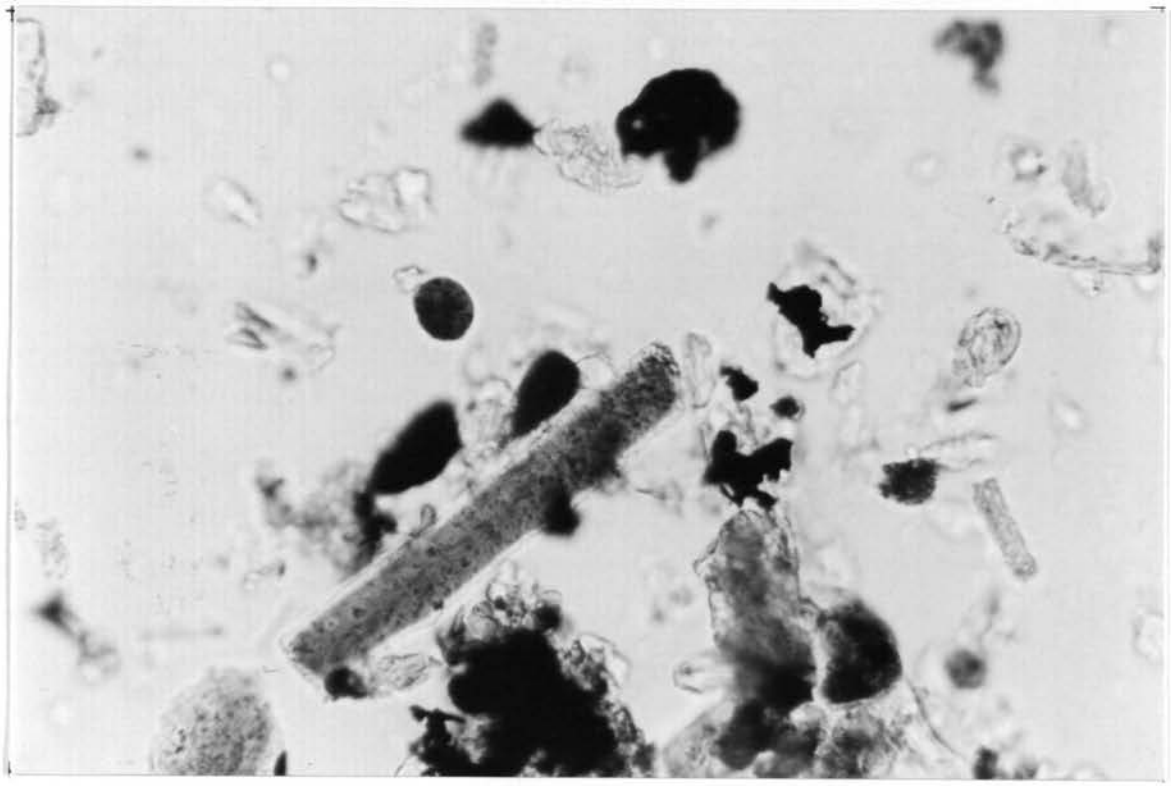
PLATE 35

Plate 36

A MU 50595: Ecology Reserve, Site ER3, 0 - 100 mm. This is a site on the creek bank. There is a large amount of charcoal and charcoal encased plant opal in this sample, as well as dark opal with occluded material in it. PPL.

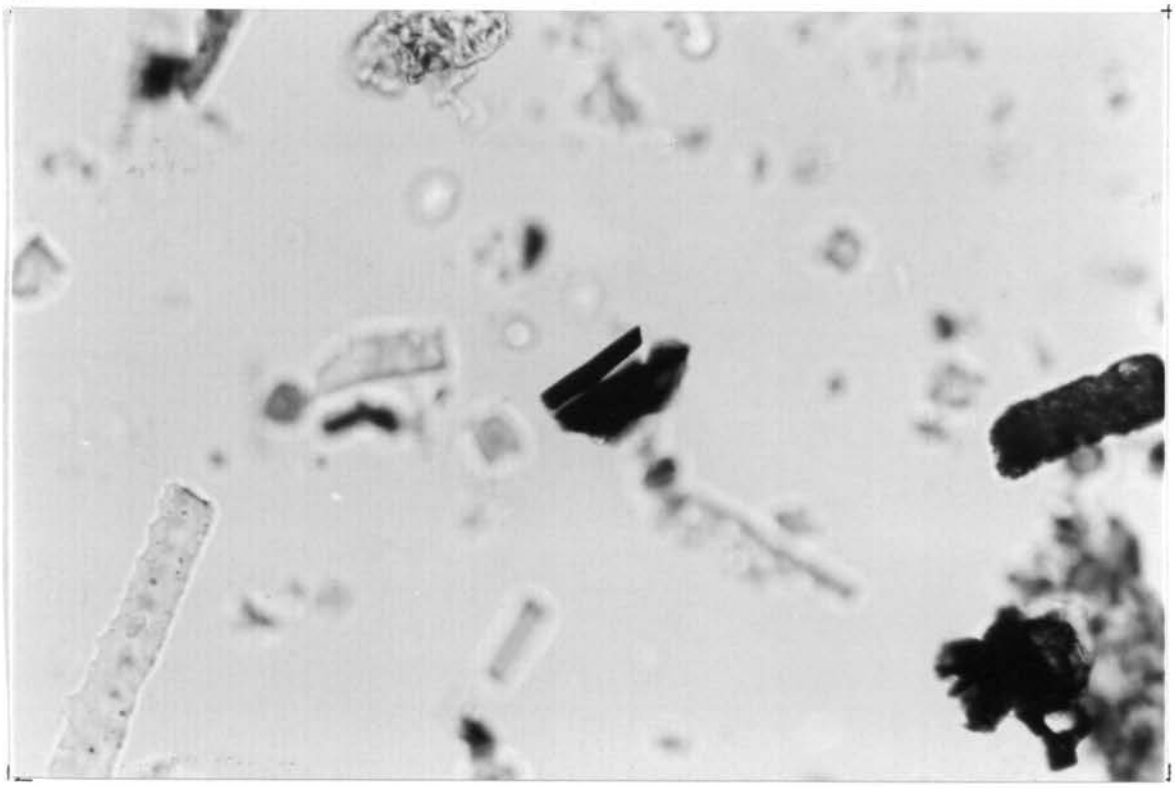
B MU 50598: Ecology Reserve, Site ER3, 1000 mm+. The charcoal in this soil profile is still very evident at this depth and beyond. PPL.

A



0 µm 100

B



0 µm 100

PLATE 36

Plate 37

A MU 50624: Diatoms from the Chalk Mountain deposit. These are quite distinctive, and do not appear in the soil in the field sites. PPL.

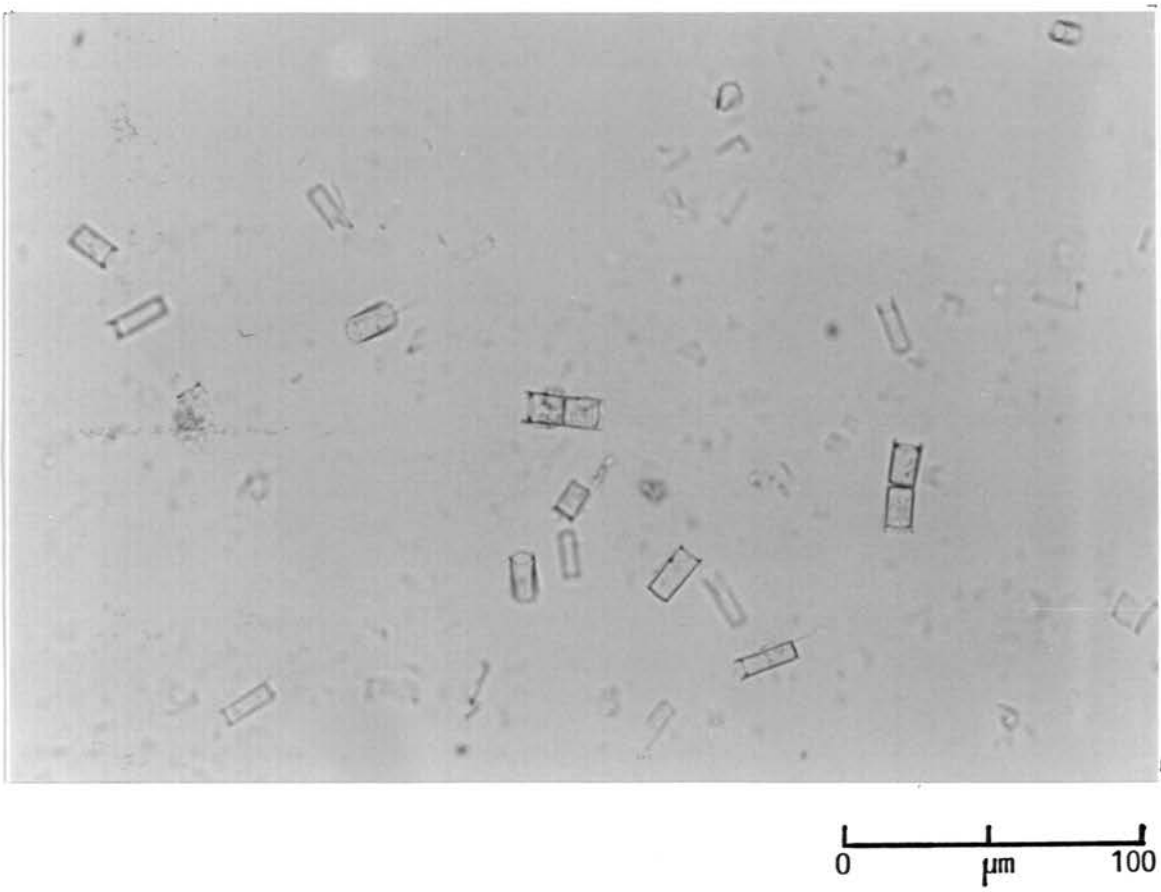


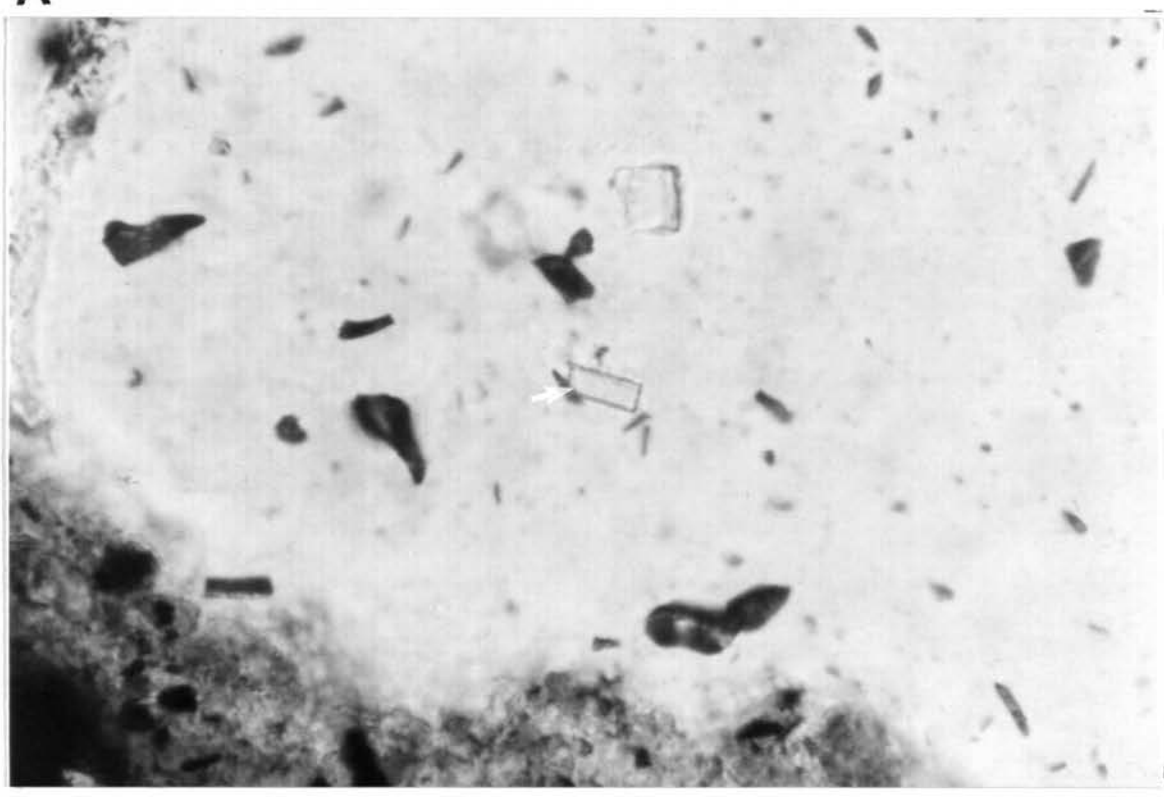
PLATE 37

Plate 38

A MU 50625: Photograph of thin section of soil 0 - 70 mm, Site 8. This sample was removed undisturbed from the field, diatoms placed on the surface, and subjected to repeated wetting, ponding of water, and drying. The sample was solidified and sliced. Diatoms were present to the base of the sample. This photograph shows a diatom within a major void in the soil (arrow). PPL.

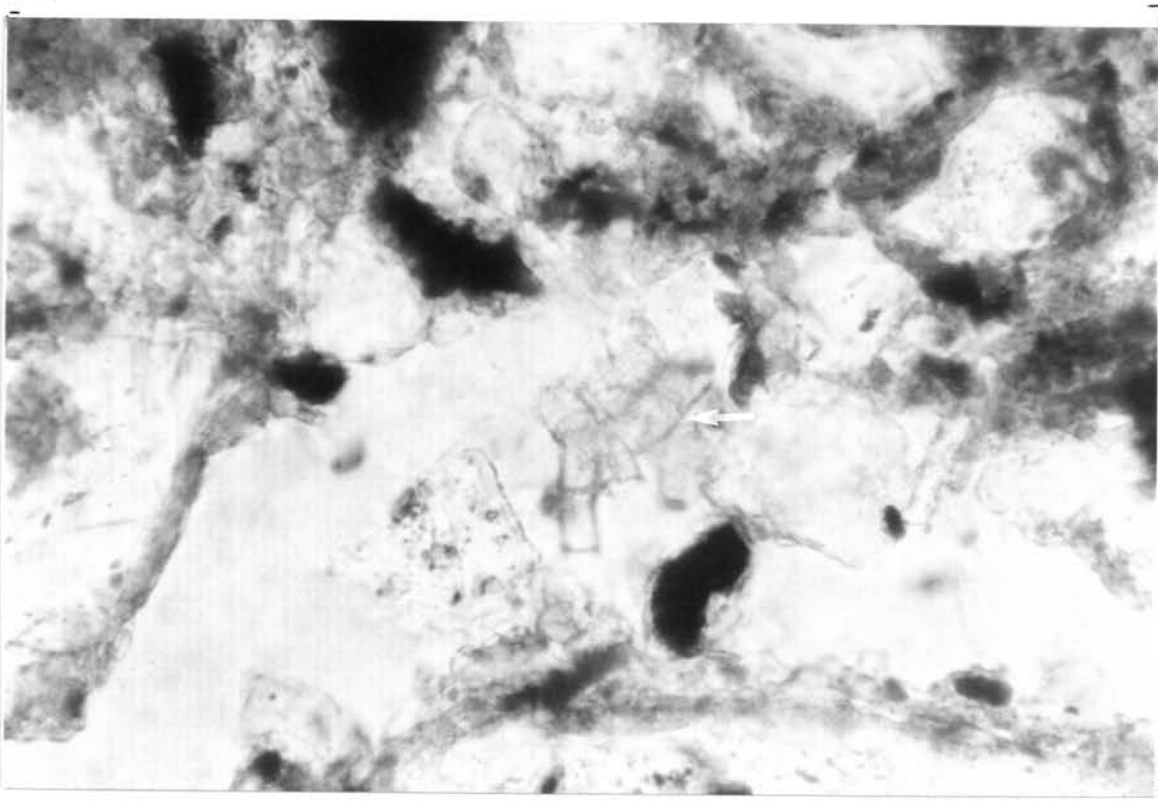
B MU 50625: As above. Here a group of the diatoms is caught in a void wall. It can be seen from this how such material would become incorporated into the soil. PPL.

A



0 μm 50

B



0 μm 50

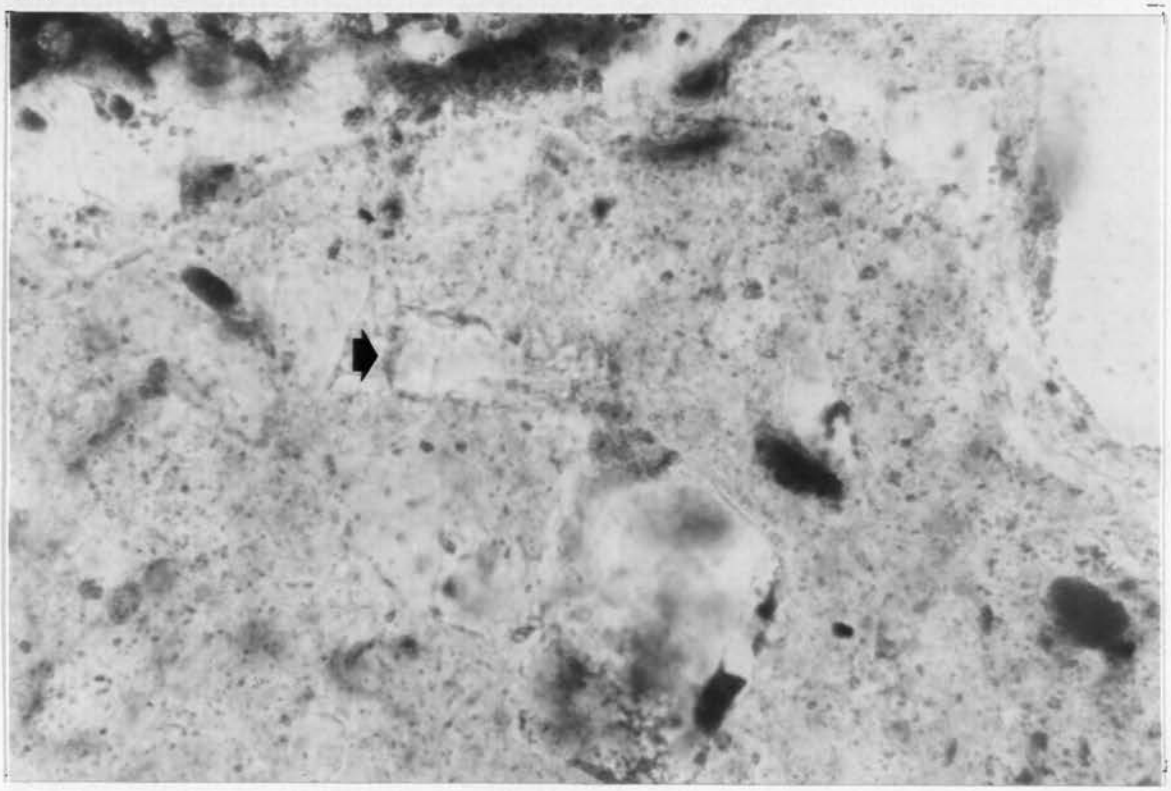
PLATE 38

Plate 39

A MU 50625: Same sample as in Plate 38. This photograph shows a piece of plant opal within the soil (arrow). PPL.

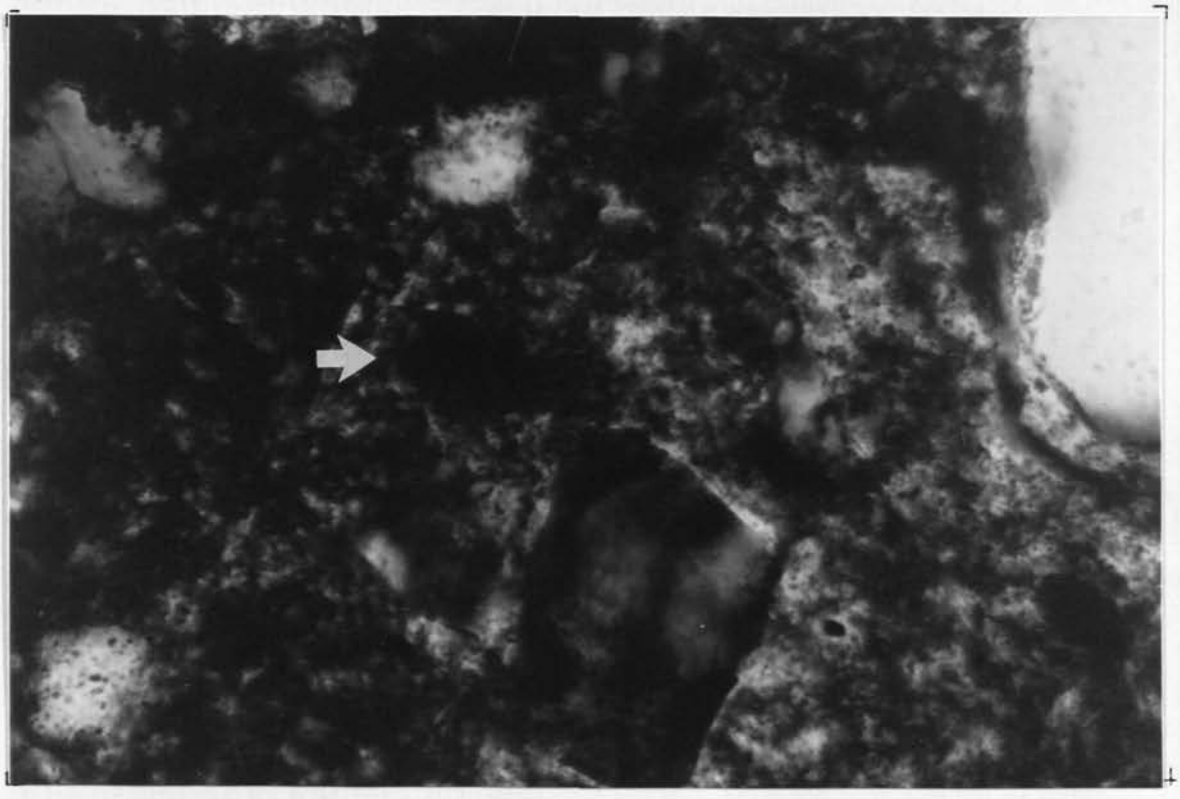
B MU 50625: As above, crossed polarised light [arow] (XPL). It is envisaged that plant opal could migrate through the soil in a similar manner to the diatoms.

A



0 µm 50

B



0 µm 50

PLATE 39

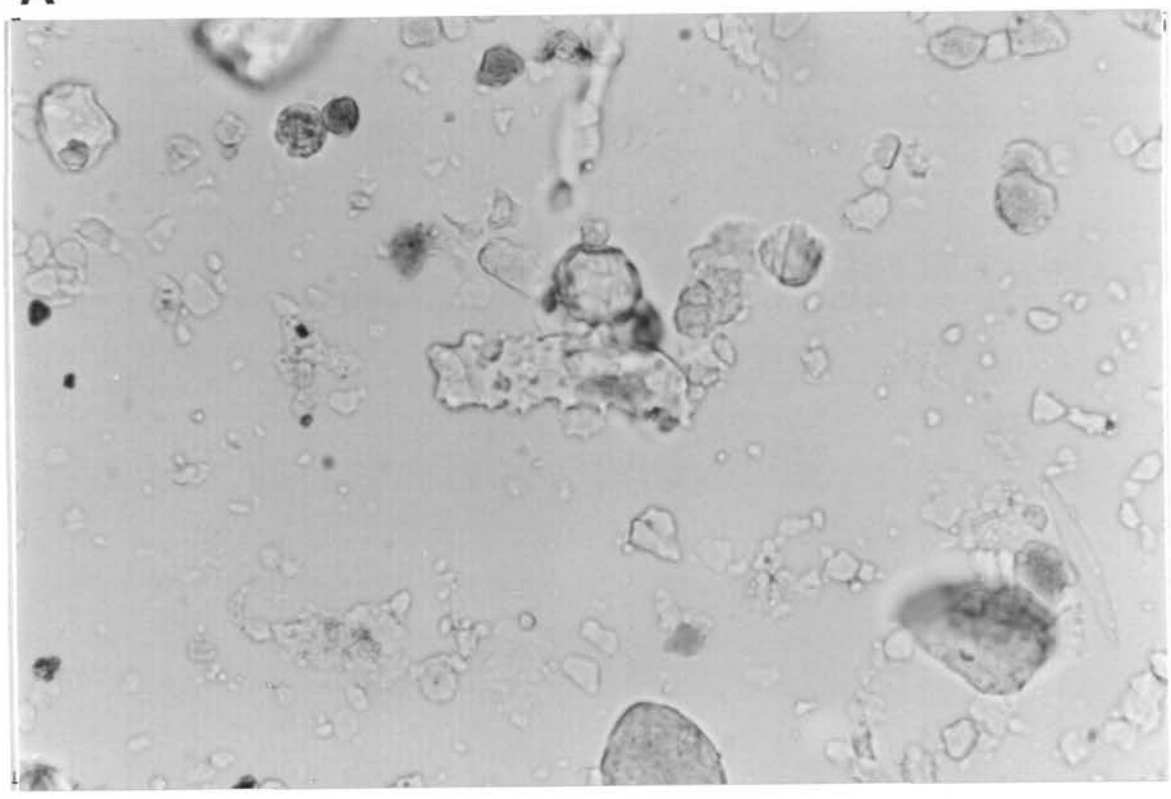
Plate 40

Photographs of plant opal separated from sediment Site 8, mallee, Pilliga State Forests.

A MU 50599: Plant opal from sheeting constructed above ground by termites. PPL.

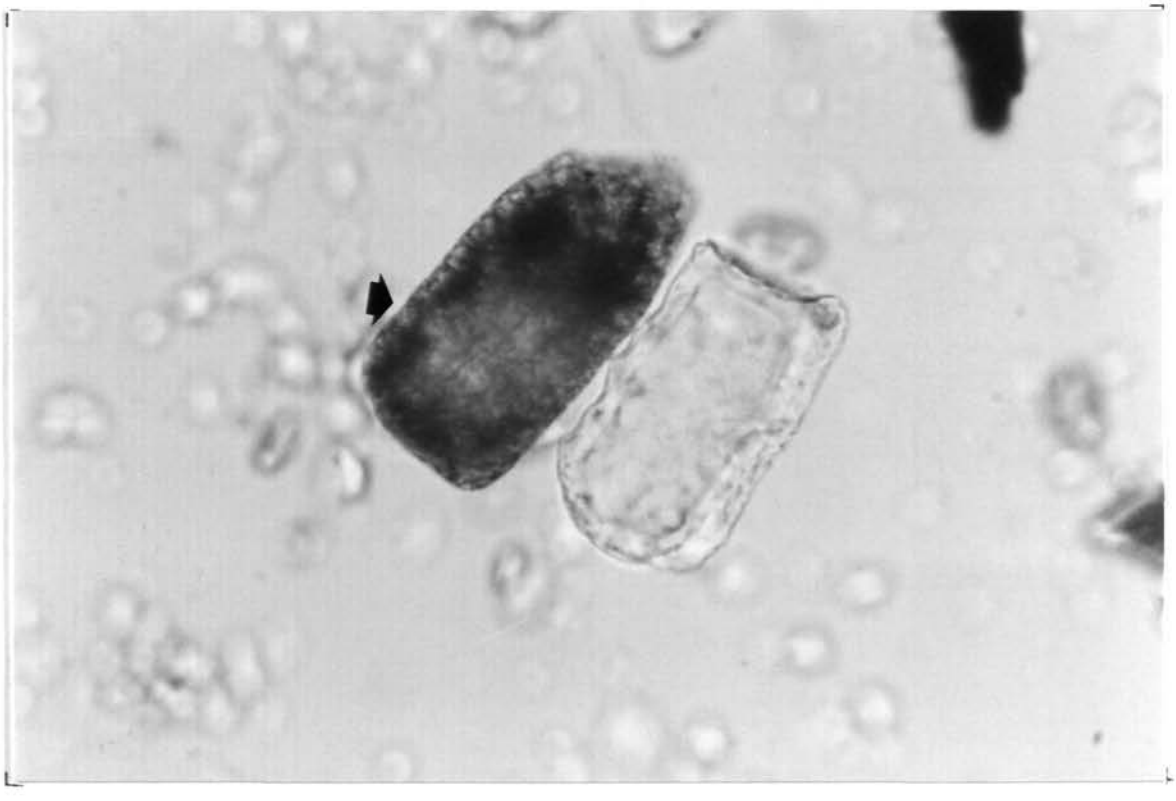
B MU 50599: As in A. Photograph shows 3D sheets, one of which has dark inclusions (arrow). PPL.

A



0 µm 50

B



0 µm 50

PLATE 40

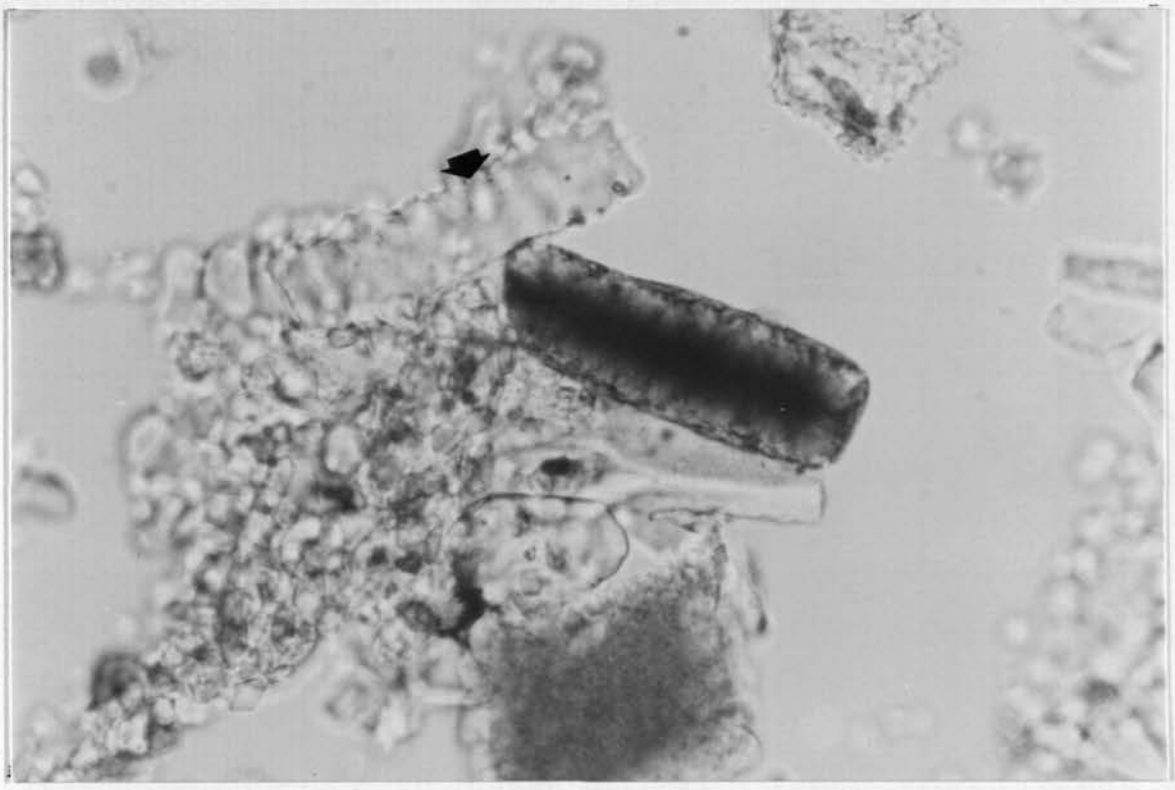
Plate 41

Photographs of plant opal separated from sediment Site 8, mallee, Pilliga State Forests.

A MU 50603: Plant opal from A horizon. Includes a ridged rod (arrow) and rod containing inclusions. PPL.

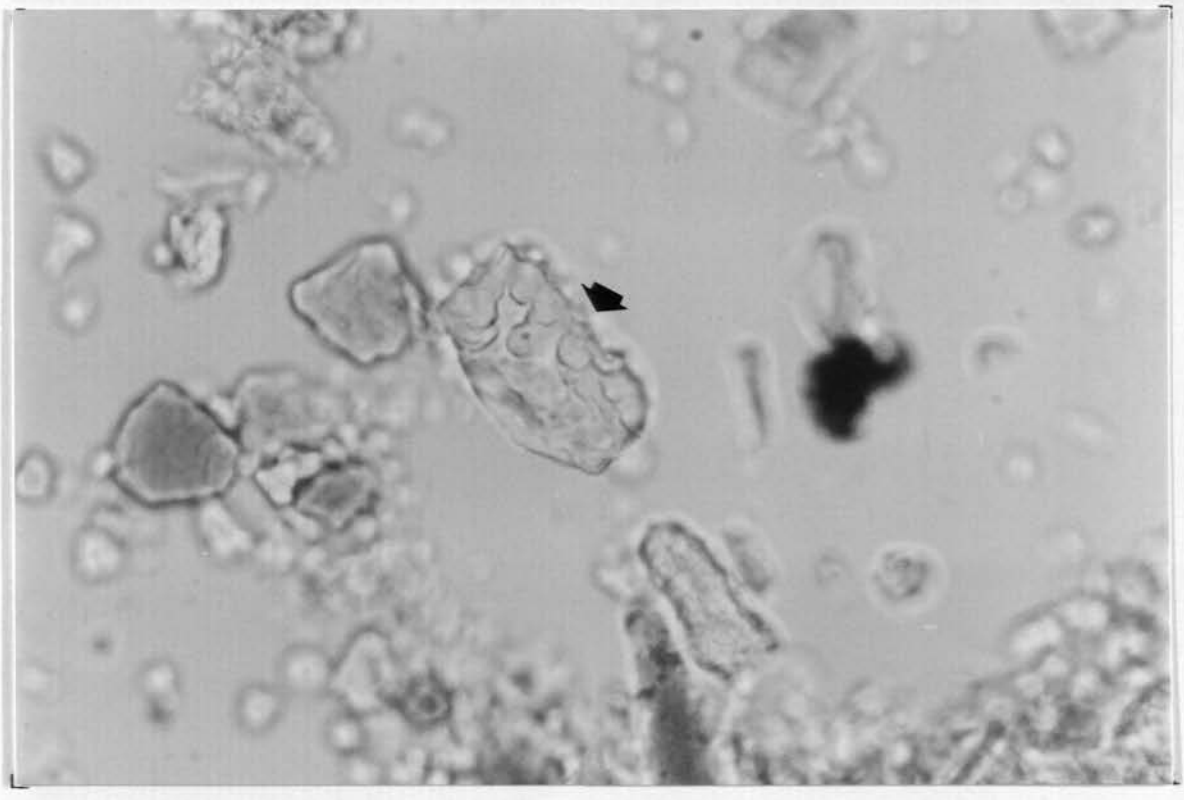
B MU 50603: Plant opal from A horizon. A pitted 3D rough sheet (arrow). PPL.

A



0 µm 50

B



0 µm 50

PLATE 41

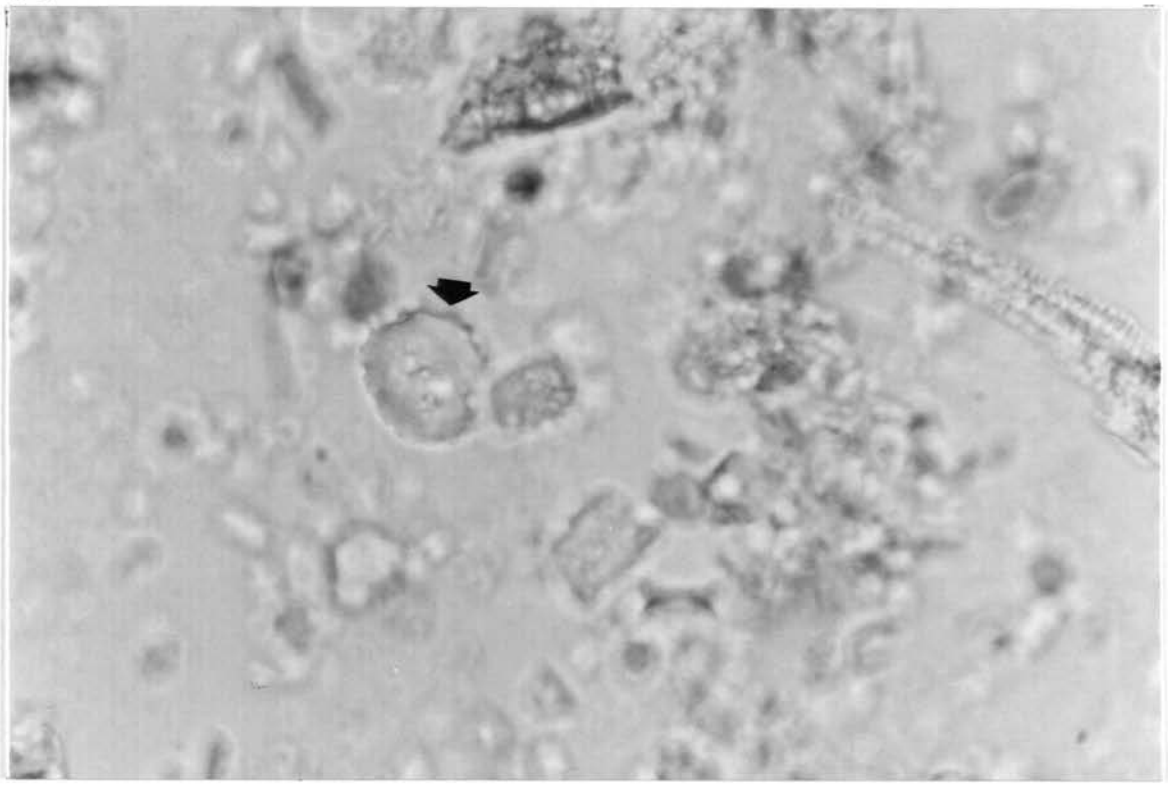
Plate 42

Photographs of plant opal separated from sediment Site 8, mallee, Pilliga State Forests.

A MU 50605: Plant opal from the domes (sample D1). Includes ridged rods and rough spheres (arrow). PPL.

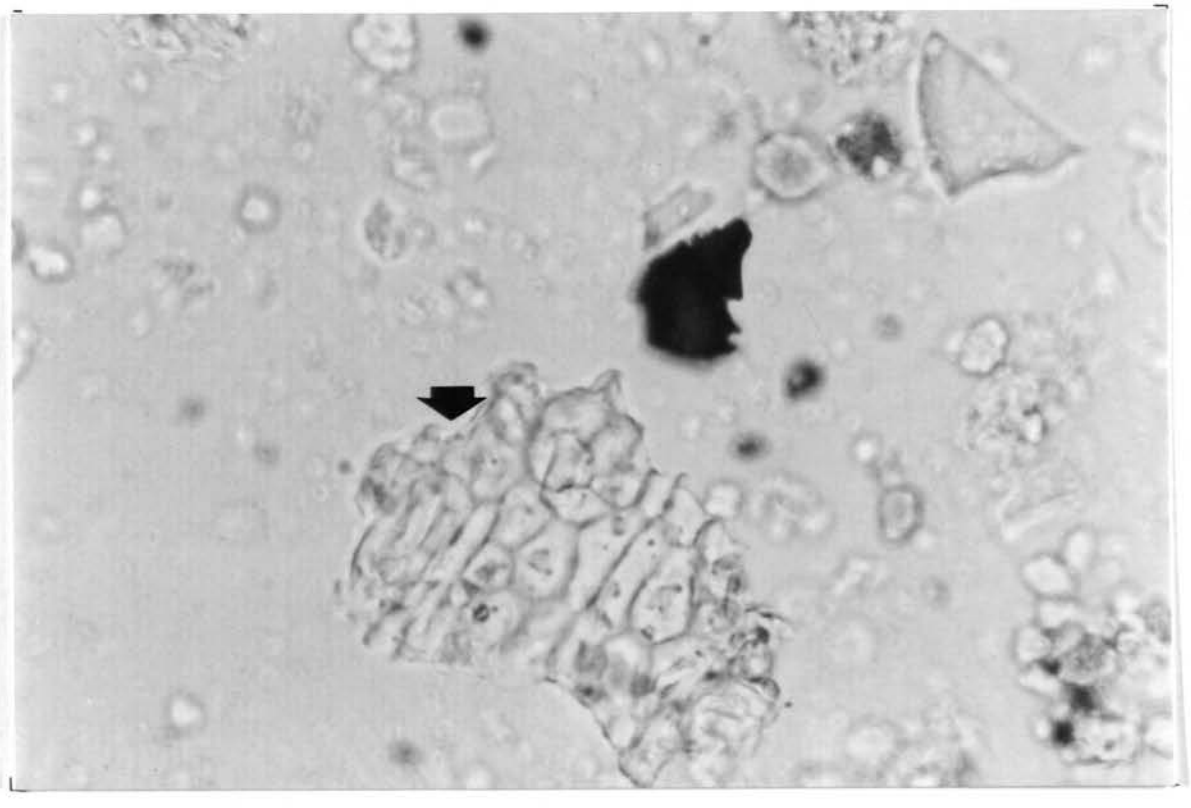
B MU 50607: Plant opal from faunal channels, B horizon sample (F1). A multicelled sheet (arrow). PPL.

A



0 µm 50

B



0 µm 50

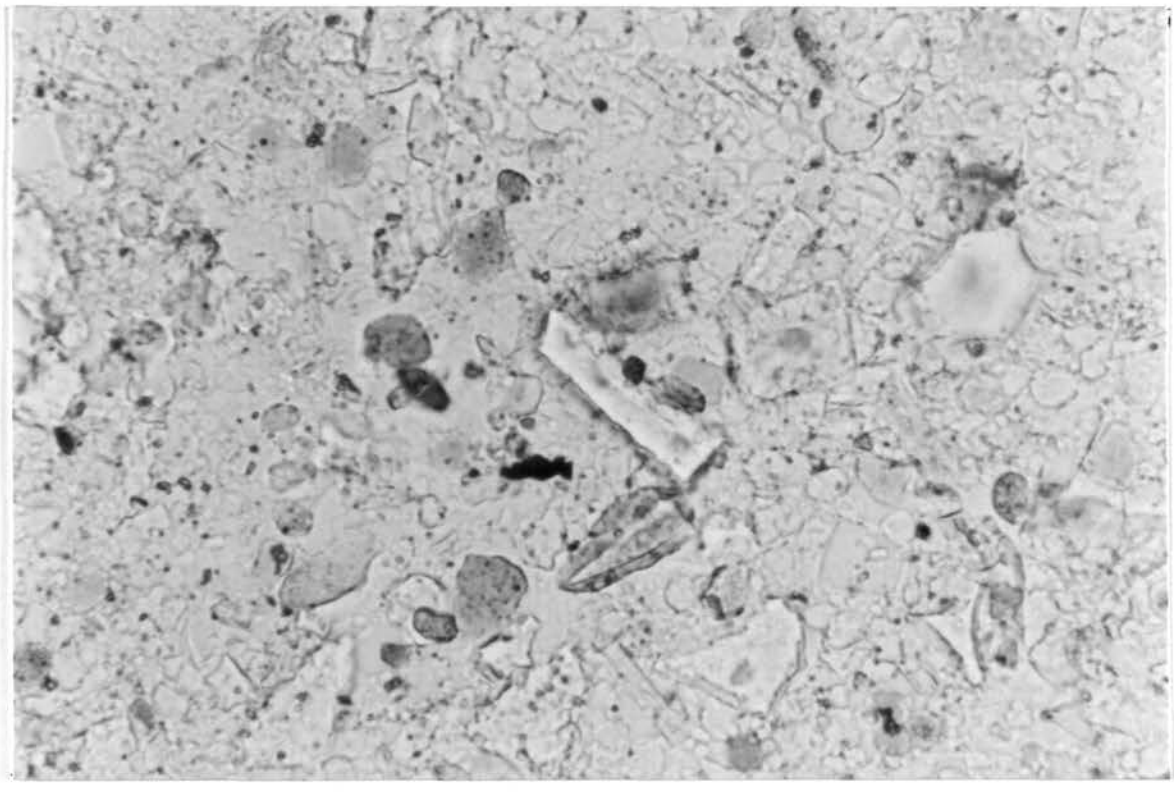
PLATE 42

Plate 43

Photographs of plant opal separated from sediment Site 8, mallee, Pilliga State Forests.

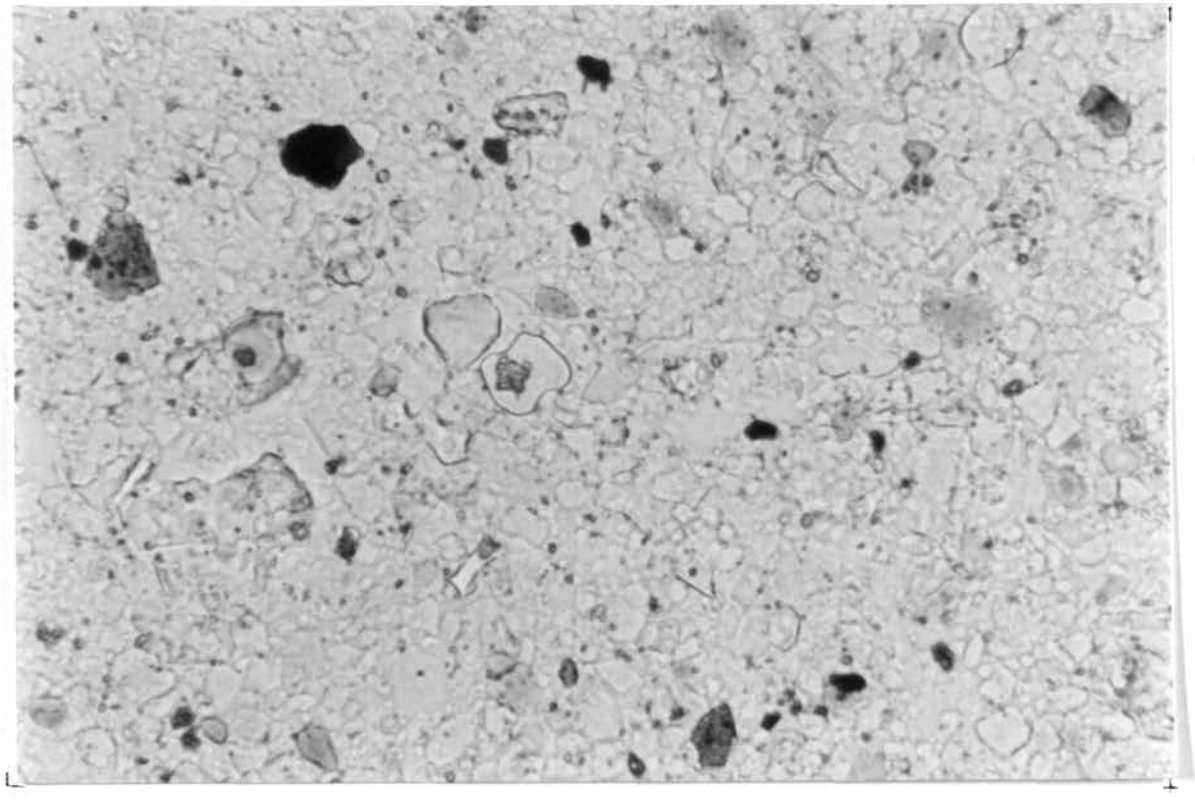
A-B MU 50606: Plant opal from the B horizon (sample B1). PPL.

A



0 μm 50

B



0 μm 50

PLATE 43

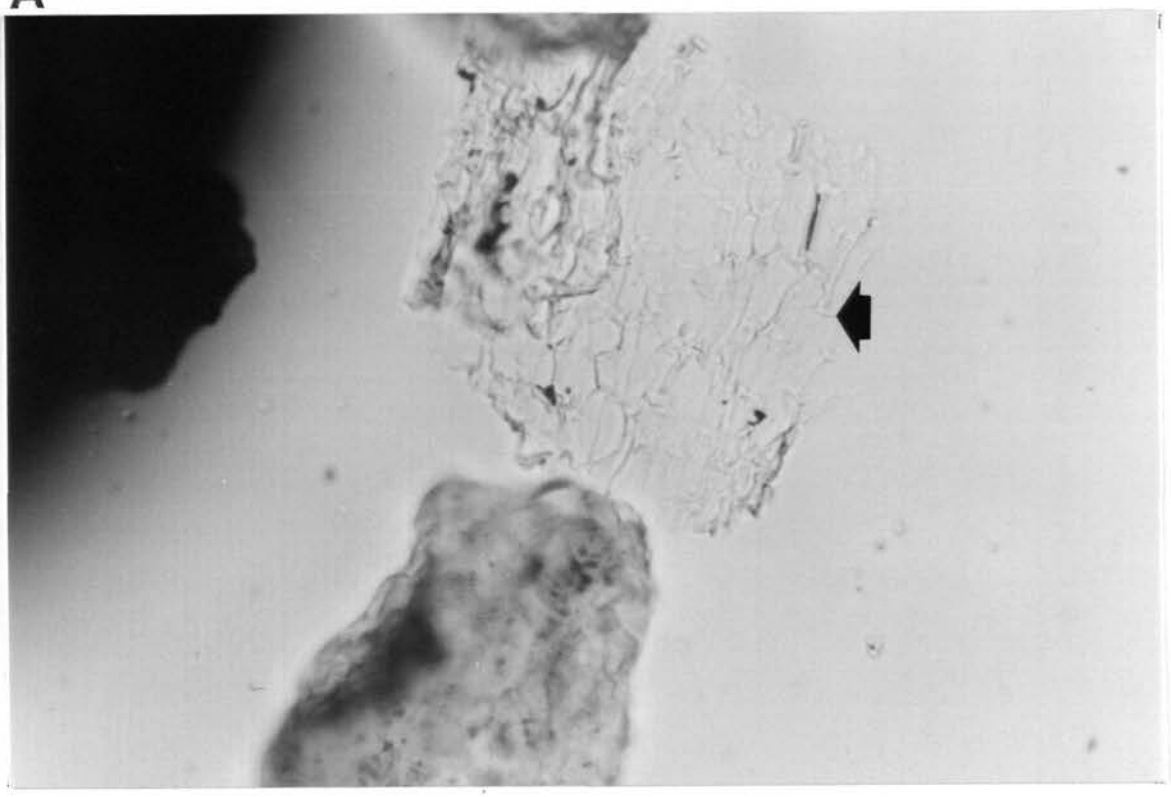
Plate 44

Photographs illustrating the problems encountered during separation of plant opal from sediment by heavy liquids. Sediment used was from Site 6, broom plain pinch samples.

A During wet sieving of the whole sample to remove the sand it was found that large multicelled sheets as well as a few smaller diameter pieces of plant opal were caught in the sieve. This plate shows a large multicelled sheet (arrow). Sample MU 50620. PPL.

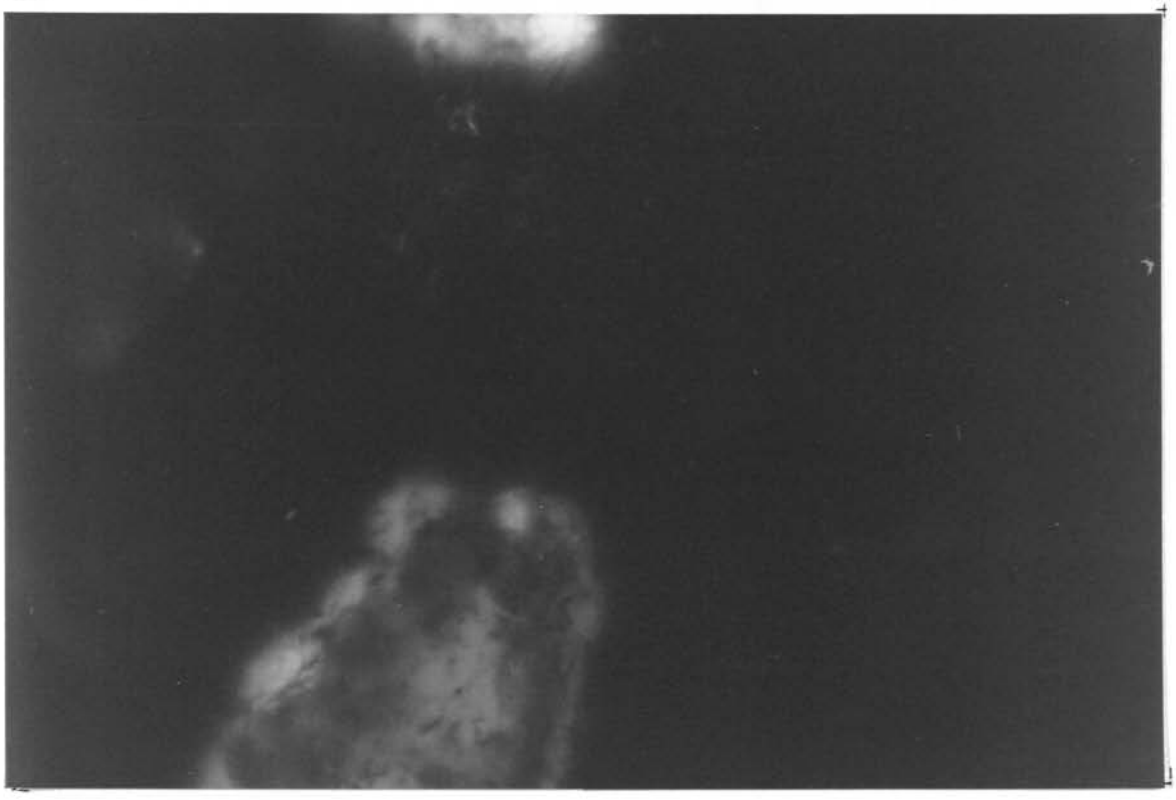
B Above in cross-polarized light, demonstrating the isotrophic nature of the opal. XPL.

A



0 µm 100

B



0 µm 100

PLATE 44

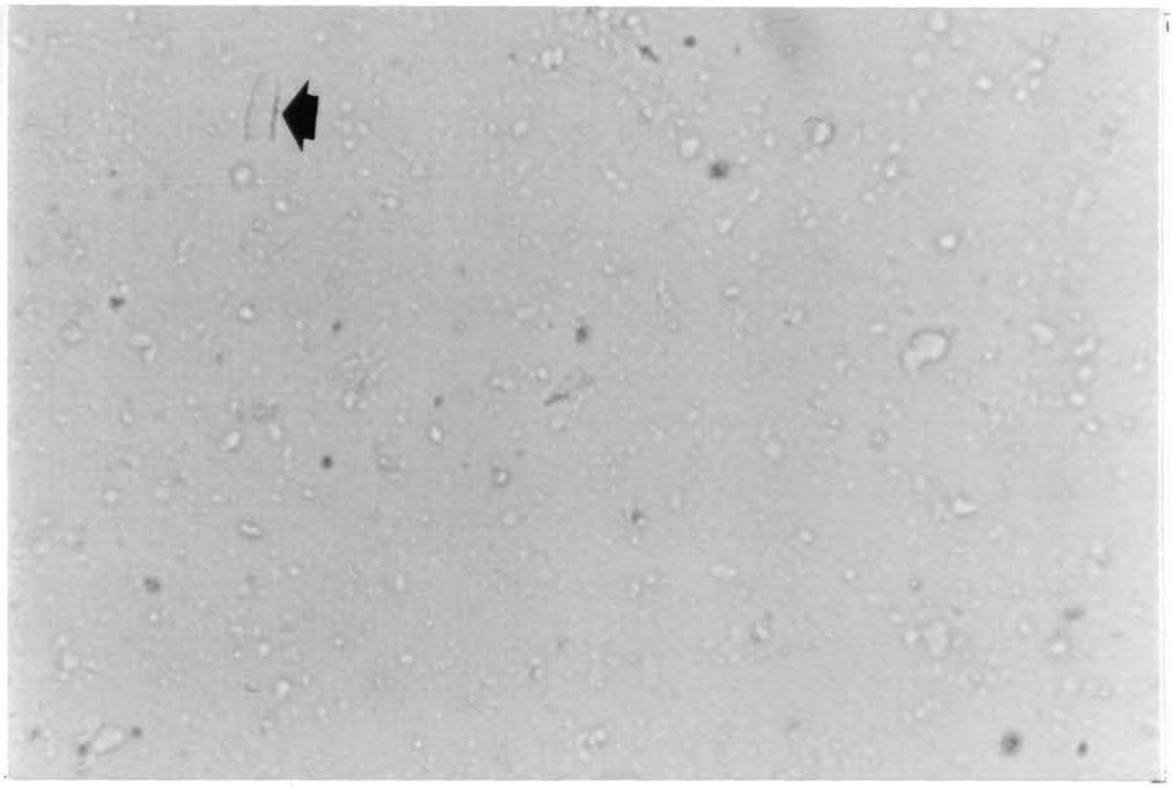
Plate 45

Photographs illustrating the problems encountered during separation of plant opal from sediment by heavy liquids. Sediment used was from Site 6, broom plain pinch samples.

A MU 50623: Clay which is siphoned off during sedimentation. It contains many small, often sheety pieces of opal (arrow). PPL.

B MU 50622: Silt material with a Specific Gravity greater than 2.3. This was found to contain no opal. PPL.

A



0 µm 50

B

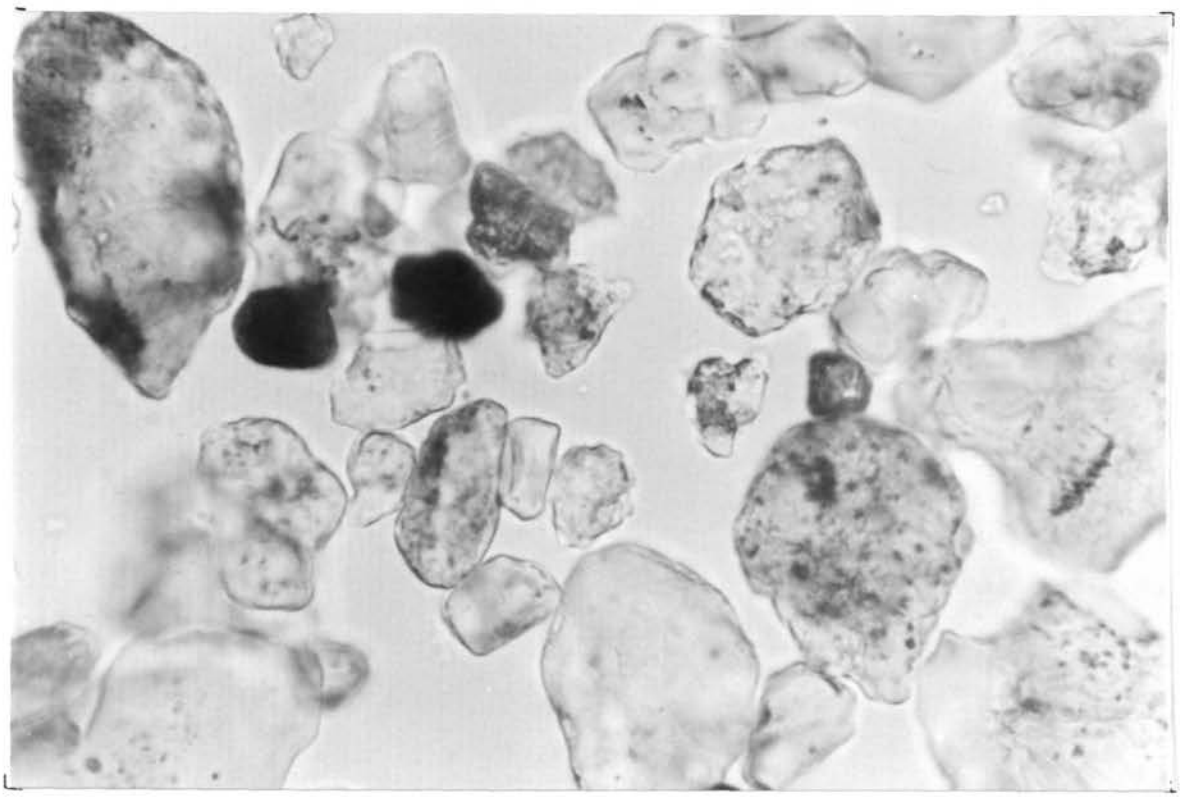


PLATE 45

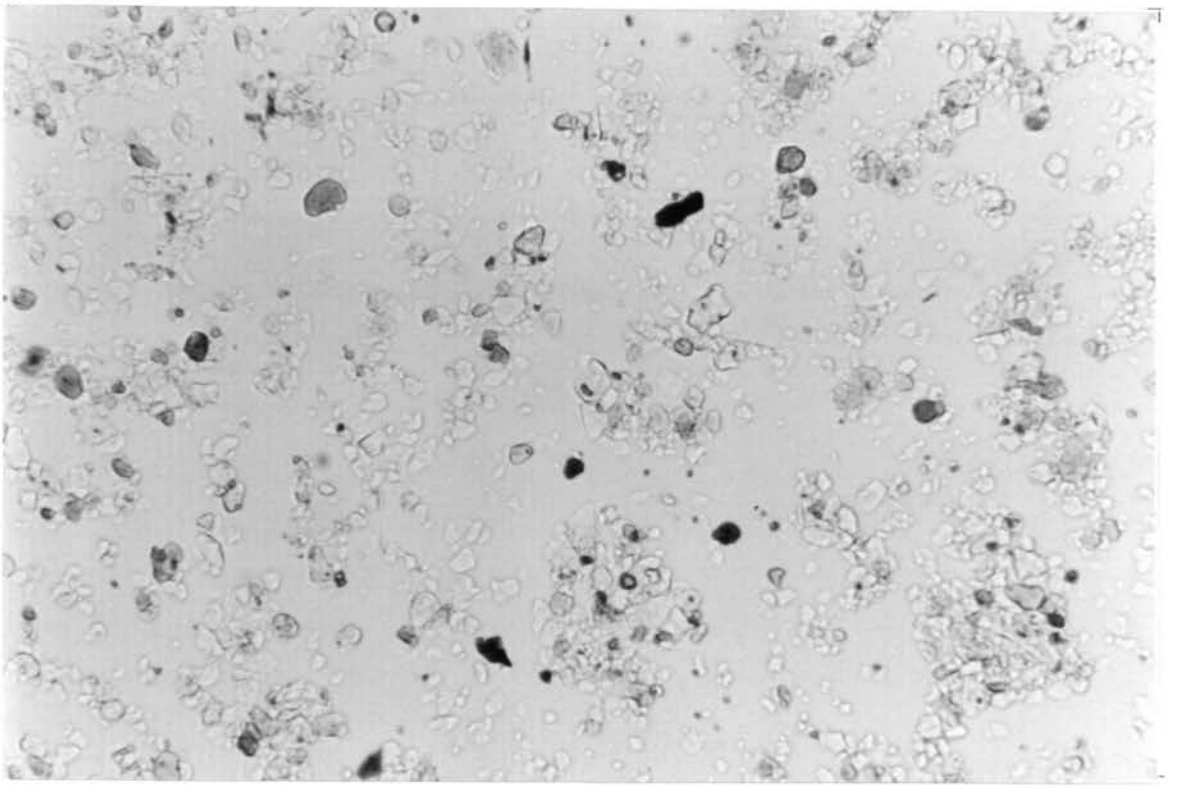
0 µm 50

Plate 46

Photographs illustrating the problems encountered during separation of plant opal from sediment by heavy liquids. Sediment used was from Site 6, broom plain pinch samples.

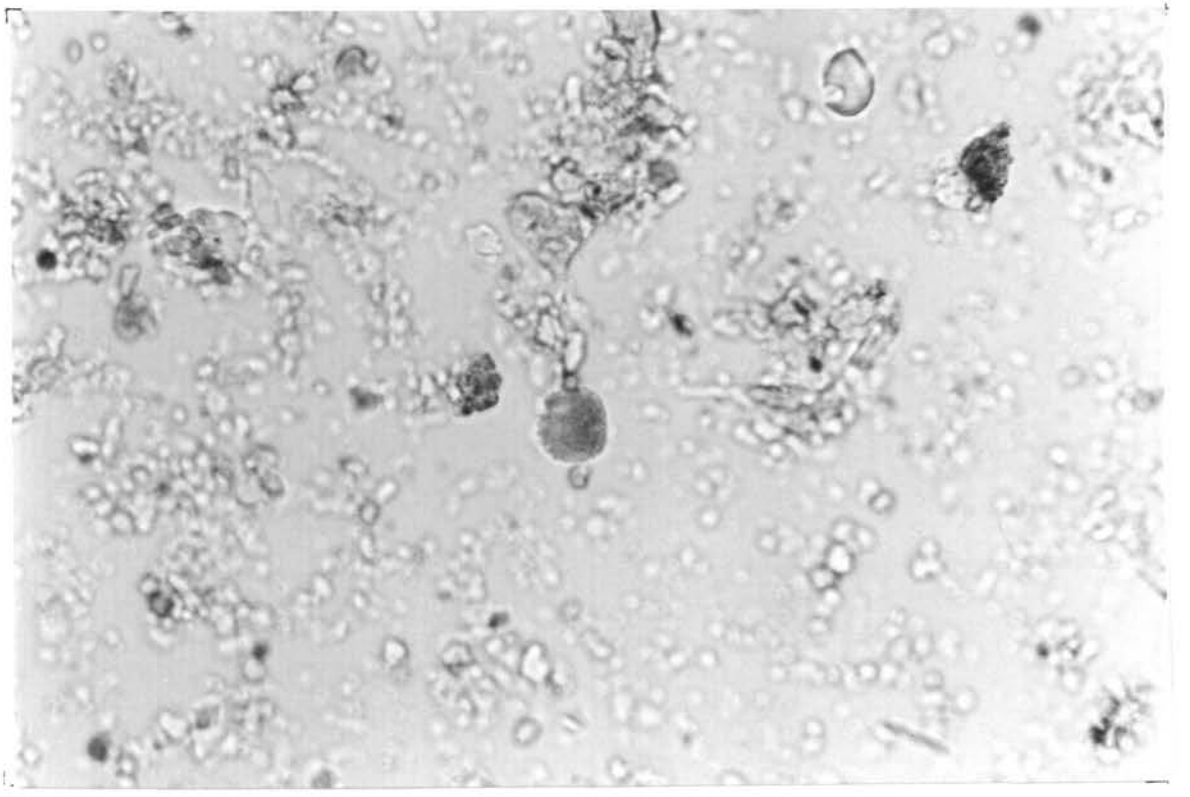
A-B MU 50621: Supernatant liquid from cleaning the separated opal. This should be clear liquid but is found to contain a large amount of opal. PPL.

A



0 µm 100

B



0 µm 100

PLATE 46

APPENDICES
