

Pollen microphotographs from Georgia, Caucasus.

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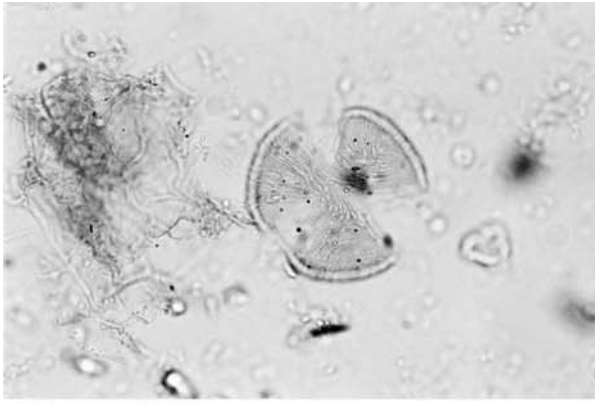
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This contribution presents 166 photographs of pollen grains that are commonly encountered in sediments from Georgia, are difficult to identify or are endemic to the region. In the first category are arboreal pollen types such as *Pinus*, *Quercus* and *Carpinus*, and herbaceous types from the Poaceae and Chenopodiaceae families. In the second category are the great diversity of, amongst others, Asteraceae, Apiaceae and Caryophyllaceae, as well as problematic types such as *Castanea* and *Sedum*. The third category includes endemics such as *Asineuma campanuloides*, *Grossheimia macrocephala*, *Zelkova carpinifolia* and *Pterocarya fraxinifolia*. The photographs are arranged in alphabetical order by taxonomic family, genus and species. All photographs are at the same scale and magnification unless explicitly noted.

Material labelled as 'type material' was obtained from botanical specimens generously provided and identified by Dr Henrikh Avakov, Institute of Paleobiology, Tbilisi. Material labelled as 'fossil' or 'subfossil' was identified using the pollen keys listed below and is labelled according to pollen types rather than botanical names. All images were vetted by Jacqueline van Leeuwen (University of Bern) and notations in square brackets indicate instances where palynological and botanical identifications may disagree. In these cases, palynologists are advised to consult the pollen-morphological literature below to ensure their identifications are in harmony with recognised pollen types. The list is not intended to be exhaustive or comprehensive, but merely an aid to palynological studies in the Caucasus.

Literature:

- Beug, H.-J., 2004. *Leitfaden der Pollenbestimmung für Mitteleuropa und angrenzende Gebiete*. Verlag Dr Friedrich Pfeil, München, 542 pp. (in German).
- Bobrov, A.E., Kuprianova, L.A., Litvintseva, M.V. and Tarasevich, V.F., 1983. *Spory i Pyl'tsa*. Nauka, Leningrad, 208 pp. (in Russian).
- Chester, P.I. and Raine, J.I., 2001. Pollen and spore keys for Quaternary deposits in the northern Pindos Mountains, Greece. *Grana*, 40: 299-387.
- Gogichaishvili, L.K., Ramishvili, M.N. and Saqvaridze, M.D., 1975. *The Morphology of the Pollen of Some Plants Causing Allergic Diseases*. Metsniereba, Tbilisi (in Georgian; English summary).
- Kuprianova, L.A. and Aleshina, L.A., 1972. *Pyl'tsa i Spory Rastenii*. Nauka, Leningrad, 170 pp. (in Russian).
- Kuprianova, L.A. and Aleshina, L.A., 1978. *Pyl'tsa Dvudol'nykh Rastenii*. Nauka, Leningrad, 184 pp. (in Russian).
- Moore, P.D., Webb, J.A. and Collinson, M.E., 1991. *Pollen Analysis*. Blackwell Science Publishers, Oxford, 216 pp.
- van Zeist, W. and Bottema, S., 1977. Palynological investigations in Western Iran. *Palaeohistoria*, 24: 19-85.



Aceraceae *Acer*-type
Fossil material, Lake Jvari 162 cm



Adiantaceae *Adiantum*-type
Fossil material, Tsavkisi Wetland 700 cm



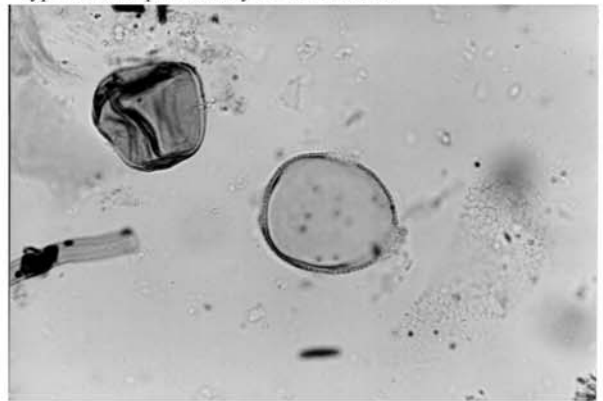
Alismataceae *Alisma arcuatum*
Type material, Tsavkisi Wetland



Anacardiaceae *Cotinus coggygria*
Type material provided by Dr E. Kvavadze



Anacardiaceae *Pistacia*-type (centre)
Fossil material, Lake Kumisi 170 cm



Anacardiaceae *Pistacia*-type (centre)
Fossil material, Lake Kumisi 170 cm



Apiaceae *Angelica tatiana* (centre)
Type material, Lake Lisi



Apiaceae *Aphanopleura trachysperma* (centre)
Type material, Sakhare Lake



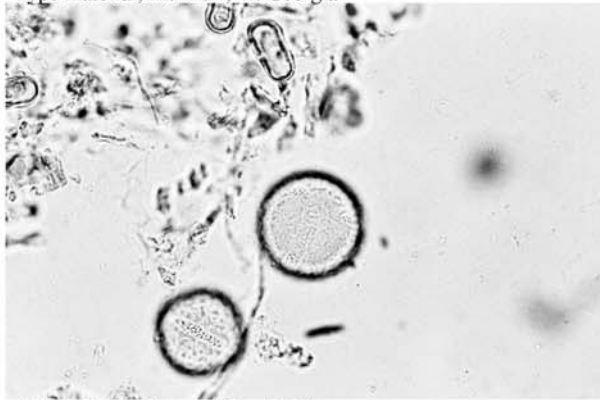
Apiaceae *Chaerophyllum temulum*
Type material, Tbilisi



Apiaceae *Daucus carota* (centre right)
Type material, Mukhuri, W. Georgia



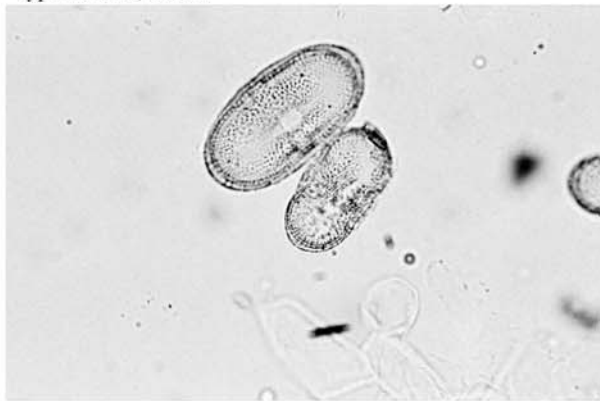
Apiaceae *Eryngium* sp.
Type material, Tsodreti Lake



Apiaceae *Ferulago setiflora* (top)
Type material, Gldani



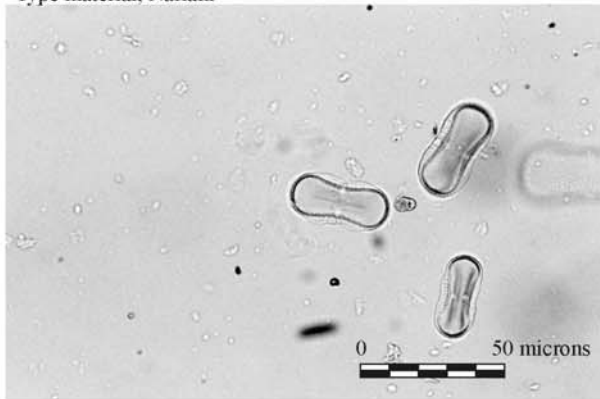
Apiaceae *Heracleum sibiricum* [*Anthriscus*-type?]
Type material, Tbilisi



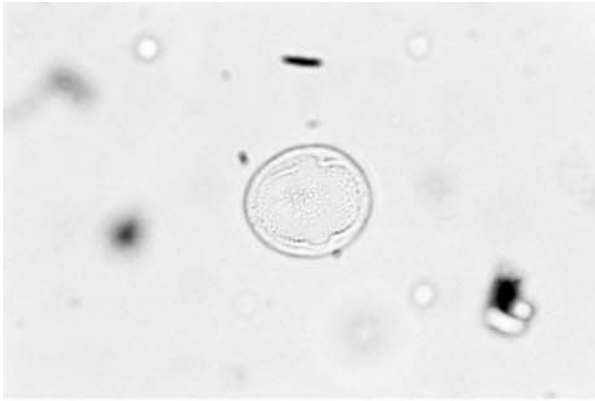
Apiaceae *Heracleum sosnovskii*
Type material, Nariani



Apiaceae *Hippomoranthum crispum* (centre)
Type material, Saguramo Mts.



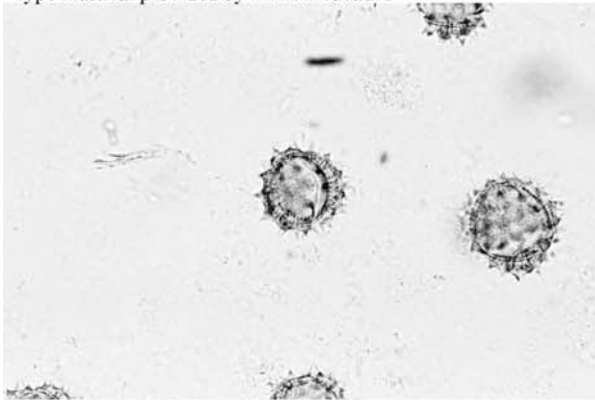
Apiaceae *Torilis japonica*
Type material, Mukhuri, W. Georgia



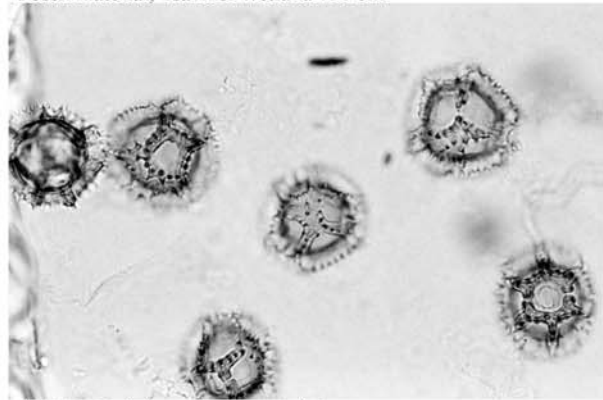
Araliaceae *Hedera colchica*
Type material provided by Dr E. Kvavadze



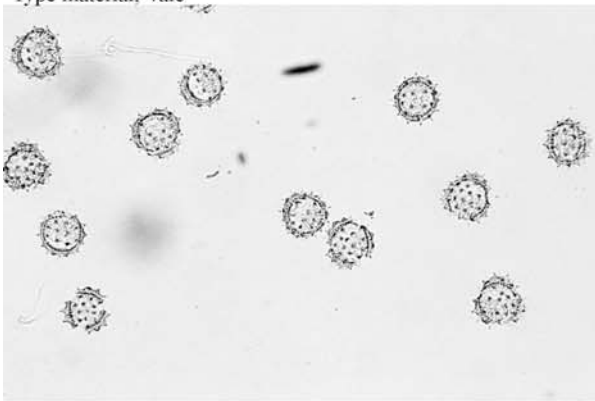
Araliaceae *Hedera*-type
Fossil material, Tsavkisi Wetland 730 cm



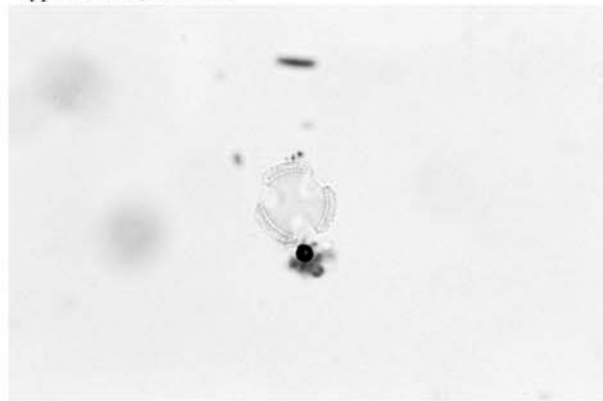
Asteraceae *Achillea nabeleki*
Type material, Vale



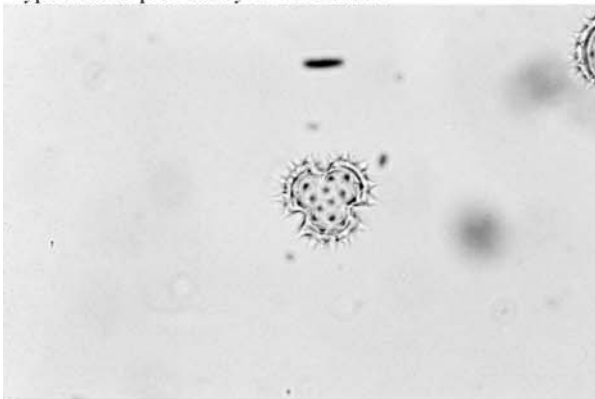
Asteraceae *Achyrophorus maculatus*
Type material, Lake Lisi



Asteraceae *Anacyclis ciliatus*
Type material provided by Dr E. Kvavadze



Asteraceae *Artemisia fasciculata*
Type material provided by Dr E. Kvavadze



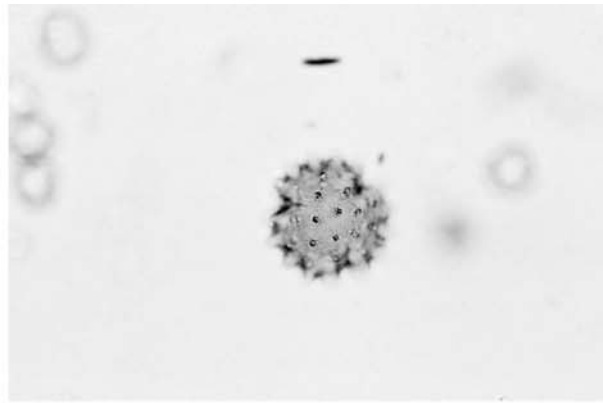
Asteraceae *Calimeris savatieri*
Type material, Gldani



Asteraceae *Carduus acanthocephalus* [*Centaurea scabiosa*-type?]
Type material, Mtatsminda



Asteraceae *Carduus onopordioides*
Type material, Tabatsquri



Asteraceae *Carduus seminudus*
Type material, Sakhare Lake



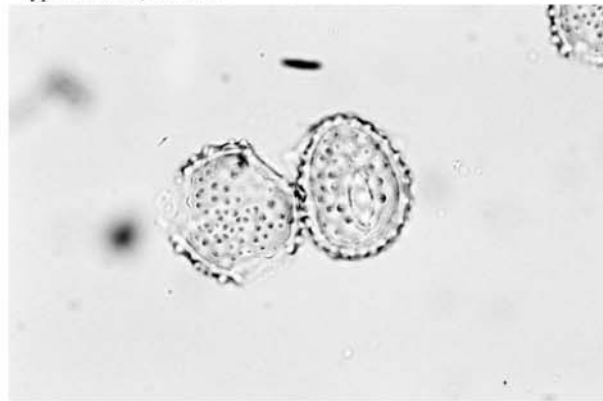
Asteraceae *Centaurea cheiranthifolia*
Type material, Nariani



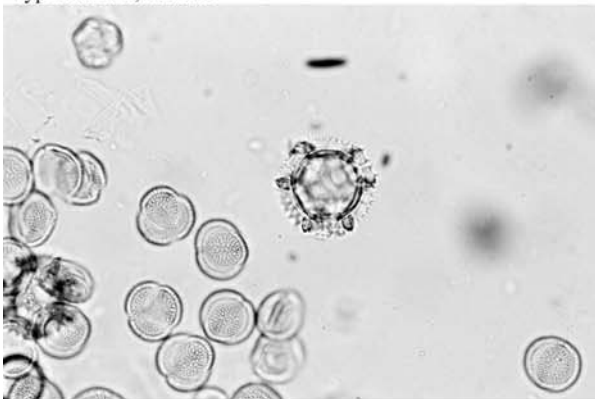
Asteraceae *Centaurea cheiranthifolia*
Type material, Nariani



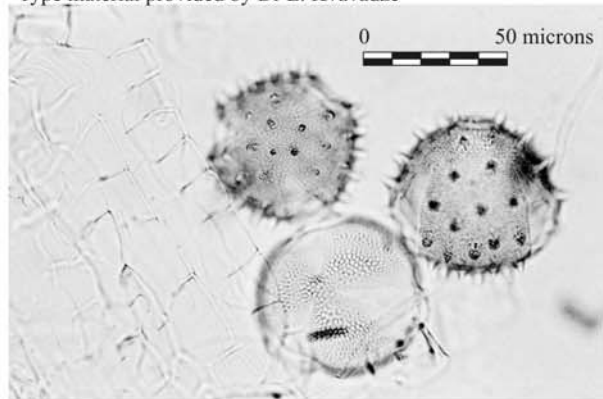
Asteraceae *Centaurea nigrifimbria* (centre and right)
Type material, Nariani



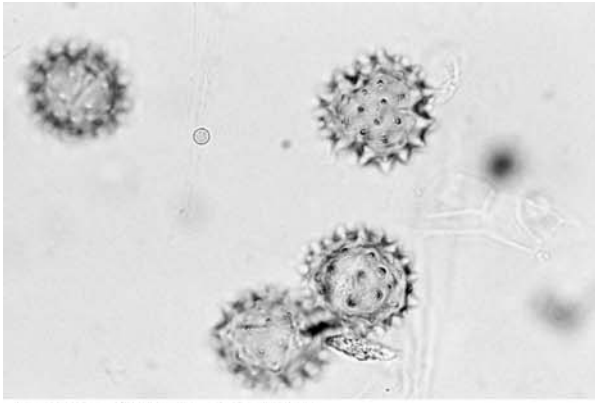
Asteraceae *Centaurea phrygia*
Type material provided by Dr E. Kvavadze



Asteraceae *Cicerbita olgae* (at centre)
Type material, Lake Lisi



Asteraceae *Cirsium frikii* (top, above *Cucumis* sp.)
Type material, Tabatsquri



Asteraceae *Cousinia carduiiformis*
Type material, Sakhare Lake



Asteraceae *Echinops*-type
Fossil material, Lake Kumisi 20 cm



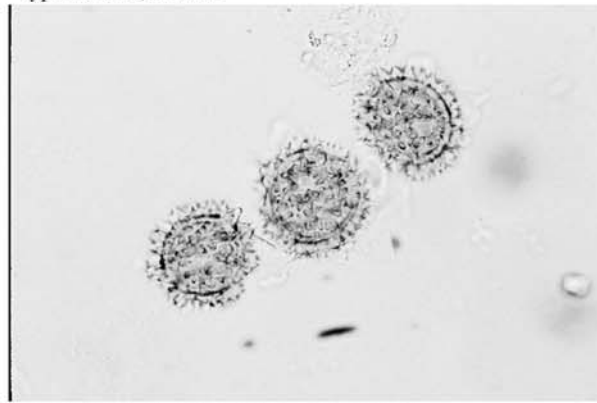
Asteraceae *Grossheimia macrocephala*
Type material, Nariani



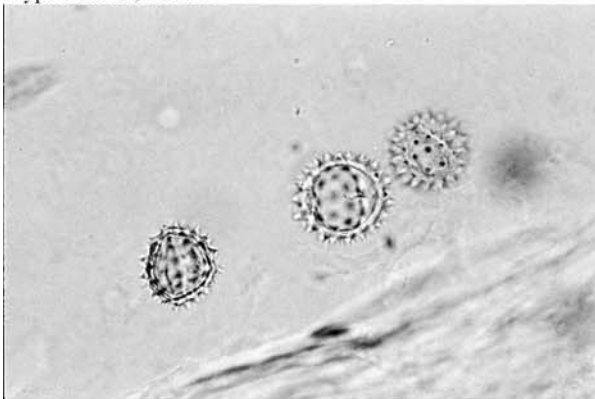
Asteraceae *Grossheimia macrocephala*
Type material, Nariani



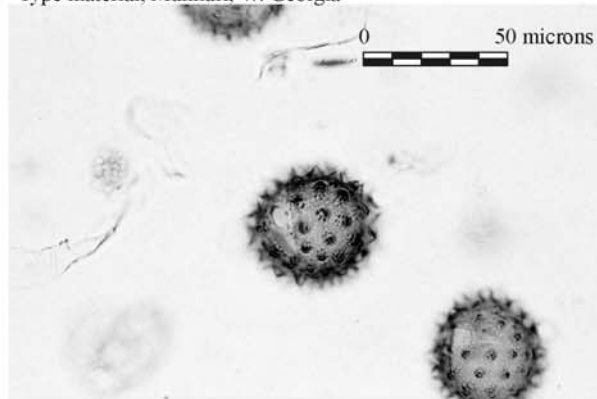
Asteraceae *Grossheimia macrocephala*
Type material, Nariani



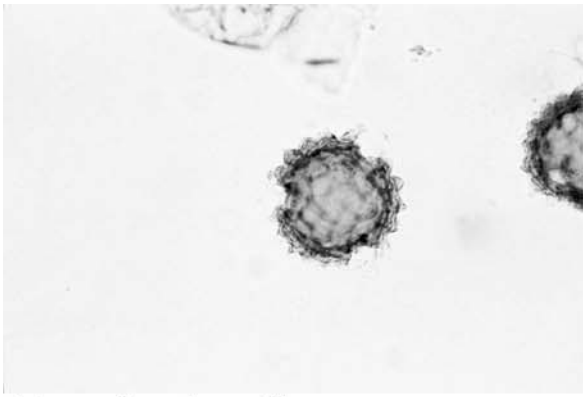
Asteraceae *Inula salicina* [*Scorzonera*-type?]
Type material, Mukhuri, W. Georgia



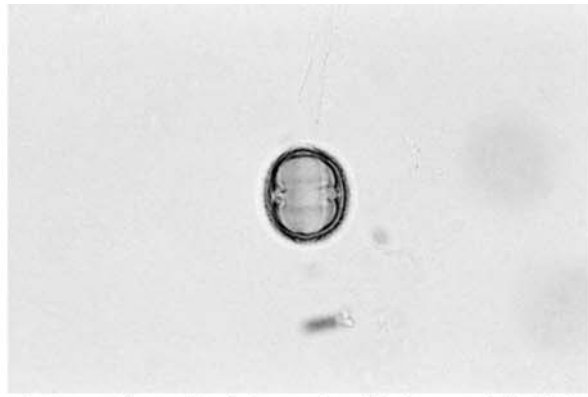
Asteraceae *Lynosyrus femini*
Type material, Mtatsminda



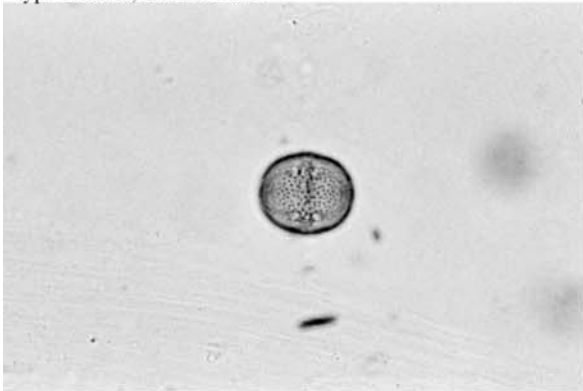
Asteraceae *Onopordum acanthium* [*Cirsium*-type?]
Type material, Sakhare Lake



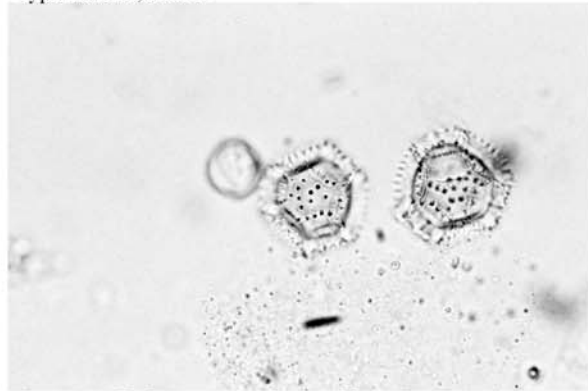
Asteraceae *Onopordum acanthium*
Type material, Sakhare Lake



Asteraceae *Onopordum heteracanthum* [*Centaurea solstitialis*-type?]
Type material, Gldani



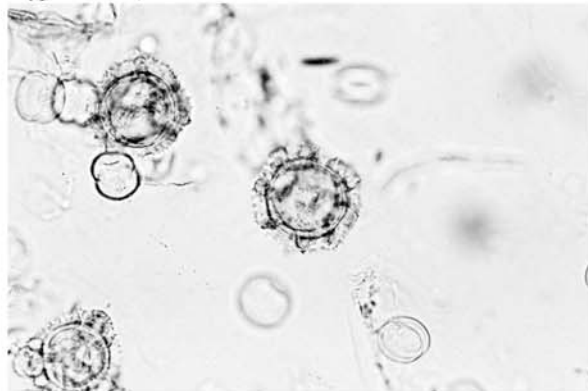
Asteraceae *Onopordum heteracanthum* [see above]
Type material, Gldani



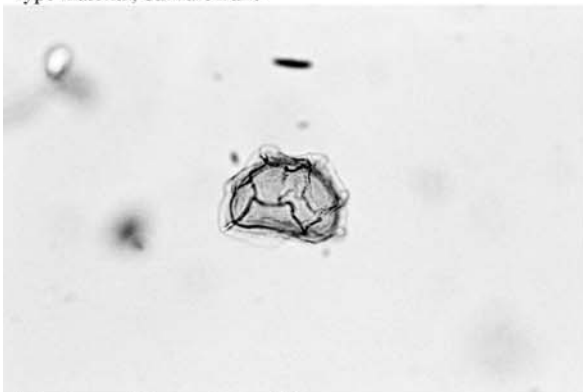
Asteraceae *Podospermum calcitrapifolia*
Type material, Lake Lisi



Asteraceae *Pterotheca marschalliana*
Type material, Sakhare Lake



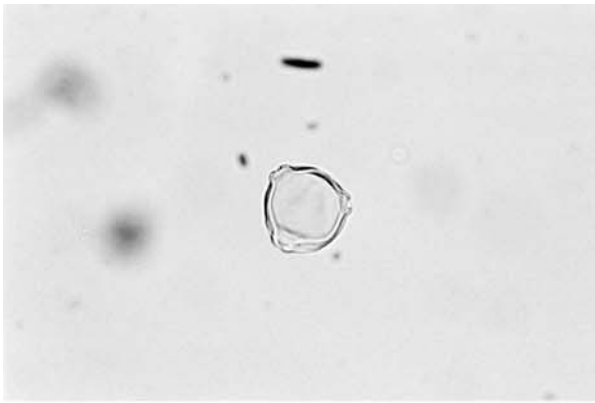
Asteraceae *Sonchus palustre*
Type material, Lake Cherepanov



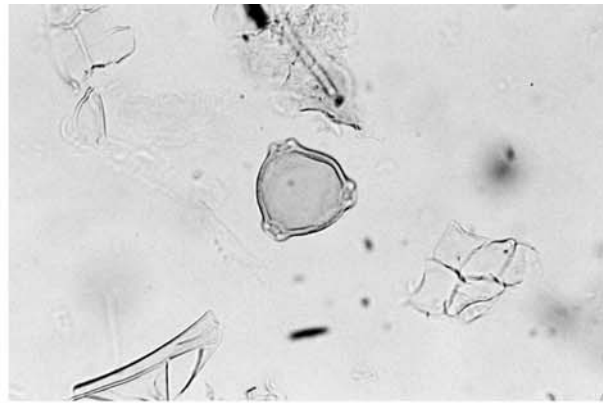
Athyriaceae *Athyrium distentifolium*
Type material provided by Dr E. Kvavadze



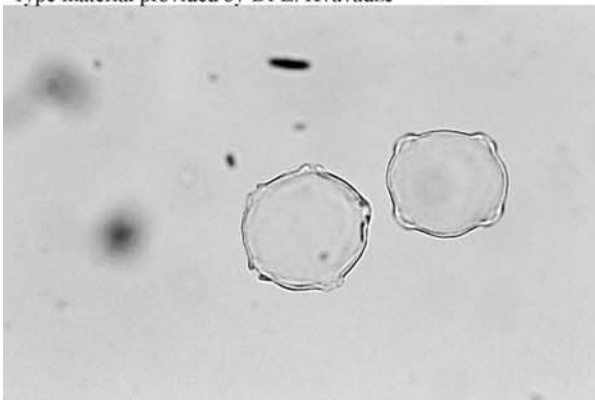
Betulaceae *Alnus*-type
Subfossil material, Lake Jvari surficial sediments



Betulaceae *Betula litwinowii*
Type material provided by Dr E. Kvavadze



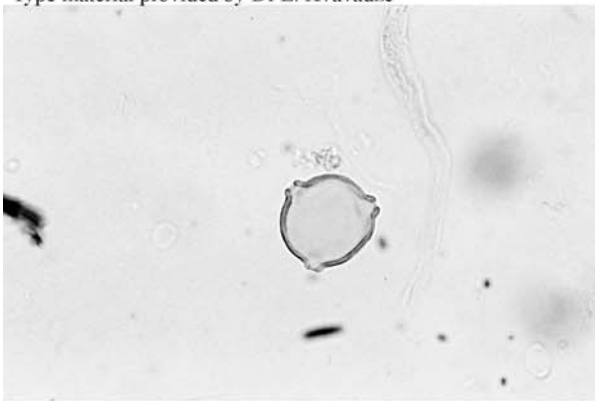
Betulaceae *Betula*-type
Fossil material, Lake Baret'i 112 cm



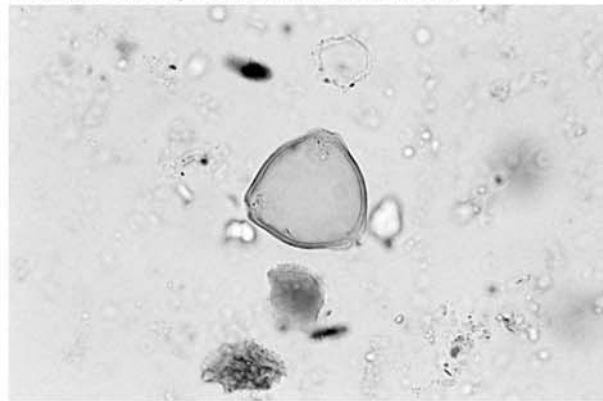
Betulaceae *Carpinus betulus* (syn. *C. caucasica*)
Type material provided by Dr E. Kvavadze



Betulaceae *Carpinus betulus*-type
Subfossil material, Lake Jvari surficial sediments



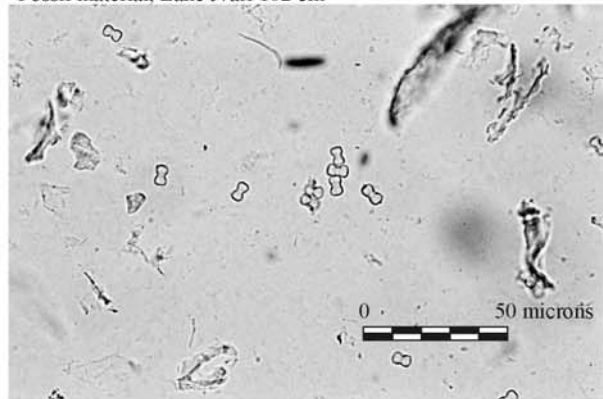
Betulaceae *Carpinus orientalis* (*Ostrya*-type)
Subfossil material, Lake Jvari surficial sediments



Betulaceae *Corylus*-type
Fossil material, Lake Jvari 162 cm

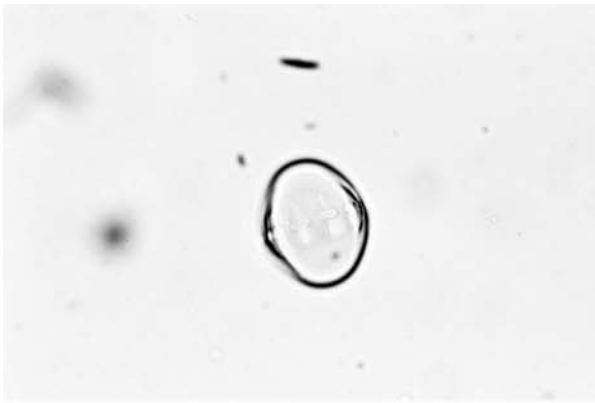


Boraginaceae *Anchusa gmelinii*
Type material, Lake Imera

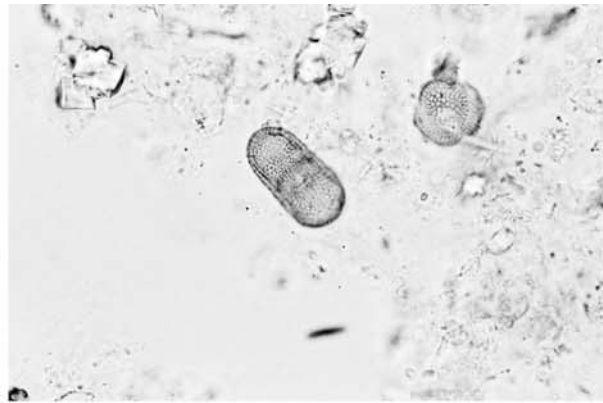


Boraginaceae *Pulmonaria mollissima* [*Myosotis*-type?]
Type material, Trialeti Wetland

0 50 microns



Boraginaceae *Symphytum grandiflorum*
Type material provided by Dr E. Kvavadze



Brassicaceae *Alyssum calycinum* var. *desertorum* (top right)
Type material provided by Dr E. Kvavadze



Brassicaceae *Capsella bursa-pastoris*
Type material, Sakhare Lake



Brassicaceae *Clypeola jonthlaspi*
Type material, Lake Imera



Brassicaceae *Conringia austriaca* (lower left)
Type material, Tsalka



Brassicaceae *Erophila verna*
Type material, Lake Imera



Brassicaceae *Rorippa prostrata* (lower right)
Type material, Sakhare Lake



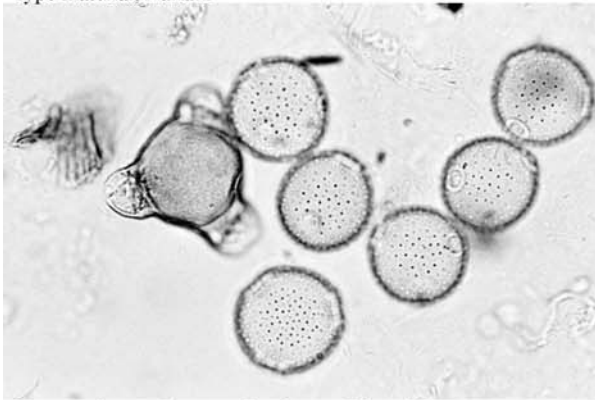
Buxaceae *Buxus*-type
Fossil material, Lake Bareti 112 cm



Campanulaceae *Asineuma campanuloides* (centre)
Type material, Nariani



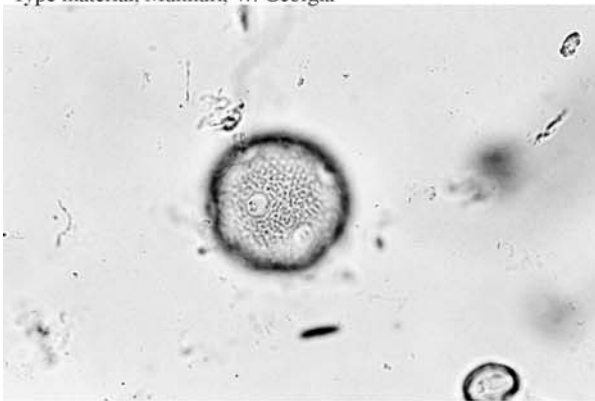
Campanulaceae *Asineuma campanuloides*
Type material, Nariani



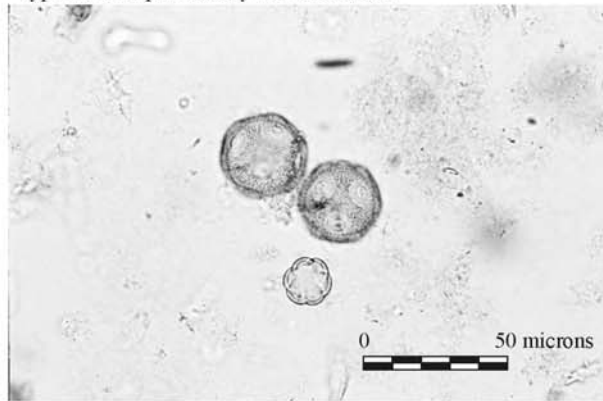
Campanulaceae *Campanula allariaefolia* (right)
Type material, Mukhuri, W. Georgia



Caprifoliaceae *Lonicera orientalis*
Type material provided by Dr E. Kvavadze



Caryophyllaceae *Dianthus orientalis*
Type material, Mukhuri, W. Georgia



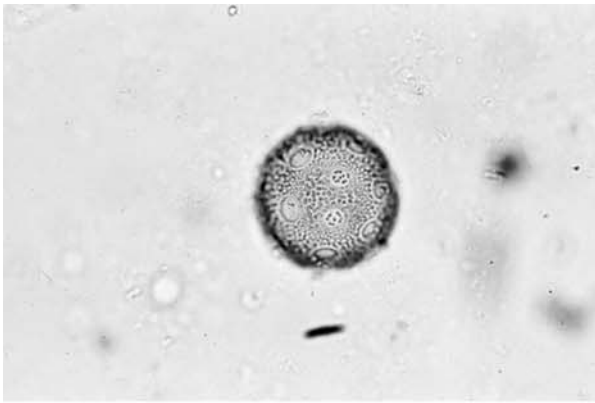
Caryophyllaceae *Gypsophila heteropoda*
Type material, Tbilisi



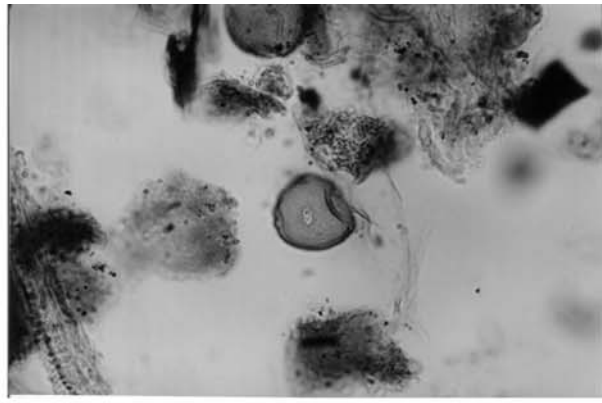
Caryophyllaceae *Scleranthus annuus* [*Silene vulgaris*-type?]
Type material, Lake Cherepanov



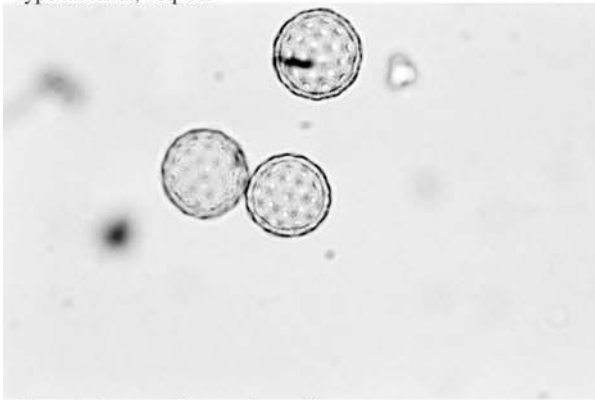
Caryophyllaceae *Scleranthus*-type
Fossil material, Tsavkisi Wetland 400 cm



Caryophyllaceae *Silene iberica*
Type material, Tsqneti



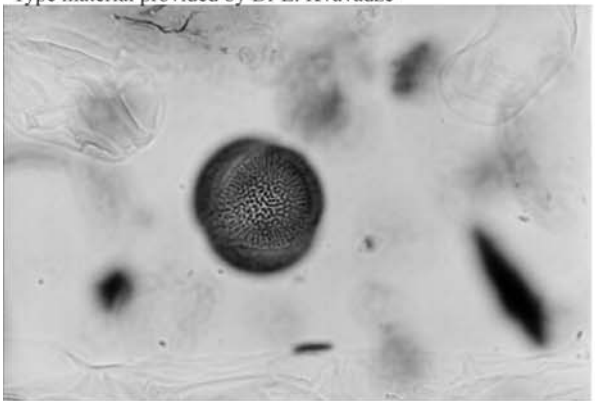
Celtidaceae *Celtis*-type
Fossil material, Tsavkisi Wetland 510 cm



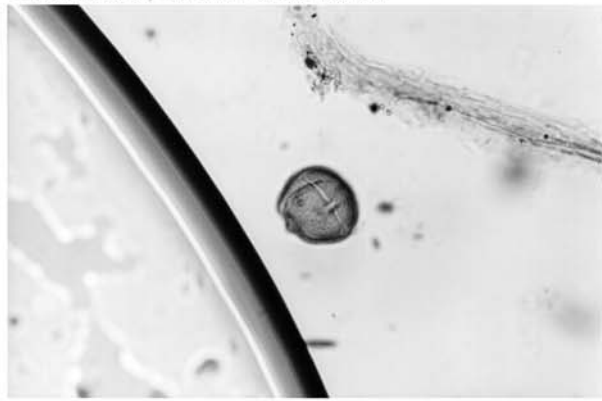
Chenopodiaceae *Chenopodium album*
Type material provided by Dr E. Kvavadze



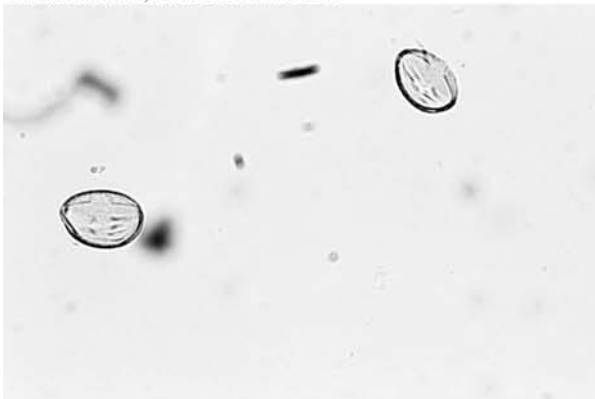
Cistaceae *Helianthemum*-type
Fossil material, Tsavkisi Wetland 780 cm



Convovulaceae *Convovulus arvensis*-type
Fossil material, Lake Kumisi 250 cm



Cornaceae *Cornus mas*-type
Fossil material, Tsavkisi Wetland 500 cm



Crassulaceae *Sedum oppositifolium*
Type material provided by Dr E. Kvavadze



Crassulaceae *Sedum pallidum*
Type material, Mukhuri, W. Georgia



Crassulaceae *Sedum pallidum*
Type material, Mukhuri, W. Georgia



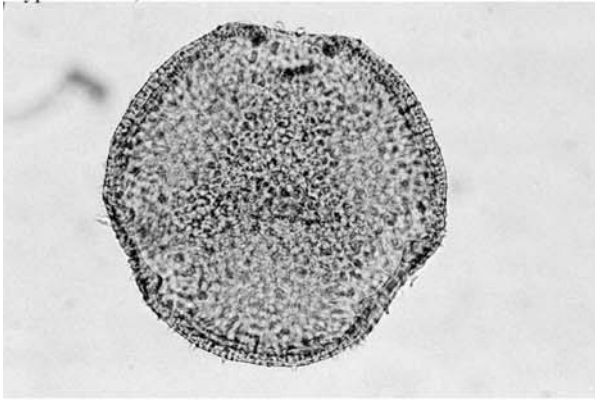
Cupressaceae *Juniperus*-type
Fossil material, Tsavkisi Wetland 780 cm



Cyperaceae *Acorellus pannonicus*
Type material, Lake Imera



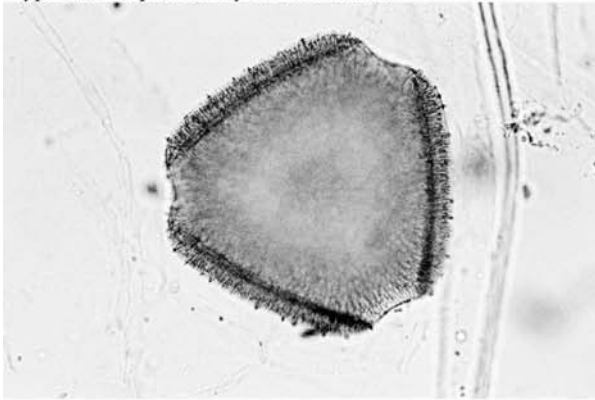
Cyperaceae *Carex dacica*
Type material, Gldani



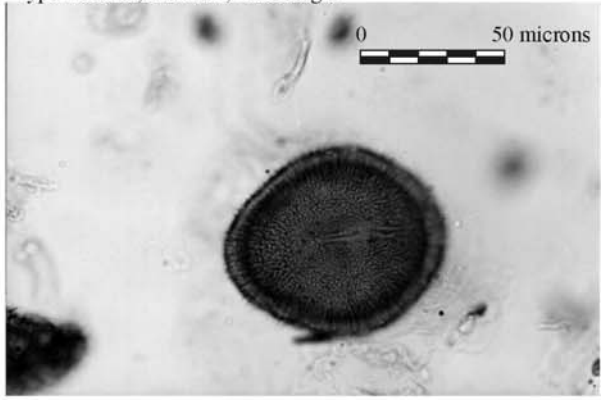
Dipsacaceae *Cephalaria caucasica*
Type material provided by Dr E. Kvavadze



Dipsacaceae *Knautia heterotricha* [*Dipsacus*?]
Type material, Mukhuri, W. Georgia



Dipsacaceae *Scabiosa caucasica*
Type material, Nariani



Dipsacaceae *Scabiosa*-type
Fossil material, Tsavkisi Wetland 700 cm



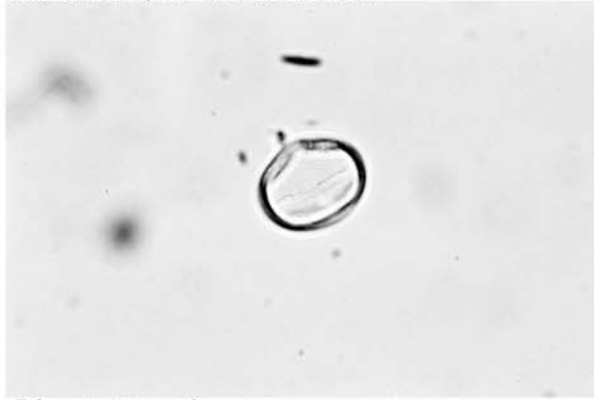
Ephedraceae *Ephedra procera*
Type material provided by Dr E. Kvavadze



Ephedraceae *Ephedra*-type
Fossil material, Tsavkisi Wetland 240 cm



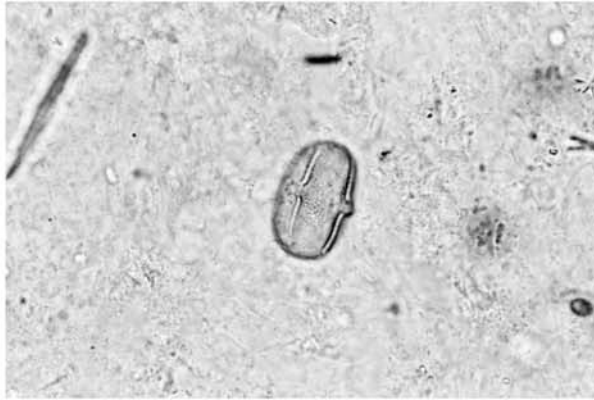
Ericaceae *Rhododendron caucasica*
Type material provided by Dr E. Kvavadze



Fabaceae *Astracantha aurea*
Type material provided by Dr E. Kvavadze



Fabaceae *Astragalus stevenianus*
Type material, Sakhare Lake



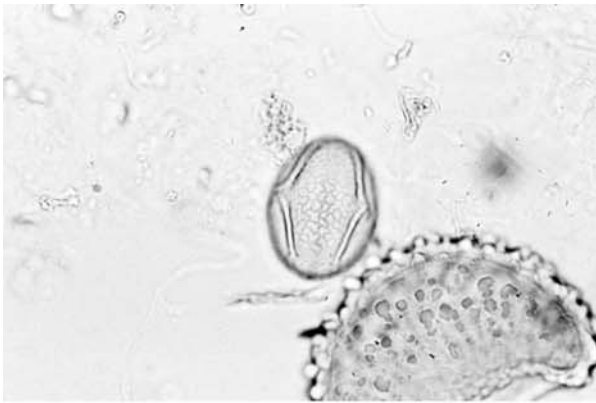
Fabaceae *Astragalus stevenianus*
Type material, Sakhare Lake



Fabaceae *Medicago polychroa*
Type material, Sakhare Lake



Fabaceae *Onobrychis nemejci*
Type material, Tbilisi



Fabaceae *Trifolium scabrum* (centre)
Type material, Mukhuri, W. Georgia



Fagaceae *Castanea sativa*
Type material provided by Dr E. Kvavadze



Fagaceae *Fagus orientalis*
Type material provided by Dr E. Kvavadze



Fagaceae *Fagus orientalis*
Subfossil material, Lake Baretí surficial sediments



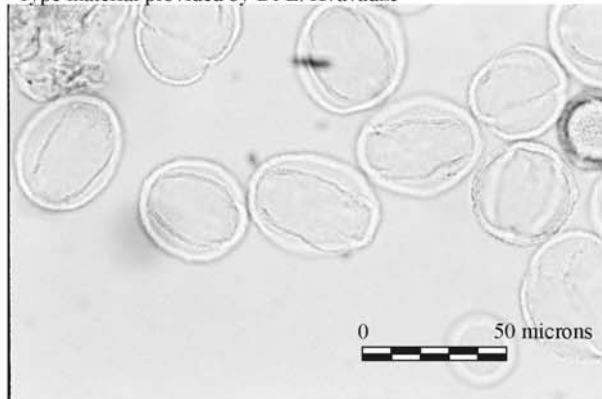
Fagaceae *Fagus orientalis*
Subfossil material, Lake Jvari surficial sediments



Fagaceae *Quercus hartwissiana*
Type material provided by Dr E. Kvavadze



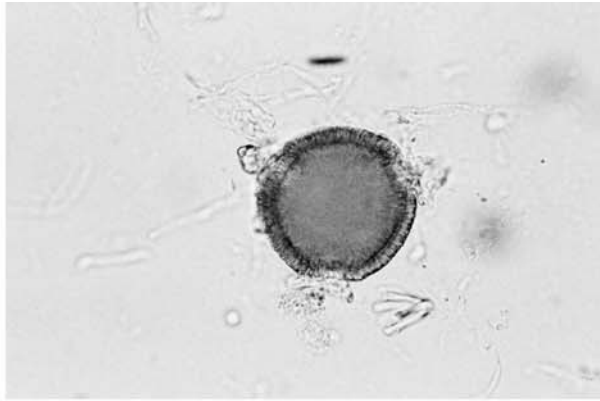
Fagaceae *Quercus (Q. iberica)*
Subfossil material, Lake Jvari surficial sediments



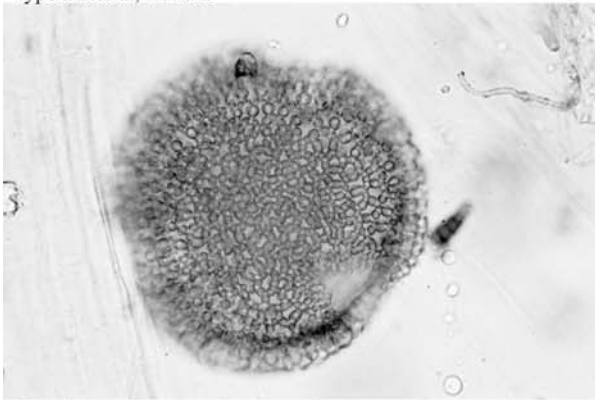
Fagaceae *Quercus macranthera*
Type material provided by Dr E. Kvavadze



Gentianaceae *Gentiana septemfida*
Type material, Nariani



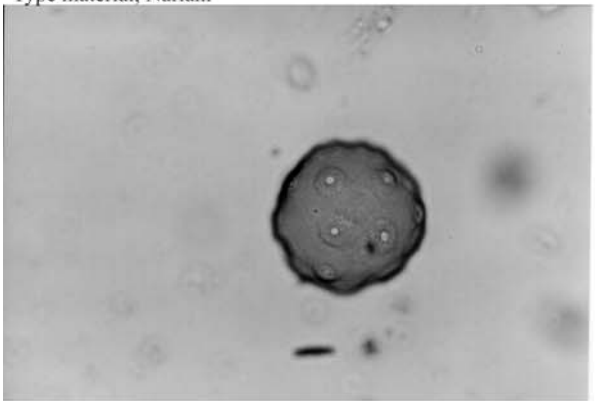
Geraniaceae *Geranium depilatum*
Type material, Sakhare Lake



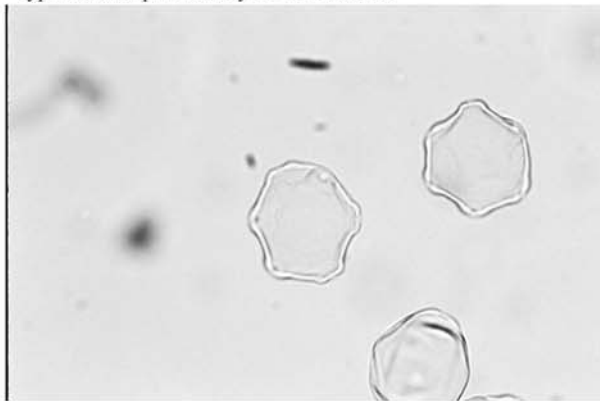
Geraniaceae *Geranium hymnocaulon*
Type material, Nariani



Hypericaceae *Hypericum linarioides*
Type material provided by Dr E. Kvavadze



Juglandaceae *Juglans regia*-type
Fossil material, Lake Kumisi 220 cm



Juglandaceae *Pterocarya fraxinifolia*
Type material provided by Dr E. Kvavadze



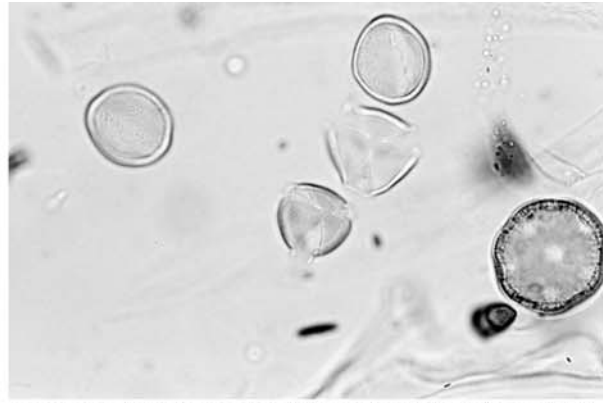
Lamiaceae *Ballota ruderalis*
Type material, Mtatsminda



Lamiaceae *Hyssopus angustifolius* (top)
Type material, Mtatsminda



Lamiaceae *Marrubium catariaefolium*
Type material, Mtatsminda



Lamiaceae *Marrubium goktschaicum* (with *Scleranthus* at right)
Type material, Lake Cherepanov



Lamiaceae *Marrubium leonuroides*
Type material, Mtatsminda



Lamiaceae *Salvia nemorosa*
Type material, Sakhare Lake



Lamiaceae *Sideritis*-type
Fossil material, Tsavkisi Wetland 650 cm



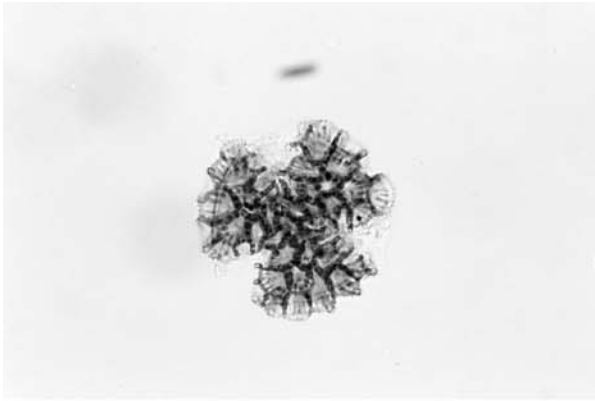
Lamiaceae *Teucrium chamaedrys*
Type material, Mukhuri, W. Georgia



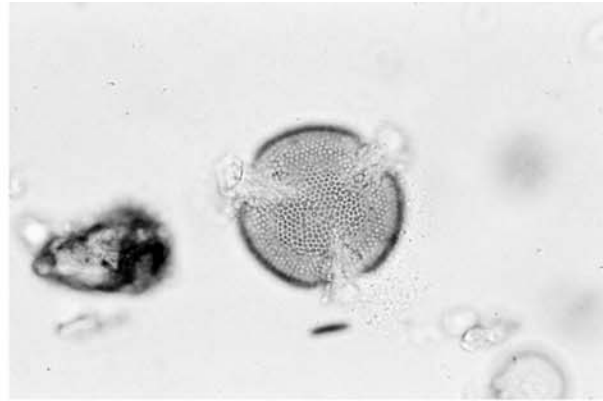
Liliaceae *Allium moschatum*
Type material, Mtatsminda



Liliaceae *Gagea hellenae*
Type material, Mukhatgverdi



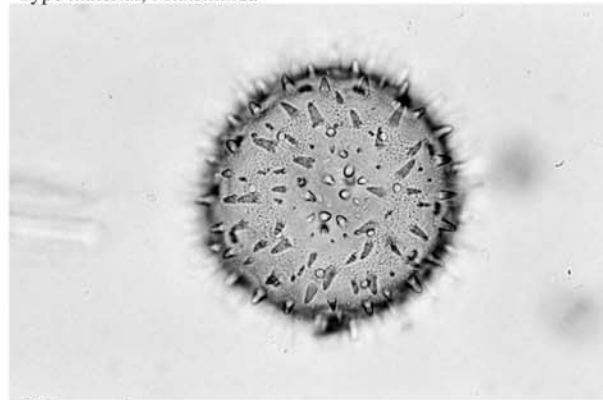
Limoniaceae *Limonium scoparium*
Type material provided by Dr E. Kvavadze



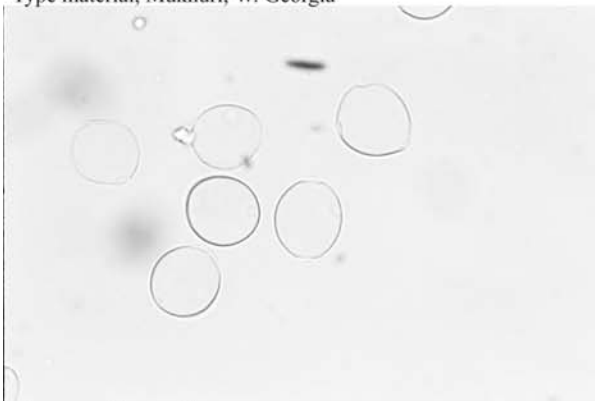
Linaceae *Linum nervosum*
Type material, Mtatsminda



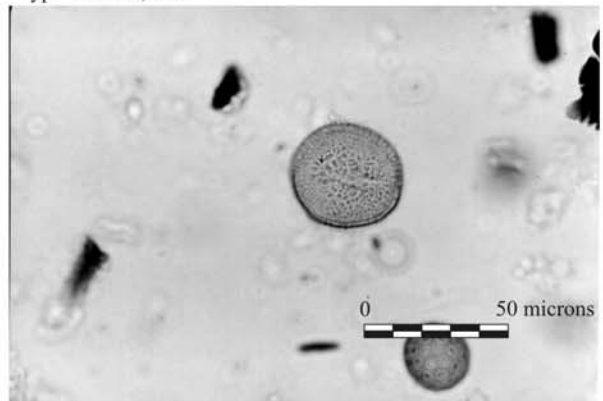
Lythraceae *Lythrum salicaria* (larger grains at left)
Type material, Mukhuri, W. Georgia



Malvaceae *Lavatera punctata*
Type material, Vale



Moraceae *Morus alba*
Type material provided by Dr E. Kvavadze



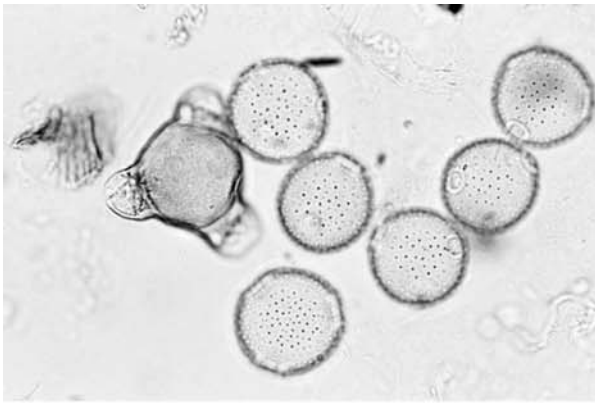
Nymphaeaceae *Nymphaea*-type
Fossil material, Lake Kumisi 230 cm



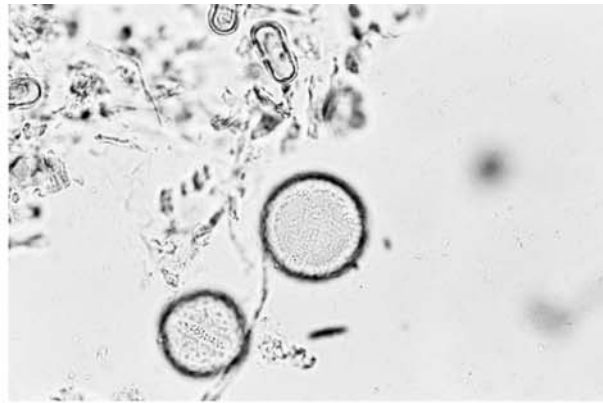
Oleaceae *Fraxinus*-type
Fossil material, Tsavkisi Wetland 590 cm



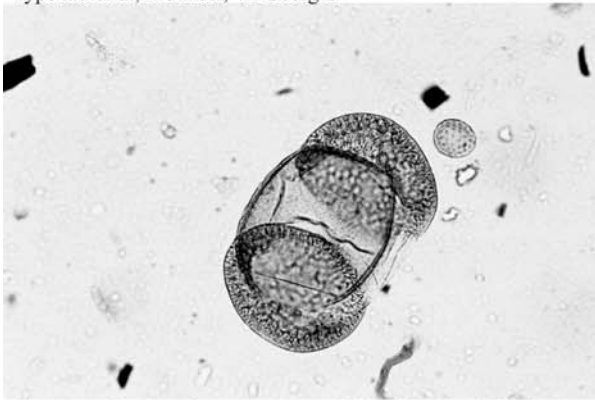
Oleaceae *Olea europaea*-type
Fossil material, Tsavkisi Wetland 780 cm



Onagraceae *Circaea lutetiana* (single grain at left)
Type material, Mukhuri, W. Georgia



Papaveraceae *Corydalis marschalliana* (centre and lower left)
Type material, Mukhatgverdi



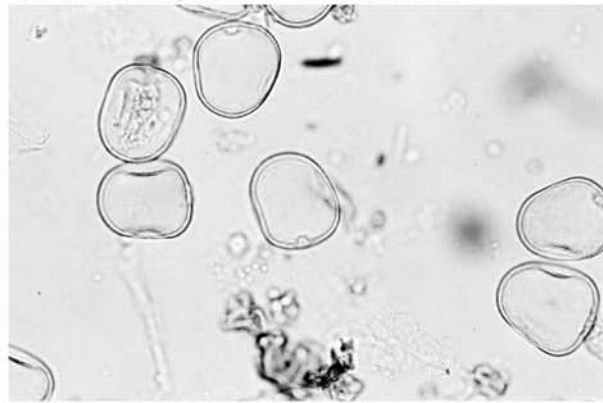
Pinaceae *Abies nordmanniana*-type **N.B. 50% magnification**
Fossil material, Lake Jvari 162 cm



Pinaceae *Pinus*-type
Subfossil material, Lake Jvari surficial sediments



Platanaceae *Platanus*-type
Fossil material, Lake Kumisi 250 cm



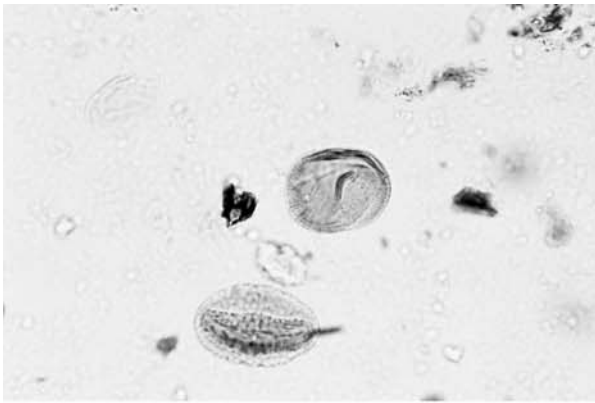
Poaceae *Alopecurus pratensis*
Type material, Sakhare Lake



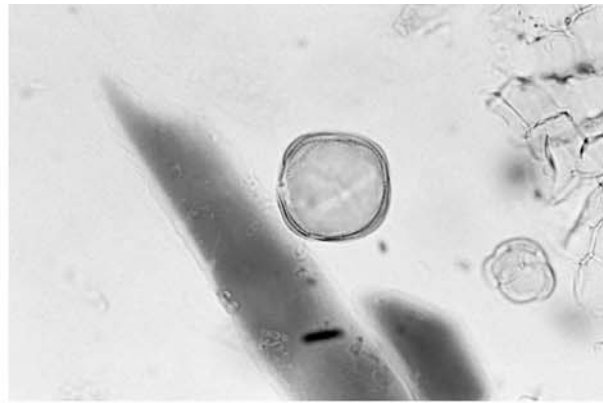
Poaceae *Triticum*-type
Subfossil material, wheat field in Vale, Southern Georgia



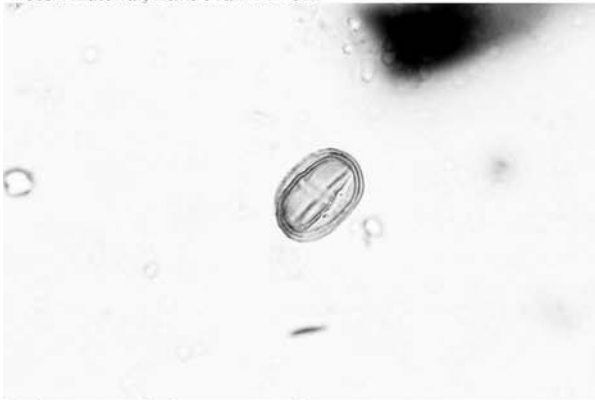
Polygalaceae *Polygala transcaucasica*
Type material provided by Dr E. Kvavadze



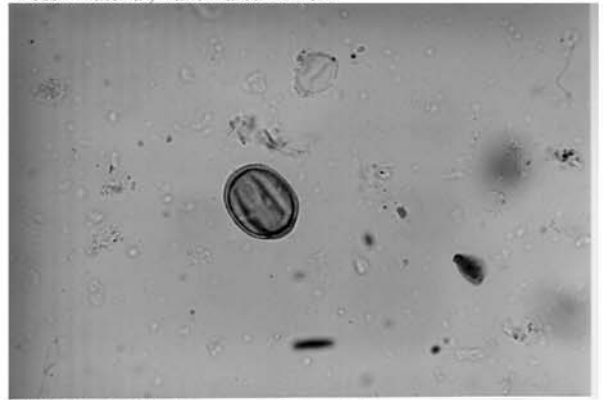
Polygonaceae *Polygonum aviculare*-type (centre)
Fossil material, Lake Jvari 162 cm



Polygonaceae *Polygonum aviculare*-type
Fossil material, Lake Baret'i 112 cm



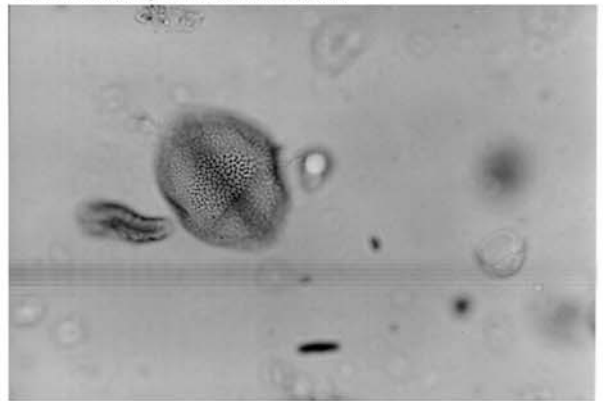
Polygonaceae *Polygonum aviculare*-type
Fossil material, Lake Jvari 162 cm



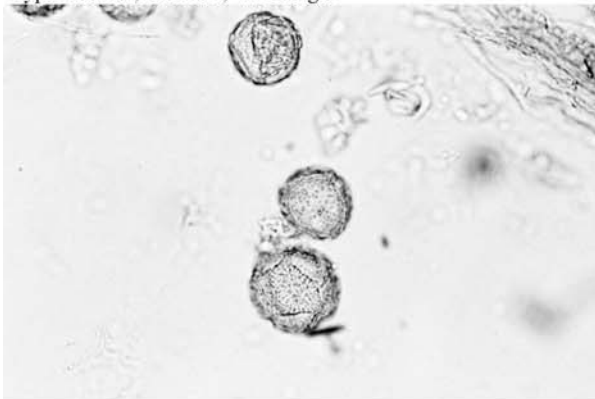
Polygonaceae *Polygonum aviculare*-type
Fossil material, Lake Kumisi 240 cm



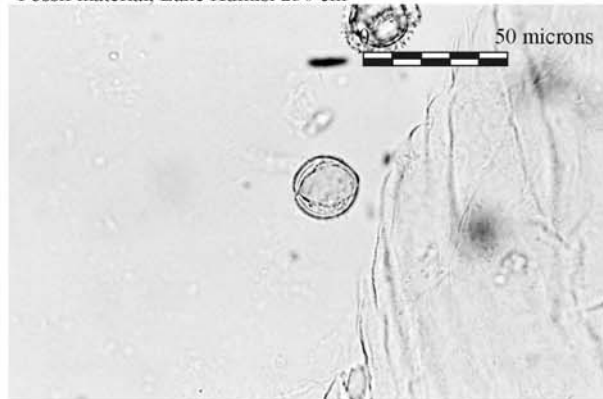
Polypodiaceae *Polypodium vulgare*
Type material, Mukhuri, W. Georgia



Potamogetonaceae *Potamogeton* subgenus *Coleogeton*-type
Fossil material, Lake Kumisi 230 cm



Ranunculaceae *Adonis vernalis* [*Ranunculus*-type?]
Type material, Lake Cherepanov



Resedaceae *Reseda lutea* (centre)
Type material, Sakhare Lake



Rhamnaceae *Paliurus spina-christi*
Type material provided by Dr E. Kvavadze



Rosaceae *Agrimonia eupatoria*
Type material, Mukhuri, W. Georgia



Rosaceae *Cotoneaster melanocarpus*
Type material provided by Dr E. Kvavadze



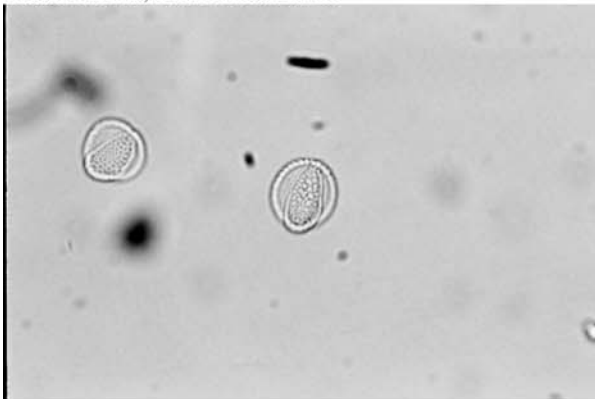
Rosaceae *Rosa canina*
Type material provided by Dr E. Kvavadze



Ruppiaceae *Ruppia*-type
Fossil material, Lake Kumisi 240 cm



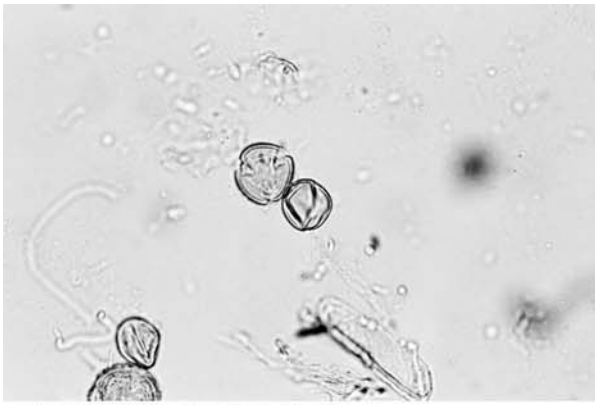
Rutaceae *Dictamnus caucasicus*
Type material provided by Dr E. Kvavadze



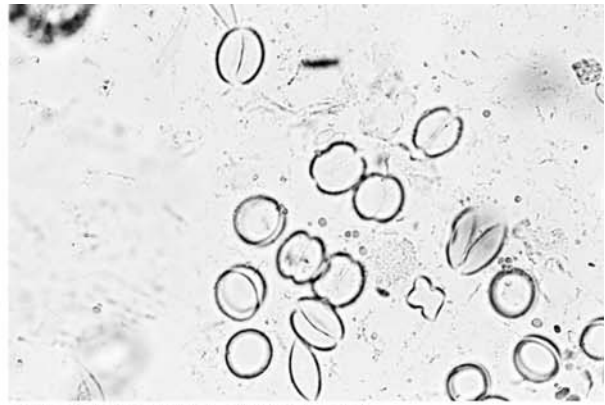
Salicaceae *Salix caprea*
Type material provided by Dr E. Kvavadze



Scrophulariaceae *Digitalis ciliata*
Type material, Mukhuri, W. Georgia



Scrophulariaceae *Digitalis ferruginea*
Type material, Lake Imera



Scrophulariaceae *Pedicularis sibthorpii*
Type material, Lake Cherepanov



Scrophulariaceae *Verbascum phoeniceum*
Type material, Sakhare Lake



Scrophulariaceae *Verbascum pyramidatum*
Type material provided by Dr E. Kvavadze



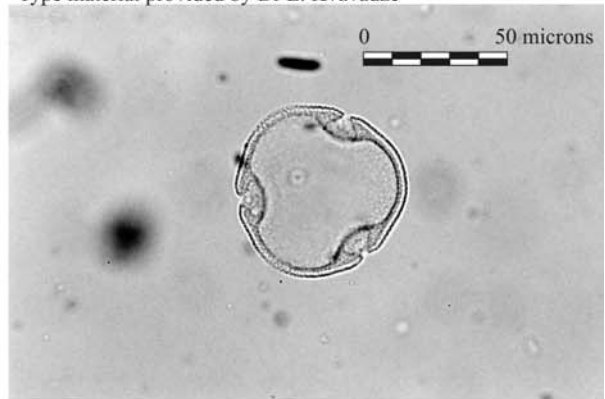
Scrophulariaceae *Veronica arvensis*
Type material, Trialeti Wetland



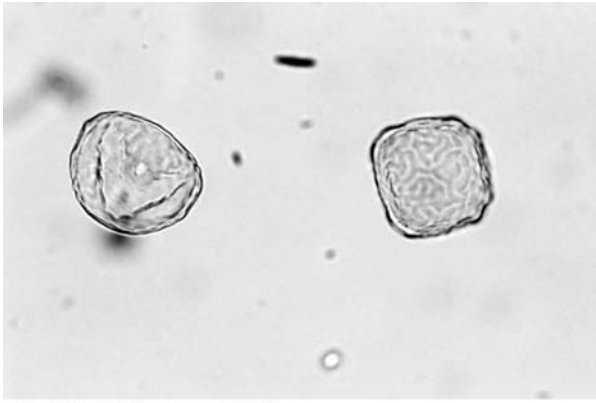
Staphyleaceae *Staphylea pinnata*
Type material provided by Dr E. Kvavadze



Taxaceae *Taxus baccata*
Type material provided by Dr E. Kvavadze



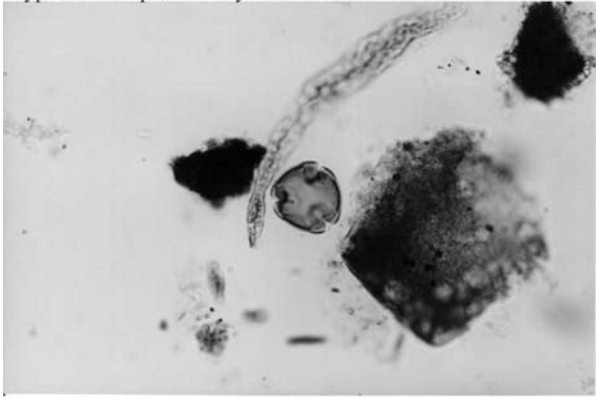
Tiliaceae *Tilia begonifolia*
Type material provided by Dr E. Kvavadze



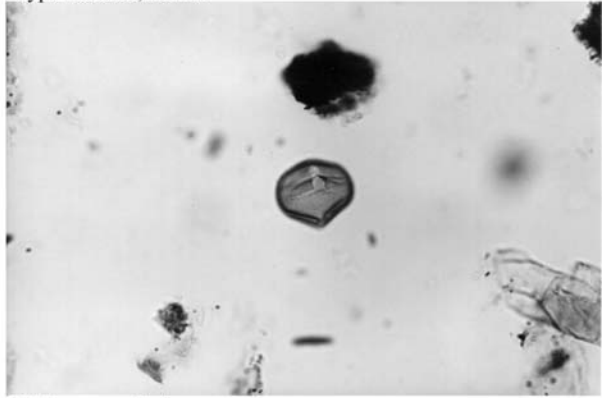
Ulmaceae *Zelkova carpinifolia*
Type material provided by Dr E. Kvavadze



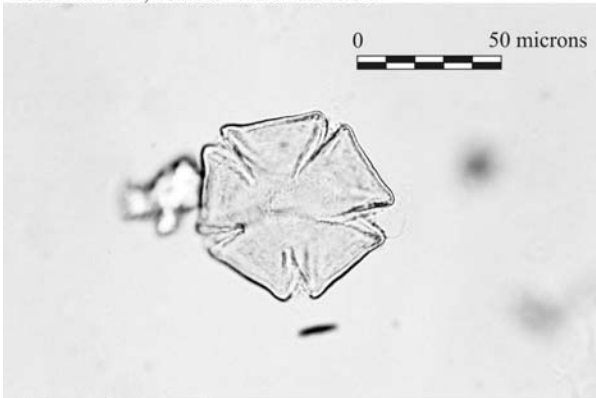
Urticaceae *Parietaria cryptorum*
Type material, Tbilisi



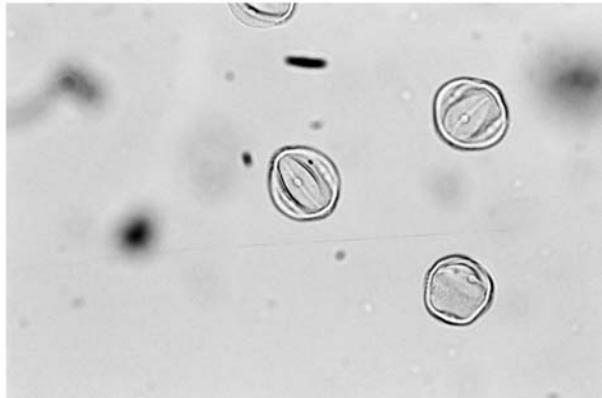
Verbenaceae *Verbena*-type
Fossil material, Tsavkisi Wetland 520 cm



Verbenaceae *Verbena*-type
Fossil material, Tsavkisi Wetland 520 cm



Violaceae *Viola occulta*
Type material, Lake Imera



Vitaceae *Vitis vinifera*
Type material provided by Dr E. Kvavadze