# The first Australian palynologist: Isabel Clifton Cookson (1893–1973) and her scientific work

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Isabel Clifton Cookson (1893–1973) of Melbourne, Australia, was one of that country's first professional woman scientists. She is remembered as one of the most eminent palaeontologists of the twentieth century and had a distinguished research career of 58 years, authoring or co-authoring 93 scientific publications. Isabel worked with great distinction on modern and fossil plants, and pioneered palynology in Australia. She was a consumate taxonomist and described, or jointly described, a prodigious total of 110 genera, 557 species and 32 subspecific taxa of palynomorphs and plants. Cookson was a trained biologist, and initially worked as a botanist during the 1920s. At the same time she became interested in fossil plants and then, Mesozoic–Cenozoic terrestrial (1940s–1950s) and aquatic (1950s–1970s) palynomorphs. Cookson's research into the late Silurian–Early Devonian plants of Australia and Europe, particularly the *Baragwanathia* flora, between the 1920s and the 1940s was highly influential in the field of early plant evolution. The fossil plant genus *Cooksonia* was named for Isabel in 1937 by her principal mentor in palaeobotany, Professor William H. Lang. From the 1940s Cookson focussed on Cenozoic

floras and, with her students, elucidated floral affinities by comparative analyses of micromorphology, anatomy and *in situ* pollen/spores between fossil and extant taxa. This lead to an interest in pre-Quaternary and Quaternary terrestrial pollen and spores, hence Isabel was the first palynologist in Australia. Her work on Paleogene and Neogene pollen and spores during the 1940s and 1950s provided incontrovertible evidence of the former widespread distribution of many important elements of Southern Hemisphere floras. During the early 1950s, while approaching her 60$^{th}$ year, Isabel turned her attention to marine palynomorphs. She worked with great distinction with Georges Deflandre and Alfred Eisenack, and also as a sole author, on acritarchs, dinoflagellate cysts and prasinophytes from the Jurassic to Quaternary of Australia and Papua New Guinea. She also co-authored papers on aquatic palynomorphs with Lucy M. Cranwell, Norman F. Hughes and Svein B. Manum. Isabel Cookson laid out the taxonomic basis for the study of Australasian Mesozoic and Cenozoic marine palynofloras by establishing, or jointly establishing, 76 genera and 386 species of marine microplankton. Her studies throughout her career, although especially in marine palynology, concentrated largely on taxonomy. However, she was one of the first palynologists to demonstrate the utility of dinoflagellate cysts for relative age dating and correlation in geological exploration.

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THE pioneering Australian botanist, palaeobotanist and palynologist Isabel Clifton Cookson (ICC) (1893–1973), affectionately known as 'Cookie', 'indefatigable Cookie' or "Isa", was one of Australia's foremost female scientists. She undertook some of the early research into botany in Australia, did benchmark research on early land plants and Cenozoic plant fossils of Australia, helped elucidate Australia's floral history, and went on to become one of the four pre-eminent dinoflagellate cyst researchers during the early part of the modern era of palynology. The other three pioneer workers on fossil dinoflagellates, Georges Deflandre (1897–1973), Alfred Eisenack (1891–1982) and Maria Lejeune-Carpentier (1910–1995), were all from Europe. Cookson collaborated with Deflandre and Eisenack. This contribution documents Isabel's remarkable life, the 58 year scientific career yielding 93 papers published over a period of 61 years (Online supporting data: Appendix 1) and her many achievements, particularly in relation to her research on palynology (Tables 1–5). Other accounts of the life and work of ICC have been published by Baker (1973a,b), Morgan (1981), Dettmann (1988, 1993) and Turner (2007).

Table 1 to be placed near here.

## The early years (1893–1916)

Isabel Clifton Cookson was born on Christmas Day 1893 in Hawthorn, Melbourne, Victoria, Australia. She was the youngest of three daughters of the English-born John Cookson, and the only child of John's second wife Elizabeth Cookson (*née* Somers) who originated from Adelaide. John and Elizabeth Cookson were 60 and 35 respectively when Isabel was born. She had two older half-sisters, Cassy and Mary, who were 33 and 27 in 1893 and a half-brother, John, who predeceased her birth. Isabel attended Hambledon Ladies' College and later the prestigious Methodist Ladies' College (MLC) in Kew, a suburb of Melbourne. She passed her Junior Public and Junior Commercial examinations in 1910 and, from an early age, had a penchant for the natural sciences, particularly in biology. Isabel's father died during 1909, when she was a schoolgirl. John Cookson's legacy to his wife was the house in Hawthorn; the two half-sisters Cassy and Mary received his other assets. Elizabeth Cookson earned a relatively meagre income after the death of her husband. Therefore, Elizabeth and Isabel Cookson were not wealthy at this time, but had at least a comfortable home. Their modest lifestyle may have stimulated Isabel's shrewd stock market investments later in life.

Isabel excelled in anatomy, botany and physiology in her Senior Public Examination in 1911. She was an extremely talented pianist, and a prefect at MLC. Cookson was also a highly gifted tennis player and represented her school, as part of the 'First-Four', and the University of Melbourne in intervarsity events against Adelaide University. She became an undergraduate in 1913 at the University of Melbourne, and obtained honours in biology in the first two years of her bachelors course. ICC graduated with a BSc with first class honours and the exhibitions in botany and zoology during April 1916 (Fig. 1). As the first recipient of the Final Honours Scholarship in botany in 1917, Isabel was required to demonstrate in practical classes (Gillbank 2010). She was elected as an Associate Member of the Royal Society of Victoria during 1916.

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**A botanical career (1916–1929)**

Isabel Cookson's initial research was on modern plants. Whilst completing her undergraduate studies, Professor Alfred J. Ewart acknowledged Isabel for providing descriptions and figures for five new taxa published in his book *Flora of the Northern Territory* (Ewart & Davies 1917); a Government Research Scholarship funded this work. Isabel's first professional position was as a research student to Frederick Chapman at the then National Museum of Victoria (now Museum Victoria) immediately following graduation in 1916 (Rasmussen 2001). She began research work for a Master of Science in botany in 1917 under the guidance of Alfred Ewart, studying fungi, and concurrently was a part-time demonstrator in botany in the Department of Biology at the University of Melbourne. She also tutored biology undergraduates at Newman College. These various strands represented the beginning of a research career that was to last for the remainder of her life, i.e., a remarkable 58 years! Cookson was to remain professionally associated with the University of Melbourne until her death, 58 years later in 1973, when she was a Research Fellow.

With Alfred Ewart's guidance, Isabel continued to attract research funds. Supported financially by another Government Research Scholarship, she began research into the longevity of cut flowers in April 1917. By 1918 she was a full time (but poorly paid) demonstrator (Gillbank 2010), and continued to be successful at obtaining research grants. Her principal mentors in Melbourne were Frederick Chapman, Alfred J. Ewart, Ethel I. McLennan and Samuel M. Wadham. The young Isabel clearly enjoyed the research and teaching environment, and worked on angiosperms and fungi. Together with her close colleague Ethel McLennan, a noted mycologist and plant pathologist (Parbery 1989), she published on ascomycetes from Australia (McLennan & Cookson 1923, 1926). Isabel was to develop a long-standing interest in mycology (Cookson 1928, 1937a, 1947a).

Unfortunately, Isabel lost her job as full-time demonstrator in 1922, but continued to research on fungi, and developed an interest in fossil plants while demonstrating part-time. After a period of considerable departmental disharmony (Parberry 1989, Gillbank 2010), she undertook the first of her many working visits to Europe in 1925–1926. Isabel travelled to the UK with Ethel McLennan in late 1925. Long-haul travel was different in those days, and the early trips to Europe and back were via long sea journeys. Both Ethel and Isabel worked on fungi with Professor Le Rayner at Imperial College London. However, the fungal cultures Isabel brought from Australia degraded badly during the long journey to Europe. By contrast, McLennan's fungal research was hugely successful. Luckily, Isabel also brought some Palaeozoic plant fossils with her, and liased briefly with Professor Sir Albert C. Seward of the University of Cambridge on her burgeoning interest in palaeobotany. Also in 1925, she also visited Professor William H. Lang at the University of Manchester in 1925 to discuss fungal research and palaeobotany.

Although Isabel returned to Melbourne from the UK in 1926 without a job, Ethel McLennan and Professor Samuel M. Wadham obtained a grant of £30 for ICC to investigate crown rot of the English walnut tree at Wandilagong in northeast Victoria. Isabel worked on this project in the Department of Agriculture at the University of Melbourne, and identified that this outbreak was due to the pathogen *Phytophthora nicotianae* B. de Haarn var. *parasitica* Dastur in diseased areas (Cookson 1929, McLennan *et al*. 1973). In terms of improving the cultivation and yields of walnuts, Isabel's findings on the occurrence and life cycle of the fungal pathogen proved invaluable. She then visited Manchester again between late 1926 and early 1927 as a mycologist in cotton research and to further work on Victorian Palaeozoic plants in collaboration with Professor William H. Lang (see below).

Following this rather uncertain period, and another working visit to the UK, Isabel returned to Australia. She was appointed as a permanent (but poorly paid) lecturer during 1929, when a new Department of Botany was established by the University of Melbourne (Gillbank 2010). This was not an era of equality in pay; women earned around half the salary of men for the same job, and had no pension rights. This appointment made Isabel one of the earliest women to become a professional scientist in Australia (Carey 2001). At this time Isabel was 36 years old and this was her first substantive academic position. She designed, taught and demonstrated an evening class in botany to first year undergraduates in botany. Baker (1973b) recalled that her lectures and practical classes were of an excellent standard, that Isabel was very clear and that she displayed a “patient attention to detail.” Cookson also taught palaeobotany to advanced botany undergraduates. A testament to the excellence of Isabel’s teaching is the fact that some of her undergraduate students went on to have productive careers in research. These included, in chronological order, Suzanne L. Duigan, Kathleen M. Pike (later McWhae), John G. Douglas and Mary E. Dettmann.

Isabel published six papers on Southern Hemisphere botany at this time (Table 2). Following her contribution to Ewart & Davies (1917), Cookson’s first article was on angiosperms from Victoria (Cookson 1921) and was issued when Isabel was only 27 years old. This was followed by McLennan & Cookson (1923, 1926) and Cookson (1928, 1929) on fungi. Unusually in Cookson (1928, p. 268), she gave her professional address as the Barker Cryptogamic Research Laboratory of the University of Manchester, rather than the University of Melbourne. This reflects that this work, on the ascomycete fungal species *Melanospora zamiae* Corda 1837 from Malawi, was undertaken in Manchester during late

1926 to early 1927 (Table 1). Her work on mycology was acknowledged by Swart & Griffiths (1974), who established the genus *Cooksonomyces* for an epiphyllous fungus associated with *Banksia* leaves for Isabel. Cookson's interest in, and knowledge of, the Australian flora never waned (Cookson 1937a), and was to be especially important in her palaeobotanical work, especially on the Paleogene–Neogene floras of Australia.

Table 2 to be placed near here.

**Botanist to palaeobotanist (mid 1920s–1950s)**

At an early stage of her career, during the early 1920s, Isabel Cookson became increasingly interested in late Silurian to Early Devonian fossil plants, and this changed her research focus markedly. It seems likely that she was introduced to palaeobotany by her earliest mentor, Frederick Chapman, who was the palaeontologist at the National Museum of Victoria in Melbourne. Cookson's interest in fossil plants came despite her entire lack of formal education in geology, however it was a fascination that was to be an enduring one. It is possible that Isabel was also inspired by Adele V. Vincent, who was the first Australian female palaeobotanist (Turner 2007, p. 190). Vincent was a contemporary of Isabel's; she graduated from the University of Melbourne in 1917 and undertook MSc studies on Silurian–Devonian floras of Victoria (Vincent 1926, Douglas & Holmes 2006). Table 3 is a synthesis of the 22 publications on palaeobotany by Isabel Cookson and her collaborators.

*Palaeozoic palaeobotany (mid 1920s–1949)*

Isabel's introduction to plant fossils was, with Frederick Chapman, to catalogue the "Sweet" collection of Late Triassic plants from Leigh Creek, South Australia (Chapman & Cookson 1926). At the same time she investigated the National Museum of Victoria's collection of Palaeozoic plant fossils, including specimens earlier examined by Vincent (1926) from Walhalla and the Rhyll bore that had been collected by the Geological Survey of Victoria. Isabel described two specimens which she allocated to *Arthrostigma*, a Northern Hemisphere genus (Cookson 1926), and recognized that consultation with palaeobotanists in England would be useful in determining the identification of other specimens in the National Museum of Victoria's collection. This decision proved extremely fortuitous. After visiting Professor Sir Albert C. Seward at Cambridge, Isabel visited Manchester to consult with Professor William H. Lang, who was keen that she return with additional Australian fossil plant material, and arranged a position for her as a mycologist in cotton research at the University of Manchester from late 1926 to early 1927. Many of the fossil plant specimens that Isabel took on her return visit to Manchester were from the collection of the National Museum of Victoria, but some she collected herself from localities in rough bushland near Woods Point, in the upper reaches of the Yarra Valley, and in adjacent high country in east Victoria. Of particular importance are those specimens of *Baragwanathia* that are associated with the graptolite *Monograptus* on the same bedding plane; some of these specimens were collected by Cookson. During the visit of late 1926 to early 1927, and on a further visit to Manchester funded by a grant in 1929, several publications were prepared (Lang & Cookson 1927, 1931, 1935, Cookson 1935). These proved to be highly significant to the understanding of early land plant evolution. She was awarded a Doctor of Science (DSc) in 1932 for her work on Palaeozoic plants; this was only the fourth time a woman had been awarded a DSc by the University of Melbourne. It is abundantly clear that William H. Lang was Cookson's true palaeobotanical mentor; he, like Cookson, was a trained botanist who became interested in palaeobotany in later life (Salisbury 1961). The collaboration with Lang on the early Palaeozoic palaeobotany of Victoria was a sustained one.

The plant fossil material from Victoria that Cookson and Lang worked on was initially not well constrained stratigraphically. Lang & Cookson (1927) published preliminary notes and photographs of the leafy shoots of a then-unamed plant and noted chronostratigraphical problems with this material. The majority of the specimens collected from the Jamieson area could not be assigned to any known pre-Carboniferous plant genus. This plant was famously described by Lang & Cookson (1935) as *Baragwanathia longifolia,* and identified as an early lycophyte (Fig. 2). Lang & Cookson (1927) also re-identified a specimen from the Rhyll Borehole as cf. *Thursophyton*. These authors commented that, on the basis of the entire flora, the material may be Middle Devonian. It was thought that the material exhibited an anomalously high level of cellular organization to be late Silurian in age. Subsequently, Lang & Cookson (1935) reported graptolite evidence indicating a late Silurian age for these plant-bearing strata. This discovery made these fossil plants the oldest vascular land plants then known in the world. The publication of Lang & Cookson (1935) was highly influential, and included unequivocal independent evidence from the graptolite genus *Monograptus* for the late Silurian (early Ludlow) age of the material collected along the Yarra Valley in Victoria by Isabel. The graptolite identifications were performed by Gertrude L. Elles of the University of Cambridge. *Baragwanathia* was named for George Baragwanath, who was then Secretary of Mines for Victoria. The age of the type material has been controversial (Jaeger 1966), but a late Silurian (Ludlow) age based on graptolite evidence has been confirmed by Garratt *et al*. (1984) and Rickards (2000). Further work on the Silurian–Devonian plants from Victoria was undertaken by Isabel in consultation with William H. Lang during the tenure of a

Grisedale Research Scholarship (1933–1934), and a Leverhulme Research Grant at the University of Manchester (1948–1949), resulting in several papers (Cookson 1935, 1937b,c, 1945a, 1949). *Baragwanathia* has a worldwide distribution, and persisted at least until the late Early Devonian (Emsian) (Hueber 1983). The work of Lang & Cookson (1927, 1931, 1935) and Cookson (1935) on the late Silurian *Baragwanathia* flora of Australia, which includes a range of lycophytes, rhyniophytes, trimeriophytes and zosterophyllophytes, revolutionized the understanding of early Palaeozoic land plant evolution, and brought ICC well-deserved international recognition (Brown 1946, Garratt *et al*. 1984, White 1986).

William H. Lang (1937, p 249–250) named the primitive plant genus *Cooksonia* from the late Silurian–Early Devonian of England and Wales after ICC. Baker (1973a,b) erroneously stated that Croft & Lang (1942) described this genus. *Cooksonia* is a dichotomously branching, leafless plant with slender axes, terminating in large sporangia. *Cooksonia hemisphaerica* and *Cooksonia pertoni* were described by Lang (1937, p 250–257), the latter after Perton Quarry, Herefordshire. Lang (1937, p. 250) wrote: "On a short visit to the (Perton) quarry in company with Dr. Isabel Cookson, she collected three extremely interesting specimens from a sandy layer close to the base of the Downton Sandstone. I am indebted to her for giving me these specimens for investigation. As will be seen, they provided the proof that the terminal structures were sporangia." Furthermore, "I propose the name *Cooksonia* in recognition not only of Dr. Isabel Cookson having collected the type specimens showing the sporangia with spores in connexion with the axes, but also of her important work on plants of still earlier geological age from Australia." (Lang 1937, p. 253).

The collaboration with Lang was clearly very scientifically successful, and it was also an extremely congenial one (Watson 2005, p. 242). When Isabel died in 1973, she left a legacy to the University of Manchester "in memory of a valuable and happy time spent there in the time of the late Professor W.H. Lang."

Fig. 2 to be placed near here.

*Cenozoic palaeobotany (1940–early 1950s)*

During the 1940s, Isabel turned her attention to research on Oligocene–Miocene fossil plants and fungi (Fig. 3) from the brown coal-bearing strata of the LaTrobe Valley, Victoria and other Paleogene–Neogene sediments in southeastern Australia (Cookson 1947a,b, 1953a, 1954a, Cookson & Duigan 1950, 1951, Cookson & Pike 1953a,b, 1954a, Clifford & Cookson 1953). The huge reserves of brown coal in the Latrobe Valley were being exploited by open cast mining for briquettes and electricity generation. Cookson's first study of the brown coal flora was of Oleaceae leaves from Yallourn, Victoria and Moorlands, South Australia. Botanical affinities were demonstrated via comparative anatomical and morphological analyses of the mummified fossil leaves and leaves from extant taxa (Cookson 1947b). Associated with the fossil leaves, within the sediment matrix, were small disc-shaped objects representing the ascomata of epiphyllous fungi that Cookson had also observed in Paleogene–Neogene lignites from other localities in Australia, Kerguelen and New Zealand (Cookson 1947c,d). Suzanne (Sue) L. Duigan, who undertook MSc studies with Cookson, collaborated with her on fossil Banksieae and Araucariaceae from the Yallourn coals and sediments from other locations (Cookson & Duigan 1950, 1951). These studies involved maceration of the mummified leaves and cones, cuticle preparation, sectioning of leaves, and extraction of pollen from both fertile material and the surrounding sediment. Suzanne Duigan then went to the University of Cambridge where she completed a PhD supervised by Professor Sir Harry Godwin, before returning to Melbourne around 1956, and collaborated once again with Cookson on fossil *Azolla* (Duigan & Cookson 1957). Kathleen M. Pike (later McWhae) also completed a MSc under Isabel. They collaborated on *Dacrydium, Phyllocladus* and *Podocarpus* (Podocarpaceae) cones, cuticles, leaves and pollen in Paleogene–Neogene coals and other sediments from Yallourn and other Australian localities (Cookson & Pike 1953a,b, 1954a). Kathleen Pike also studied Casuarinaceae and *Banksia* cones (Pike 1952), before travelling to Cambridge to work on Quaternary pollen with Harry Godwin. On her return to Melbourne, she continued pollen research with Cookson (Cookson & Pike 1954b, 1955, Pike 1956). Another plant fossil from Yallourn, *Muscites yallournensis*, which was then identified as a moss capsule, was described in collaboration with H. Trevor Clifford (Clifford & Cookson 1953). This has since been shown to be a *Typha* seed fossil by Clifford & Dettmann (2000). Other Australian Paleogene–Neogene plant taxa identified by Cookson from foliage/cuticle and/or pollen include *Acacia* and *Macrozamia* (see Cookson 1953a, 1954a).

Cookson’s palaeobotanical studies provided a rich legacy for subsequent workers, and paved the way for elucidating the floral history of Australia. Her detailed and holistic approach to anatomy, detailed illustration, *in situ* studies and morphology provided a sound basis for identifying the diverse elements of Australia’s Cenozoic vegetation. Although Cookson’s final contributions on palaeobotany were published in the early 1950’s, her continuing work on palynomorphs also contributed enormously to our understanding of the Cenozoic floral history of Australia. She donated her collection of fossil plants to the National Museum of Victoria in 1950 (Rasmussen 2001).

Cookson was an invited speaker at the official opening of the Birbal Sahni Institute of Palaeobotany, Lucknow, India, on April 3rd, 1947. At this ceremony, she was appointed to the Australian National Research Council. ICC also undertook committee work in the subject. She was a regional delegate for Australasia and Oceania of the International Organisation of Palaeobotany (IOP), and sat on the IOP committee, between 1954 and 1964 (Boureau *et al*. 1956, 1960). The Botanical Society of America made Isabel a Corresponding Member during 1957 in tribute to her contribution to botany, palaeobotany and palynology.

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**Palaeobotanist to palynologist (early 1940s onwards)**

Cookson's venture into palynology was a spinoff of her palaeobotanical research on the Yallourn brown coal floras in the 1940s. During preparation of mummified leaves, she was aware that dispersed microfossils occurred in the coal matrix. As recounted to one of us (MED), her curiosity prompted her to prepare a small portion of a Yallourn briquette using the chlorination-acetolysis method of Erdtman (1943, 1960). She was amazed that the residue contained a myriad of beautifully-shaped and sculpted pollen and spores; these included pollen of *Nothofagus* (see Fig. 4/H,I) and Proteaceae, both forming the subject of later research. In the 1940s, the modern era of palynology was in its infancy and the discipline was developing rapidly due largely to significant breakthroughs in preparation techniques and marked improvements in microscope technology (Sarjeant 2002).

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Most practitioners of palynology at that time were based in Europe or North America. Palynology in Australia began on Permian material. The earliest paper on Australian palynomorphs was Newton (1875), on the prasinophyte genus *Tasmanites* from Permian oil shales from Tasmania. Shortly after this, Bertrand & Renault (1894) and Bertrand (1896) reported similar algal palynomorphs from the Kerosene Shale of Permian age from New South Wales. These represent the first reports of palynomorphs from mainland Australia. In New Zealand, Lucy M. Cranwell published on terrestrial palynofloras from Quaternary sediments, and pollen and spores from the extant flora (e.g., Cranwell & von Post 1936, Cranwell 1939, 1940). The earliest work on Australian fossil sporomorphs was by the Indian researcher Chinna Virkki, who documented Permian pollen and spores from New South Wales and Victoria, Australia and India (Virkki 1937, 1939, 1946). A concise account of the history of palynology in Australasia was given by de Jersey *et al*. (1987).

Isabel Cookson's interest in palynology was aroused by her experiment with the Yallourn briquette, and so began her next career on this discipline. Only the Permian and Triassic specialists Noel de Jersey and John A. Dulhunty were working on palynomorphs in Australia during the early to mid-1940s (de Jersey 1946, Dulhunty 1946, 1947, Webby 1986). No one else in Australia was working on palynomorphs of pre- or post-Permian–Triassic age at that time, and ICC can be considered the founder of Australian palynology. She advised some of the other early workers on palynology in Australasia such as Basil E. Balme in Sydney and then Western Australia, R. Ashley Couper in Wellington (New Zealand), Noel de Jersey in Queensland and associates in Melbourne. Interest in palynology in Australia increased significantly following oil discoveries at Rough Range in Western Australia in 1953, and at Moonie in the Surat Basin of Queensland in 1961.

Typically, Isabel cast her net wide, and she researched the Cretaceous to Neogene pollen and spores of Australia, and the Mesozoic and Cenozoic marine microplankton of Australia and Papua New Guinea. For all her extremely distinguished contributions on Palaeozoic palaeobotany between the 1920s and the 1940s, it is in palynology where Isabel made her greatest scientific impact. She worked on several aspects, including floral affinities and taxonomy. Cookson is not known for her work on biostratigraphy, and many of her papers do not discuss correlation and ranges in depth. Despite this, Isabel was one of the first palynologists to realise that palynomorphs had potential as reliable marker fossils. The first mention of this was Cookson (1953b, p. 468, 469), in a study on Jurassic–Cretaceous and Paleogene miospores from South Australia. It was stated that: "This difference in composition suggests that the two microfloras concerned represent the vegetation of two distinct geological periods...." Isabel prepared much of her pre-Quaternary material herself; she demineralized using hydrofluoric acid, normally followed by oxidative maceration using Schulze's solution and finally treatment with dilute alkali solution (e.g., Cookson & Eisenack 1958, p 19, 20). For Quaternary and some Paleogene–Neogene material, she subjected her samples to bleaching by chlorination and/or acetolysis (Erdtman 1943, 1960, Delcourt *et al*. 1959). Noel de Jersey (personal communication to JBR, 2013) recalls her beautiful preparations, and the exquisite preservation of *Nothofagus* pollen that Isabel extracted from the Victorian brown coals (Fig. 4H).

ICC had to improvise in order to take photomicrographs of her palynomorphs. Photomicrographs published in her pre-1940 papers were taken by professionals or associates in the institutions she worked in. During the early 1940s, she sought the advice of Ernst Matthaei, an optical instrument expert and former Zeiss technical agent of the Microscope Unit associated with the Botany Department of the University of Melbourne (Gillbank 2010). Matthaei advised her, maintained her Zeiss microscope (Fig. 5) and, from pre-war equipment, devised a bellows to fit into the trinocular tube of the microscope. Isabel would climb onto a chair to focus with a spy glass on a ground glass plate set into a wooden frame, prior to the insertion of a glass photographic plate into the frame on top of the bellows and using a light-proof covering. Cookson developed and printed all of her photographs in a dark-room adjacent to her office. A similar method, somewhat modified or improvised, was used when she was overseas (Manum 2003, p. 4). Despite these limitations, Isabel consistently produced excellent photomicrographs.

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*Terrestrial palynology (early 1940s onwards)*

Isabel's first palynological research was on pollen and spores as part of her studies on the Oligocene–Miocene brown coal-bearing successions of Victoria, Australia. Her initial contribution on palynology was a short paper on Paleogene–Neogene pollen from southeastern Australia, published when Isabel was 53 (Cookson 1945b). She made the point that the palynology of the Australian brown coal deposits had not hitherto been investigated despite their economic importance and in contrast to similar resources in, for example, Germany. She investigated isolated samples from several disparate coal-bearing successions in New South Wales, South Australia and Victoria. Several localities such as Altona, Maryvale and Yallourn in Victoria were mentioned, but no actual data were given except that she noted the predominance of pollen grains from wind-pollinated plants in the Yallourn assemblages. The potential of the correlation of individual coal seams based on distinctive pollen spectra using the technique developed by Raistrick (1933) and Raistrick & Simpson (1933), and the elucidation of coal seam palaeoecology was also mentioned. She noted that, whereas the brown coal at Yallourn is dominated by coniferous wood, pollen of the southern beech *Nothofagus* is abundant suggesting that this genus occupied upland sites surrounding the coniferous coal swamp vegetation. Cookson realised that to further these palaeoecological studies, it was necessary to document pollen and spores of living Australian plants.

In this context, ICC noted fossil pollen similar to that of extant Proteaceae were also common in the samples she investigated. Isabel subsequently documented fossil pollen of *Nothofagus* from the sediments, categorizing alphabetically the ten different types she distinguished (Cookson 1946a), and relating the fossils to pollen of the extant *fusca* and *menziesii* groups of the genus. Cookson noted an intermediate type then unknown among living species, but subsequently found to be characteristic of the *brassii* group of species confined to New Guinea and New Caledonia (Cookson 1952). Following her systematic treatment of fossil *Nothofagus* pollen, which she later formalized as species using binomial nomenclature (Cookson 1959), Isabel systematically analysed lignites and associated sandstones from Kerguelen in the southern Indian Ocean forwarded to her by Sir Douglas Mawson and the Natural History Museum (Cookson 1946b, 1947d). The sporomorph and sporotype taxa described by her were attributed binomial names following the coenotype system of Erdtman (1947). This system was used by Isabel and collaborators for fossil pollen and spores until the mid 1950s; type specimens were not designated for the individual taxa. However, after attending the 1954 International Botanical Congress in Paris, France, and on learning of the nomenclatural methodology adopted by American palynologists, she thereafter treated the taxa as form genera and species, and designated types for individual species (Cookson 1957).

Isabel was given sabbatical leave in 1948 and visited the Palynology Laboratory at Stockholm, Sweden to work with Dr Gunnar Erdtman, funded by a grant from the Commonwealth Scientific and Industrial Research Organisation (CSIRO). Erdtman and ICC worked on detailing pollen of the Proteaceae, an important family of evergreen angiosperms with characteristic inflorescences, which are distributed throughout the Southern Hemisphere. The section on the Proteaceae in a classic book by Erdtman was co-written with ICC (Cookson & Erdtman 1952). This is the only co-authored section in Erdtman's (1952) landmark text on modern pollen morphology and taxonomy. During her stay in Stockholm, Isabel prepared her paper on fossil proteaceous-like pollen from the Australian Paleogene–Neogene (Cookson 1950).

On her return to Melbourne in 1949, and following discussions that began in 1947, the Brown Coal Pollen Research Unit (later referred to as the PRU) in the Botany Department of the University of Melbourne was established, and ICC was made the first head (Fig. 6). The PRU was sponsored by CSIRO and the State Electricity Commission of Victoria, and was administered by Professor John S. Turner who was head of the Botany Department and Dr Austin B. Edwards of CSIRO. Mary E. Dettmann, Suzanne L. Duigan and Kathleen M. Pike, all women, were research assistants in the PRU. This was not unusual because the world of palaeobotany was well-represented by women at this time (Watson 2005, p 249–250). When setting up this unit, Isabel must have drawn from her experiences during her visit to Gunnar Erdtman's palynology laboratory in Sweden the previous year. In her role as head of the PRU, the first one of its type in Australia, she no longer had undergraduate teaching duties and concentrated on palaeobotanical and palynological analysis of the extensive brown coal-bearing successions of Victoria. Studies of modern pollen and spores were also undertaken. Isabel worked with Suzanne L. Duigan, and independently, on the palaeobotany of Paleogene–Neogene brown coals of

Victoria and compared components of this material with extant plants (Cookson & Duigan 1950, 1951, Cookson 1956a, Duigan & Cookson 1957). Duigan was appointed a lecturer in botany by the University of Melbourne in 1960. She died in 1993 and was honoured with a *Festschrift* four years later (Kershaw 1997). ICC and Kathleen M. Pike published extensively on the Paleogene and Neogene palaeobotany and palynology of Australia (Cookson & Pike 1953a,b, 1954a,b, 1955). During this period, Cookson had the first opportunity of examining borehole sequences, and recognized the potential biostratigraphical utility of pollen and spore taxa (Cookson 1953c, 1954b,c, Baker & Cookson 1955, Harris & Cookson 1965). Based on the occurrence of *Ruffordiaspora* (*al. Mohrioisporites*; Fig. 4E), ICC suggested that the strata underlying a Paleogene–Neogene sucession in the Otway Basin are Cretaceous in age. Moreover, she distinguished two successive microfloras, one of Paleocene age and the younger of probable Eocene age. Isabel also noted the presence of reworked Palaeozoic pollen and spores in Upper Cretaceous and Paleogene–Neogene palynofloras (Cookson 1955), and that calcareous tests of foraminifera are rendered translucent in hydrofluoric acid (Cookson & Singleton 1954). A selection of pollen and spores described by Cookson are illustrated in Fig. 4.

In the later years of the 1950s, further work on Mesozoic palynofloras was undertaken (Cookson & Dettmann 1958a,b, 1959a,b,c, 1961). The terrestrial components were, in part, systematically analysed, successive microfloras noted and a range of stratigraphically significant species determined. The latter provided a reliable basis for correlation between marine and terrestrial sequences. Significantly, it was determined that the major thickness of the non-marine Otway and Strzelecki groups are of Early Cretaceous age, and not Jurassic as had been previously suggested early in the 20th century based on megafloras.

The PRU operated successfully over many years, and it unequivocally established Isabel Cookson as the leading palynologist in Australia. This research group demonstrated that palynomorphs could be used as biostratigraphical indices, and that fossil pollen-spore associations can help to trace floral evolution and history. Indeed, many of the species described and instituted by Cookson and her co-workers are important zonal indices in the pollen-spore zonal frameworks established for Australian Jurassic, Cretaceous, Paleogene and Neogene sedimentary rocks (e.g., Helby *et al.* 1987, Partridge 2006a,b,c). The work of the PRU significantly helped the intensive geological exploration of Australia for oil following World War II. The PRU sorority under Cookson published around 30 papers, and most of these were authored or co-authored by ICC with her colleagues Mary E. Dettmann, Suzanne L. Duigan and Kathleen M. Pike. The PRU is extant, and remains in the School of Botany at the University of Melbourne. It is now the Isabel C. Cookson Laboratory, however the name, personnel, research focus and funding model have all significantly changed (see http://www.botany.unimelb.edu.au/Cookson/cookson.html).

Isabel formed a close professional association with the Perth-based terrestrial palynologist Basil E. Balme, who worked at CSIRO in Sydney and then the University of Western Australia in Perth, during the 1950s (Playford & Truswell 1988). This came about while Balme was working on the Jurassic and Cretaceous pollen and spores of Western Australia (Balme 1957). Balme supplied several samples from Western Australia to Isabel during the late 1950s and early 1960s. Thie material was largely from boreholes drilled by West Australian Petroleum (WAPET), and originally released by J.R.H. McWhae. However, the Cookson and Balme team published only one paper together (Cookson & Balme 1962).

Fossil dispersed pollen and spore taxa named in her honour include the spore genus *Cooksonites* Pocock 1962, and a multitude of dispersed spore and pollen species of

Mesozoic and Cenozoic age. Additionally, several fossil fungal species bear the epithet *cooksoniae* in her honour (see http://www.indexfungorum.org). A synthesis of the 38 contributions on terrestrially derived palynomorphs authored by Isabel Cookson and her co-workers is given as Table 4.

Fig. 6. to be placed near here.

Table 4 to be placed near here.

*Marine palynologist (1945 onwards)*

*Overview.* During her extensive studies of the Cretaceous and Paleogene–Neogene pollen and spores of southeast Australia in the 1940s and 1950s, Isabel became aware of the presence of several groups of aquatic palynomorphs in the Mesozoic and Cenozoic of Australia. Specifically, ICC first observed marine microplankton in 1945 from the Nelson Bore, Victoria (Baker & Cookson 1955), but gave priority to her pollen and spore work at this time (Baker 1973b, p vi). Nonetheless, she rapidly became interested in acritarchs, brackish/freshwater algae, dinoflagellate cysts and prasinophytes. This was at a time when aquatic palynology was in its infancy, and fossil dinoflagellate cysts were assumed to be the remains of the motile cell, prior to the observations of Evitt (1961) and Evitt & Davidson (1963). Upon looking further, both geographically and stratigraphically, she realized that aquatic microplankton from the Mesozoic and Cenozoic sedimentary successions of Australia are extremely abundant, diverse and well-preserved. Furthermore, ICC recognized that these marine palynomorphs were virtually entirely undescribed, and that they had considerable biostratigraphical potential. Consequently, she was frequently consulted by oil exploration companies and state geological surveys on age determinations based on palynology. As a result of these contacts, ICC began to amass a large collection of Australian and Papuan samples that yielded superb dinoflagellate cyst assemblages. The material provided to her represented a valuable resource of subsurface core and cuttings, largely from hydrogeological boreholes, oil exploration wells and seismic shot-holes. Due to the moist, warm climate during the late Cretaceous and Cenozoic, most Australian outcrop samples have been intensely weathered over a long period of time (in many cases since the Cretaceous), and much of the palynomorph content has been destroyed by oxidation.

During 1952, ICC was promoted to Research Fellow and Senior Lecturer by the University of Melbourne. By that time equal pay legislation had been enacted and Isabel had, at last, a comfortable salary and pension rights. One year later, her first paper on organic-walled microplankton (both freshwater/brackish alga and dinoflagellate cysts) was published (Cookson 1953d); this was when she was 59, and only six years prior to Isabel's retirement! This, her 30th paper, was the first report of aquatic palynomorphs from Australia, and described Paleogene, Neogene and Quaternary hystrichospheres (as spinose dinoflagellate cysts were then known) from Victoria and Western Australia. Cookson (1953d) included the descriptions of 11 different 'hystrichospheres.' One new species, the dinoflagellate cyst *Emmetrocysta urnaformis* (as *Cannosphaeropsis urnaformis*) was formalized. *Emmetrocysta urnaformis* was the first fossil dinoflagellate cyst to be described from Australia, and the first of 386 species of aquatic palynomorphs described by Isabel and her co-workers (Table 5). Cookson (1953d) also documented *Botryococcus braunii* from the Paleogene to Quaternary of South Australia, New South Wales, Victoria and Western Australia, and *Pediastrum boryanum* from the Paleogene and Neogene of South Australia and Victoria.

It is clear that Isabel was working outside her botanical/palaeobotanical comfort zone at this time and she wrote: “The Hystrichosphaerid (dinoflagellate cyst) population of the Australian Tertiary rocks is actually greater than is indicated by this account. Several varieties more difficult to place systematically have been purposely omitted.” (Cookson 1953d, p. 121, authors additions in parentheses). With this in mind, and perhaps mindful of her successful palaeobotanical research with Professor William H. Lang in the 1920s, Cookson sought to work with the leading European marine palynologists of the time. This led to significant collaborations with Georges Deflandre, Alfred Eisenack and Svein B. Manum. She also researched on marine palynomorphs with Lucy M. Cranwell and Norman F. Hughes. By far the majority of Cookson’s work on Australasian marine microplankton was done in collaboration with Eisenack (see below). Her work in this field also influenced her friend and colleague John G. Douglas, who published a paper on the Late Cretaceous and Paleogene dinoflagellate cysts from western Victoria (Douglas 1960).

Further to the collaborations summarized above, ICC later published as a sole author on dinoflagellate cysts from the Cretaceous and Paleogene of New South Wales, South Australia, Victoria and Western Australia (Cookson 1956b, 1965a,b). Cookson (1956b) is a short contribution; four new dinoflagellate cyst and one acritarch species were described from the Cretaceous and Paleogene of localities in New South Wales, South Australia, Victoria and Western Australia. The dinoflagellate species include *Dinogymnium nelsonense*, *Isabelidinium cretaceum*, *Odontochitina porifera*, which are all early Santonian to early Maastrichtian marker species (Helby *et al*. 1987, fig. 40). The upper Eocene Browns Creek Clays of Victoria was the principal focus of Cookson (1965a), and one new dinoflagellate cyst genus, *Diphyes*, and five new microplankton species were described. The presence of the acritarch *Paucilobimorpha spinosa* in the Browns Creek Clays indicates a late Eocene (Bartonian) age (Wilson 1984, fig. 4).

Cookson (1965b) published the first part of a study on the dinoflagellate cysts of the Paleocene Pebble Point Formation of Victoria, erecting three new species, including *Palaeocystodinium australinum*, which is a marker for the Late Cretaceous (late Campanian) to Paleocene (Marshall 1984, Wilson 1984, figs 3, 4). *Glaphyrocysta retiintexta* was also reported. Wilson (1984, fig. 4) reported the range of *Glaphyrocysta* cf. *retiintexta* from New Zealand as being Paleocene to early Eocene (Ypresian/Lutetian).

A tabulated synopsis of synthesis of the 33 research papers on aquatic palynomorphs written by Isabel Cookson and her co-workers is given as Table 5. All aquatic palynomorph taxa below generic level mentioned herein are listed in Online supporting data: Appendix 2 with full author citations.

*The French connection (Deflandre and Cookson, 1954; 1955).* Isabel spent her 1954 sabbatical leave in France, and visited Professor Georges-Victor Deflandre at the Laboratoire de Micropaléontologie de l'École Pratique des Hautes Etudes, in Paris. At that time Deflandre was the leading authority on fossil dinoflagellates (Sarjeant 1973, 1999a, Evitt 1975, Noel 1975, Verdier 1975), and ICC sought to collaborate with him on prepared Jurassic to Neogene material from Australia (New South Wales, South Australia, Victoria and Western Australia) and Papua New Guinea. A preliminary account and a major monograph arising from this work were published (Deflandre & Cookson 1954, 1955 respectively).

The study by Deflandre & Cookson (1955) represents the first comprehensive account of fossil marine microplankton from the Jurassic to Neogene of the Southern Hemisphere. Marine microplankton from 40 samples from throughout mainland southern Australia and Papua New Guinea were described. The research for this work was done entirely in Paris during 1954 on material, most of which, Isabel had prepared in

Melbourne. Most of the siliciclastic samples were powdered, boiled in hydrofluoric acid, then subjected to chlorination and acetolysis and finally treated with dilute alkali solution (Deflandre & Cookson 1955, p. 245). The sample W.451 from the Era River District of Papua New Guinea was stated to be from a Lower Cretaceous succession, but is clearly of Late Jurassic (Oxfordian) age due to the presence of the dinoflagellate cyst *Wanaea spectabilis* (see Helby *et al*. 1987, Riding & Helby 2001, Riding *et al*. 2010). This was one of Deflandre's last major papers on marine microplankton, and the only one which was written in English. He undoubtedly helped Isabel learn a great deal about aquatic palynomorphs, and ICC would have benefitted greatly from using *Le Fichier Micropaléontologique Général* and Deflandre's reference collection of microscope slides in Paris. This collaboration between Cookson and Deflandre was an effective one because the latter could readily identify species that had already been described from the Northern Hemisphere. Cosmopolitan dinoflagellate cyst species identified in Deflandre & Cookson (1955) include *Cordosphaeridium inodes*, *Deflandrea phosphoritica, Dinopterygium cladoides*, *Odontochitina operculata, Oligosphaeridium complex*, *Rigaudella aemula*, *Rottnestia borussica* and *Spiniferites ramosus*. Deflandre & Cookson (1955) described 45 species including the key taxa *Apectodinium homomorphum*, *Circulodinium distinctum*, *Conosphaeridium striatoconum*, *Cyclonephelium compactum*, *Eisenackia crassitabulata*, *Heterosphaeridium heteracanthum*, *Hystrichokolpoma rigaudiae*, *Isabelidinium pellucidum*, *Lingulodinium machaerophorum*, *Odontochitina cribropoda*, *Oligosphaeridium pulcherrimum*, *Operculodinium centrocarpum* and *Wanaea spectabilis*. Furthermore, the important dinoflagellate cyst genera *Cyclonephelium, Eisenackia* and *Nematosphaeropsis* were also established. A brief analysis of the biostratigraphical potential was given, including a range chart for the Paleogene and Neogene forms (Deflandre & Cookson 1955, p 301–305, table 1). This section represents one of the earliest accounts of this topic and was clearly written by Cookson; stratigraphical aspects were never discussed by Deflandre (Sarjeant 1973, p. 327).

Deflandre & Cookson (1955) demonstrated for the first time that marine Upper Cretaceous sedimentary rocks were present in Victoria. Specifically, this material was between 1882 m and 1757 m in the Nelson Bore, Victoria (Baker & Cookson 1955). Following this discovery, the Mesozoic successions of Victoria became targets in oil exploration operations in Victoria (Baker 1973b).

Isabel was known to be keen to collaborate further with Deflandre on another visit to Europe between November 1956 and April 1957. This was agreed well in advance with Deflandre, and Isabel duly booked her passage and prepared materials to study in France. However, this second visit to Paris was postponed by Deflandre during October 1956. Because of the significant logistics involved, ICC went ahead with her journey and instead sought collaboration with Alfred Eisenack in Germany. This brought about the end of her joint research with Georges Deflandre, and the only outputs from this collaboration are Deflandre & Cookson (1954, 1955). In ICC's first post-Deflandre paper on marine microplankton, it was stated that "The present and fourth contribution was to have been made in conjunction with Professor G. Deflandre of Paris, but pressure of work and other unforeseen circumstances rendered this impossible. Professor A. Eisenack then agreed to act as collaborator to assist with the taxonomic section of this paper." (Cookson & Eisenack 1958, p. 19).

*Germany calling (mid–late 1950s onwards).* Because the collaboration with Georges Deflandre did not eventuate during the 1956–1957 visit to Europe, without one word of German, Isabel turned to the eminent palynologist Professor Alfred Eisenack of the University of Tübingen, Germany. Alfred Eisenack (1891–1982) was one of the pioneers of palynology in modern times, and worked on a diverse array of palynomorph groups including acritarchs, chitinozoa, dinoflagellate cysts and scolecodonts from the Palaeozoic, Mesozoic and Cenozoic (Gocht 1982a,b, Gocht & Sarjeant 1983, Sarjeant 1985, 1999b). Eisenack retired from his undergraduate teaching duties during 1957, therefore he had more time to spend on collaborative research. Thus began a long and extremely fruitful scientific partnership between Cookson and Eisenack on the Jurassic, Cretaceous and Paleogene organic microplankton of Australia and Papua New Guinea. Like Georges Deflandre, Alfred Eisenack had a wealth of knowledge on dinoflagellate cysts and could readily identify the cosmopolitan forms in Isabel's Australian preparations. The majority of the material that they studied was late Early Cretaceous (largely Aptian–Albian), Late Cretaceous and Paleogene (Table 5).

Isabel visited Germany again between October 1958 and March 1959; this was her last sabbatical as a member of the academic staff at the University of Melbourne. Isabel made five further visits to Tübingen, during 1961, 1965, 1968, 1970 and 1972, following her retirement in 1959, all of which were largely self-financed. However, ICC frequently referred to funding from CSIRO (e.g., Cookson & Eisenack 1960a, p. 18). She would travel to Germany for visits of several weeks at a time with prepared material from Australasia with her; Eisenack never travelled to Melbourne. Cookson stayed at the Eisenack family home in Reutlingen, and she and Alfred worked both at his flat and at the Geologisch-Paläontologisches Institut in nearby Tübingen. Gocht & Sarjeant (1983, p. 472) reported that "Cookson became a close – if sometimes rather demanding – friend, staying with Alfred Eisenack and his wife Helene in Reutlingen during her visits to Germany".

This scientific partnership was to last the remainder of Isabel's life and Cookson and Eisenack published 21 papers together between 1958 and 1982 (Table 5). These include three that were published posthumously (Cookson & Eisenack (1974, 1979, 1982). It cannot be overstated how profoundly scientifically productive the Cookson and Eisenack team were. For example, they published three papers in 1960, three in 1965 and four during 1961 and 1962 (Cookson & Eisenack 1960a,b, 1961a,b, 1962a,b, 1965a,b,c, Eisenack & Cookson 1960).

Cookson & Eisenack (1962a, p. 497) stated that: "The authors' names are arranged in alphabetical order, without implication of seniority." Unequivocally, both authors contributed equally to these contributions, however only in Eisenack & Cookson (1960) was Alfred Eisenack listed as first author. This highly significant body of work was consistently characterized by attractive and well-balanced plates of superb photomicrographs. The photographs were mainly taken in Tübingen using an old Leitz monocular microscope to which Eisenack attached a box camera made from an old biscuit tin in order to project the image onto glass negatives or a camera (Fig. 7, Gocht 1982b, Gocht & Sarjeant 1983). The residues appear to be very clean of extraneous organic debris and resistant mineral grains. Many of the specimens figured are single grain mounts, however, Cookson's use of Schulze's solution as an oxidant followed by alkali solution would tend to produce 'clean' palynomorph assemblages. Five Mesozoic dinoflagellate cyst species described by Cookson and Eisenack are illustrated in Fig. 8. Cookson and Eisenack jointly erected 68 genera and 298 species of acritarchs, dinoflagellate cysts, prasinophytes and miscellaneous aquatic palynomorphs (Table 5). This prodigious effort laid the basis for the development of the Mesozoic–Cenozoic stratigraphical marine palynology of Australasia (e.g., Evans 1966, Morgan 1980, Wiseman 1980, Marshall 1984, Wilson 1984, Davey 1988, 1999, Helby *et al*. 1987, 1988, 2004, Backhouse 1988, McMinn 1988, Bint & Marshall 1994, Burger 1996, Laurie & Foster 2001, Partridge

2006a,b,c,d, Mantle 2009a,b, Riding *et al*. 2010, Mantle & Riding 2012 and references therein).

Fig. 7 to be placed near here.

Several of the Cookson and Eisenack papers were significant monographs (e.g., Cookson & Eisenack 1958, 1974, 1982), or important papers based on relatively large numbers of samples (e.g., Cookson & Eisenack 1960a,b, 1962a,b, 1969, 1970b). However, some of them were based on small numbers of samples; Cookson & Eisenack (1965b, 1967a,b, 1971) were each based on single samples (Table 5). The Cookson and Eisenack publications were dominantly taxonomic, they rarely described or listed the entire assemblages and typically mentioned stratigraphical aspects relatively briefly. However, a significant biostratigraphical section and a range chart were given in the first paper (Cookson & Eisenack 1958, p 61–70, tables 1, 2). Furthermore, Cookson & Eisenack (1960a, p. 16) stated: "The present investigation definitely confirms the opinion earlier by Deflandre and Cookson (1955) and by Cookson and Eisenack (1958 and 1959 [1960b]) that, whilst some Australian microplankton have a relatively long time range, others have a strictly limited vertical distribution" (present authors clarification in square parentheses). They also noted that the marine microplankton assemblages from the lower part of the Gearle Siltstone, the upper part of the Gearle Siltstone and the Toolonga calcilutite in the Rough Range South No. 1 Bore are distinct from each other. A basic range chart was also presented by Cookson & Eisenack (1960b, table 1). During the late 1960s and early 1970s, Cookson and Eisenack frequently included brief introductions by geologists with local knowledge of the samples studied (e.g., Cookson & Eisenack 1967b, 1970b, 1971). The format and style of the Cookson and Eisenack papers did not discernibly evolve or progress between 1958 and 1982.

The first joint paper, Cookson & Eisenack (1958), was a large monograph on Jurassic and Cretaceous marine microplankton from New South Wales, Papua New Guinea, Queensland, South Australia and Western Australia. This work was published during March 1958, when Isabel and Alfred were 64 and 66 years old respectively. A log illustrating the positions of 43 samples from the Upper Jurassic and Lower Cretaceous succession at Omati, Papua New Guinea was given (Cookson & Eisenack 1958, fig. 2). This was most unusual; normally Cookson and Eisenack simply listed the successions they studied and typically the precise numbers of samples they studied is not clear. The Jurassic material is of Callovian to Tithonian age due to the occurrence of key markers such as *Dingodinium jurassicum* (Fig. 8D), *Herendeenia pisciformis*, *Nannoceratopsis pellucida*, *Omatia montgomeryi*, *Pyxidiella pandora*, *Scriniodinium crystallinum*, *Wanaea clathrata*, *Wanaea digitata* and *Wanaea spectabilis* (see Helby *et al*. 1987, figs 15, 21). The majority of the Cretaceous material is of Aptian–Albian age, and this interval produced index species such as *Dioxya armata, Endoceratium ludbrookiae* and *Endoceratium turneri* (see Morgan 1980). Some Late Cretaceous material from Western Australia was included and this yielded Santonian–Maastrichtian marker taxa such as *Dinogymnium westralium*, *Isabelidinium korojonense* and *Isabelidinium pellucidum* (see Helby *et al*. 1987, fig. 40). Twelve new genera, 53 new species and three new subspecies were described. The new genera include *Broomea, Dingodinium, Muderongia* and *Wanaea*. The publication of Cookson & Eisenack (1958) was one of the first to discuss dinoflagellate cyst biostratigraphy.

Their 1958 paper was followed two years later by three papers on the Mesozoic of Australia and Papua New Guinea which, between them, erected 73 new species (Cookson

& Eisenack 1960a,b, Eisenack & Cookson 1960). Cookson & Eisenack (1960a) published an important taxonomic paper on the Cretaceous (Albian to Campanian) marine microplankton of Victoria and Western Australia. Sixteen genera and 31 species of acritarchs and dinoflagellate cysts were described. The new genera include *Amphidiadema, Ascodinium, Gillinia, Microdinium, Nelsoniella* and *Xenikoon*. Many key marker species were established including *Amphidiadema denticulata, Ascodinium acrophorum* (Fig. 8B), *Disphaeria macropyla, Gillinia hymenophora* and *Nelsoniella tuberculata*. *Conosphaeridium striatoconum, Nelsoniella aceras* (Fig. 8C), *Odontochitina porifera, Palaeohystrichophora infusorioides* and *Xenikoon australis* were all recorded, and are Cenomanian to Campanian index species in the zonal scheme of Helby *et al*. (1987, figs 37, 40). The principal emphasis of Cookson & Eisenack (1960b) was on the Late Jurassic (Oxfordian to Tithonian) of Western Australia and Papua New Guinea, however some Lower Cretaceous (Aptian) material was included. Six new genera and 31 new species were described. The new genera include *Belodinium* and *Komewuia,* and the most important new species described include *Belodinium dysculum, Egmontodinium toryna, Komewuia glabra* (Fig. 8A) and *Tubotuberella apatela*. The biostratigraphy of selected taxa were discussed (Cookson & Eisenack 1960b, p 259–261, table 1). The 1960 paper by Eisenack & Cookson is an important study on the Early Cretaceous (Aptian and Albian) of Queensland, South Australia and Western Australia. It is a follow-up paper to that of Cookson & Eisenack (1960a). Three new genera, 17 new species and one new subspecies of dinoflagellate cysts were described. The three new genera include *Diconodinium* and *Trichodinium*. The new species include *Batioladinium micropodum, Trichodinium pellitum*, *Wrevittia cassidata* and *Wrevittia helicoidea*.

Cookson and Eisenack's (1961a) paper was the first by these authors on the Paleogene. It is on dinoflagellate cysts and prasinophytes from the Eocene of Rottnest

Island, Western Australia. The new dinoflagellate cyst genus *Rottnestia*, four new species, and two new subspecies were described. The presence of *Deflandrea phosphoritica*, *Diphes colligerum*, *Rottnestia borussica* and *Wilsonidium lineidentatum* is indicative of a probable early Eocene (Ypresian–Lutetian) age (Wilson 1984, fig. 4, 1988, fig. 4).

Cookson & Eisenack (1961b, 1962a,b) published three papers largely on the Cretaceous (Aptian–Campanian) of Australia. The first of these is on dinoflagellate cysts from the Belfast No. 4 Bore, Victoria; one new genus and five new species were erected. A probable Senonian (Coniacian–Campanian) age was invoked, however the occurrence of *Amphidiadema denticulata* and *Isabelidinium belfastense* means that the samples are late Santonian in age (Helby *et al*. 1987, fig. 40). The 1962a paper by Cookson & Eisenack is an important contribution on Cretaceous (largely Albian–Cenomanian) dinoflagellate cysts and acritarchs from Western Australia, with additional material from Queensland, South Australia and Victoria. Four new genera, 23 new species and one new subspecies were described. The new dinoflagellate cyst genera include *Canninginopsis* and *Spinidinium*. The most important new species described include *Amphidiadema rectangularis*, *Canninginopsis denticulata* and *Circulodinium attadalicum* (see Helby *et al*. 1987, figs 26, 37). Selected forms of aquatic microplankton from the Cretaceous and Eocene of Western Australia were described by Cookson & Eisenack (1962b). The majority of the samples are of Albian to Cenomanian age, however some Campanian and Eocene material was included. Four new genera, *Halophoridia, Horologinella, Lecaniella* and *Schizocystia*, were described. *Horologinella* is a dinoflagellate cyst. *Halophoridia* and *Schizocystia* are acritarchs, and *Lecaniella* is a green algal genus.

It is clear that, between 1963 and 1966, Cookson and Eisenack turned their attention from the Mesozoic to the Paleogene. They published five papers on the Paleogene marine palynology of southeastern Australia (Cookson & Eisenack 1965a,b,c, 1967a,b). All these papers, except Cookson & Eisenack (1965a), are on material of late Paleocene to Eocene age. The marine palynology of the Paleogene Dartmoor Formation of Victoria was studied by Cookson & Eisenack (1965b), and one new dinoflagellate cyst genus and seven new microplankton species were established. These include the cosmopolitan dinoflagellate cyst *Apectodinium hyperacanthum*, which is an important marker for the latest Paleocene to earliest Eocene (latest Thanetian–earliest Ypresian) (Powell 1992, figs 4.5, 4.6; Kender *et al*. 2012). Cookson & Eisenack (1965c) documented dinoflagellate cysts from the Paleocene Pebble Point Formation of Victoria, and described five new species. *Eisenackia crassitabulata*, *Rottnestia borussica* and *Senegalinium*? *dilwynense* indicate a late Paleocene to early Eocene (?Thanetian–Ypresian) age (Wilson 1984, fig. 4, 1988, fig. 4). Four new microplankton species were described from Tasmania by Cookson & Eisenack (1967a). The occurrences of *Apectodinium homomorphum*, *Cordosphaeridium inodes* and *Wilsonidium lineidentatum* are suggestive of the late Paleocene to Eocene (Thanetian–Bartonian; Wilson 1984, fig. 4; 1988, fig. 4). Cookson & Eisenack (1967b) described the marine palynology of the late Paleocene Rivernook Bed of Victoria, and three new species were established. The presence of *Apectodinium hyperacanthum* and *Muratodinium fimbriatum* is consistent with a latest Paleocene to earliest Eocene (latest Thanetian–earliest Ypresian) age by comparison with Europe (Powell 1992, figs 4.5, 4.6; Stover *et al*. 1996, fig. 32). By contrast, the presence of *Cordosphaeridium inodes* and *Hystrichololpoma rigaudiae* are suggestive of an exclusively Eocene age by comparison with the Southern Hemisphere (Wilson 1984, fig. 4, 1988, fig. 4).

Cookson & Eisenack (1965a) studied the marine microplankton from the upper Eocene Browns Creek Clays of Victoria, and established two new genera and 13 new species. Marker species such as *Deflandrea phosphoritica*, *Impagidinium elegans*, *Phthanoperidinium*? *eocenicum* and *Schematophora speciosa* indicates a late Eocene (Priabonian) age (Wilson 1984, fig. 4).

Between 1968 and 1971, Isabel and Alfred focussed back on the Mesozoic, and Cookson & Eisenack (1968, 1969, 1970a,b, 1971) are largely on the Cretaceous (Albian to Campanian) of Western Australia. Only Cookson & Eisenack (1970a) includes Paleogene material and samples from Victoria.

Cretaceous dinoflagellate cysts were described from two samples from the Gingin Brook No. 4 Borehole by Cookson & Eisenack (1968). This material was supplied by A.E. Cockbain of the Geological Survey of Western Australia in response to a request for samples from Isabel in 1967. The uppermost sample is Late Cretaceous, probably Santonian, in age due to the occurrence of species such as *Gillinia hymenophora*, *Manumiella*? *cretacea* and *Manumiella lata* (see Marshall 1984; Helby *et al*. 1987, fig. 40). The lowermost horizon is late Albian to early Cenomanian on the basis of key markers such as *Canninginopsis denticulata* and *Litosphaeridium siphoniphorum* (see Helby *et al*. 1987, fig. 37).

Dinoflagellate cysts from the Cretaceous Osborne Formation at Balcatta were documented by Cookson & Eisenack (1969). The material studied was stated to be of Albian–Cenomanian age, however it is clearly significantly younger, and is of latest Turonian to early Santonian age due to the occurrence of key markers such as *Chatangiella tripartita*, *Conosphaeridium striatoconum* and *Isabelidinium glabrum* (Fig. 8F; Helby *et al*. 1987, figs 37, 40). Cookson & Eisenack (1970a) is a brief account of some green algae from the Cretaceous and Paleogene of Victoria and Western Australia.

The Cretaceous marine microplankton of the Eucla Basin was studied by Cookson & Eisenack (1970b). The new dinoflagellate cyst genus *Maduradinium* and 22 new marine microplankton species were established. The authors stated that the range of ages studied is Albian–Cenomanian and Coniacian–Campanian. Many of the taxa are not established marker species, but the occurrences of *Dinogymnium westralium*, *Heterosphaeridium conjunctum*, *Maduradinium pentagonum* and *Magallanesium balmei* are indicative of a late Santonian to early Campanian age (Marshall 1984, Helby *et al*. 1987, fig. 40). Cookson & Eisenack (1971) is on the 'Mid'-Cretaceous (Albian–Cenomanian) marine microplankton from the Eyre No. 1 Bore; the new acritarch genus *Enigmasphaera* and 11 new marine microplankton species were described.

Three Cookson and Eisenack papers were published following Isabel's death in 1971. The first of these is a major monograph on the Late Jurassic, Cretaceous and Paleogene of Australia and Papua New Guinea (Cookson & Eisenack 1974). It was clearly a joint contribution. It was stated on p. 87 that, when the project was virtually finished, Eisenack received a message from Melbourne informing him of Cookson's death on the 1st of July 1973. The dedication by Eisenack on the first page is "In memory of joint work" (*In Erinnerung an gemeinsame Arbeit*). Eisenack also commented in the epilogue (p. 87) that Isabel's life was almost exclusively devoted to her scientific work, and how happy he was to have worked with her. These are touching tributes to a prodigiously productive 15-year collaboration between these legendary palynologists. The second posthumous contribution was Cookson & Eisenack (1979). This is a short paper which described three new genera of green algae from the Cretaceous (Albian and younger) from the Eucla Basin in Western Australia. Eisenack explained on p. 77 that, on her last visit to Tübingen in 1972, ICC left behind some Australian material for him to study and exploit as he saw fit. After the death of Isabel in 1973, Eisenack felt it was his duty to publish under both their names. Isabel Cookson's final paper, published nine years after her death, was Cookson & Eisenack (1982) and is the second part (*Zweiter Teil*) of Cookson & Eisenack (1974). It was largely written by Eisenack, and was completed and submitted to the journal by Hans Gocht, a long-time collaborator and colleague, following Eisenack's death in April 1982. Cookson & Eisenack (1982) is an extensive monograph on the Late Jurassic, Cretaceous and Paleogene of Queensland, South Australia, Tasmania and Western Australia. Material from the majority of the sample base of Cookson & Eisenack (1974) was treated, plus samples from additional sections from Queensland, South Australia and Tasmania.

The type material of the Australian dinoflagellate cysts described by Isabel Cookson and her co-workers between 1955 and 1974 was rephotographed and issued as a set of 35 mm colour transparencies by Helby & Partridge (1980).

Fig. 8 to be placed near here.

*Poles apart? An Australian-Norwegian alliance (1959–1964).* On the basis of her distinguished work on Silurian–Devonian palaeobotany, Isabel was invited for an extended working visit to the University of Oslo in Norway by Professor Ove Arbo Høeg from late May 1959 to early January 1960. Jorunn Os Vigran was an undergraduate student at Oslo at the time, and recalls how "Miss Cookson" or "Missen" was treated with great respect by everyone in the Department (personal communication to JBR, 2013). Ove Høeg was an expert on the Devonian floras of Spitsbergen. It was during this trip to Oslo that ICC first worked with the first Norwegian pre-Quaternary palynologist, Svein Bendik Manum (Fig. 9). At that time Manum worked solely on terrestrial palynomorphs, and ICC and he discussed their shared interest in pollen and spores, and the stock market! Manum was specifically interested in the Paleogene palynology of the Arctic region, and had just received some supposedly marine sedimentary rock samples from the Paleogene of Spitsbergen that he had not prepared. The ever-enthusiastic, diligent and industrious Isabel offered to process this material in Oslo in order to spend her Norwegian sojourn more productively. Manum (2003, p. 4) recounted how, two days later, ICC excitedly asked him to look at some distinctive large dinoflagellate cysts. This experience instantly made Svein interested in these fascinating marine palynomorphs. These large, bicavate peridiniacean forms with two distally-rounded prominent polar horns were later named for Isabel as *Svalbardella cooksoniae* by Manum (1960) (Fig. 10). This species is a cold-water form and is typical of the Oligocene of the Northern Hemisphere, although its total range is Eocene to Oligocene (Head & Norris 1989, Manum *et al*. 1989, Powell 1992, Van Simaeys *et al*. 2005, Pross *et al*. 2010, Śliwińska & Heilmann-Clausen 2011). At this time, Svein Manum was working on the Paleogene of the Canadian Arctic in order to compare it with his work in Spitsbergen (Manum 1962), and searched the collections of the second Norwegian "Fram"-expedition (1892–1902) to the Queen Elizabeth Islands. He found samples of Paleogene coals, and also took a subsample of a soft, grey shale from Graham Island in Arctic Canada. This shale proved to be pre-Paleogene, and ICC eagerly offered to help in the study of the abundant dinoflagellate cysts and pollen. Indeed, Manum (1991) stated that Isabel "immediately insisted that we should work on it." While in Oslo Isabel also met and befriended the palynologist Jorunn Os Vigran, however they never worked together.

This visit by ICC to Oslo in 1959–1960, and another trip to Norway between October and December 1961, resulted in three joint publications with Svein Manum (Table 5). Isabel also visited Norway in May 1963 during one of her German sojourns (see above). The 1961 visit was during winter and Manum recalls that Isabel was nervous of the slippery icy pavements in Oslo, and how he had to lead her by the arm on the homeward journey after work. Much of their joint research was done via correspondence because Isabel only visited Norway occasionally, and Manum never visited ICC in

Melbourne. The first of these three joint papers was Cookson & Manum (1960), a short contribution on the taxonomy of some prasinophytes from the Cretaceous and Paleogene of Australia, Papua New Guinea and Spitsbergen. Three species of the new genus *Crassosphaera* were described. Interestingly, this is only the second paper where Isabel gave an address other than the University of Melbourne; both authors are listed as being at the Institute of Geology, University of Oslo, Norway. Cookson & Manum (1964) was a brief note on the taxonomy of the Late Cretaceous dinoflagellate cysts now known as *Chatangiella tripartita* and *Chatangiella victoriensis* (see Fig. 8E) from Victoria and Western Australia.

Manum & Cookson (1964) is by far the most important output by the Cookson-Manum team, and built on the previous work of Manum (1963). This is a major work on the marine microplankton from the single shale sample from Graham Island, in Arctic Canada mentioned above. The bulk of this work is a systematic section, which included the descriptions of 11 new species of dinoflagellate cysts. The sample is rich in cavate peridiniacean taxa, especially representatives of *Chatangiella* and *Isabelidinium*. Several species originally described from Australia were noted, including *Microdinium ornatum*, *Odontochitina costata* and *Trigonopyxidia ginella*. Fern spores and gymospermous pollen are present, although angiosperm pollen was not encountered. Manum & Cookson (1964) assigned an early Late Cretaceous age to this sample, and assumed it to be from the Hassel Formation. However, Felix & Burbridge (1976) established that the sample is from the Kanguk Formation, and is of late Cenomanian to early Campanian in age. This age assessment can be refined further. The presence of prominent *Chatangiella* spp., together with *Heterosphaeridium difficile*, and the absence of the Cenomanian–Turonian markers *Litosphaeridium siphoniphorum* and *Stephodinium coronatum*, is indicative of a Coniacian to early Santonian age for this sample (Costa & Davey 1992, Nøhr-Hansen 1996, Stover *et* *al*. 1996). Manum & Cookson (1964) also studied two samples stated to be from the Hassel Formation from Ellef Rignes Island, Arctic Canada, which yielded similar microplankton associations to the Graham Island sample. In fact they are from the Kanguk Formation (Felix & Burbridge 1976, Manum 1991). Marine microplankton from nearby Banks Island documented by Thorsteinsson & Tozer (1962) are also similar to the assemblages from Ellef Rignes and Graham islands. This major work was completed by correspondence between Melbourne and Oslo. Copies of Manum & Cookson (1964) were much in demand because it was published at a time when many oil companies were starting to explore the Canadian Arctic archipelago, and there was hardly any biostratigraphical data available from this region.

Svein Manum was appointed as a professor at Makerere University, Kampala, Uganda, where he was Head of Botany between 1967 and 1970. Isabel visited Svein there in November 1969, and they undertook a two-day safari to Murchison Falls National Park which Isabel thoroughly enjoyed.

Figs 9 and 10 to be placed near here.

*The old country revisited. Cambridge (1961–1964).* Isabel Cookson was one of several palynologists from Australia and New Zealand to work with Norman F. Hughes at the University of Cambridge during the 1950s and 1960s. The others were R. Ashley Couper, Mary E. Dettmann, Elizabeth M. Fowler (later Kemp then Truswell), Geoffrey Norris and Geoffrey Playford. ICC travelled to Cambridge, where she had previously visited the botanist and palaeobotanist Professor Sir Albert C. Seward in 1925, during 1959, 1961 and 1963.

Isabel first worked on Cretaceous marine palynomorphs from three samples from the middle Albian and lower Cenomanian succession exposed in a cement quarry near Barrington, Cambridgeshire, UK during visits in 1959 and 1961. Two of these were collected and prepared by one of us (MED) for pollen and spores in 1959. A diverse and spectacular association of dinoflagellate cysts with some acritarchs and prasinophytes was discovered from the Gault, Cambridge Greensand and West Melbury Marly Chalk (formerly Chalk Marl) formations (middle Albian–lower Cenomanian), and ICC was extremely enthusiastic about documenting these assemblages. One paper, Cookson & Hughes (1964), resulted from this collaboration and nine new species were described, some of which are reliable index species in the 'Middle' Cretaceous. These marker taxa include *Apteodinium maculatum* subsp. *grande*, *Carpodinium obliquicostatum, Cauveridinium membraniphorum*, *Endoceratium dettmannae*, *Epelidosphaeridia spinosa*, *Leberidocysta chlamydata*, *Litosphaeridium siphoniphorum*, *Ovoidinium scabrosum*, *Ovoidinium verrucosum* and *Xiphophoridium alatum* (for example Verdier 1974, Foucher 1981, 1983, Below 1984, Heilmann-Clausen 1987, Masure 1988, Costa & Davey 1992, Tocher & Jarvis 1996). The microtome sections of *Endoceratium dettmannae* and *Scriniodinium campanula* (see Cookson & Hughes 1964, pl. 7, figs 4, 8, 9) were made by one of us (MED) using the technique outlined by Hughes *et al*. (1962).

Cookson & Hughes (1964) unequivocally demonstrated that ICC had become an genuine expert in dinoflagellate cysts in the decade since her first paper on marine microplankton (Cookson 1953d). This is because Norman F. Hughes (1918–1994) was a well known researcher on Cretaceous pollen and spores (Batten 1986). Hughes was assuredly not a specialist on aquatic palynomorphs, and it is clear that Isabel was entirely responsible for the systematic section in Cookson & Hughes (1964), which comprises the overwhelming majority of this paper.

*Americana (1967).* Isabel's fifth and final collaborator on marine microplankton was Lucy M. Cranwell of Tucson, Arizona, USA. ICC had known the New Zealand-born Cranwell for many years largely due to their shared interest in *Nothofagus* pollen, and visited her during early 1963. They published one paper, Cookson & Cranwell (1967) on the palynology of a single sample of Eocene age from near Punta Arenas in southern Chile. The original intention was to help determine the spatial and temporal distribution of the southern beech tree, *Nothofagus*. However, although *Nothofagus* pollen was found, the sample is dominated (>70–80%) by dinoflagellate cysts and Cranwell requested Isabel's help with these. The genus *Deflandrea* is prominent, and the Eocene marker *Areosphaeridium diktyoplocum* was recorded. *Deflandrea oebisfeldensis* and *Thalassiphora pelagica* were also noted; these species are both typical of the Eocene (Stover *et al*. 1996). The new species *Operculodinium severinii* was also described.

*Taxonomic tributes to Isabel Cookson from the world of dinoflagellate cysts.* Because of her emormous contribution to dinoflagellate cyst taxonomy, the genera *Cooksonidium, Cooksoniella*, *Isabelia* and *Isabelidinium* were named after ICC. *Cooksonidium* was erected by Stover & Williams (1995), and contains two Eocene species; the type species is *Cooksonidium capricornum*. *Cooksoniella*, which was described by Vozzhennikova (1967), is invalid because it is a junior synonym of *Chatangiella* according to Lentin & Williams (1975). *Isabelia* was introduced by Lentin & Williams (1975) to accommodate many of the Late Cretaceous cavate peridiniacean species described by Isabel and her co-authors. This bicavate to circumcavate genus is characterized by an omegaform hexa anterior intercalary periarchaeopyle formed by the 2a plate, which is clearly visible in the type species, *Isabelidinium korojonense*. However, the name *Isabelia* is preoccupied by a Brazilian orchid, so Lentin & Williams (1977) established *Isabelidinium* as a substitute generic name. Additionally, there are eight dinoflagellate cysts with the specific name *cooksoniae* (see Lentin & Williams 1989, p. 11); one of these is the appropriately-named *Isabelidinium cooksoniae.*

Table 5 to be placed near here.

**Retirement? (1959–1972)**

Isabel officially retired from her position as Senior Lecturer in Botany at the University of Melbourne in 1959, after returning from a sabbatical visit to Norway. However she continued in active research as an Honorary Research Fellow until mid-1972. Her *alma mater* generously provided Isabel with an office and laboratory facilities. With no teaching, or administrative duties, Cookson had more time to pursue her life's work of research into palaeobotany and palynology. ICC was prodigiously productive post 1959; she published 33 of her 93 papers after her retirement! Isabel was also Honorary Associate in Palaeontology at the National Museum of Victoria in Melbourne between 1959 and 1962; the majority of her type and figured palynomorph specimens from eastern Australia are curated there. Type and figured material from Western Australia from Cookson & Eisenack (1968) and subsequent papers on Western Australia is lodged with the Geological Survey of Western Australia in Perth; all the earlier Western Australian material is curated at Museum Victoria. ICC was also made a Full Member and, immediately after this, a Life Member of the Royal Society of Victoria in 1959.

Cookson continued to visit Germany to collaborate with Alfred Eisenack in retirement, and she visited Tübingen in 1961, 1965, 1968, 1970 and 1972. All but one (Cookson & Eisenack 1958) of her 21 joint papers with Eisenack were published after she retired. During the 1940s her university salary had significantly increased, and Isabel began to invest her savings in the stock market at this time. She quickly became an astute and skillful investor, and used profits from share dealing to fund her research generally and her working trips to Germany in retirement. One of Isabel's favourite stocks was Mount Isa Mines of northwest Queensland, some of which she bought in the 1940s, for no other reason that it reminded her of one of her nicknames ("Isa")! Despite this rather subjective reasoning, Mount Isa Mines proved an excellent investment for her.

A two day symposium on Mesozoic and Cenozoic palynology was held in honour of Isabel during May 1971 at the 43rd Congress of the Australian and New Zealand Association for the Advancement of Science (ANZAAS) at the University of Queensland, Brisbane (Fig. 11). The symposium, convened by Geoffrey Playford, was well attended by palynologists from geological surveys, oil companies and universities. The resulting *Festschrift* volume (Glover & Playford 1973) was published by the Geological Society of Australia and was reviewed by Hughes (1975) and Traverse (1975).

Fig. 11 to be placed near here.

Isabel sadly died of a heart attack on July 1st 1973, aged 79 years, 7 months, at her home in Hawthorn, Victoria following a short illness. She passed away only six months prior to her 80th birthday. Unfortunately, she died while her *Festschrift* (Glover & Playford 1973) was in press. Isabel was cremated, and later her estate was sworn for probate at

AUS$169,112. Baker (1973a) and Archangelsky (1974) published obituaries of Isabel. She bequeathed her palaeobotanical library to John G. Douglas.

The Botanical Society of America has awarded the Isabel C. Cookson Palaeobotanical Award to the best paper or poster on palaeobotany or palynology presented at their annual meeting given by a student or early-career researcher since 1976 (see http://www.botany.org/awards_grants/detail/cookson.php#79). The annual prize is of US$300, which is paid from a legacy bequeathed by ICC. The first recipient was Elisabeth A. Wheeler of Havard University for "Some fossil dicotyledonous woods of Yellowstone National Park" in 1976.

Another posthumous honour was that Cookson Place in Banks, one of the southernmost suburbs of Canberra, Australia was named in honour of Isabel (Fig. 12). The theme of the street names in Banks is botany or natural history. The suburb of Banks was named for Sir Joseph Banks (1743–1820), the famous botanist who accompanied Captain James Cook on his first great Pacific voyage between 1768 and 1771.

Fig. 12 to be placed near here.

**Overview**

Isabel Clifton Cookson was a larger-than-life character and had a long, active and very full lifetime. ICC's pioneering work in botany, palaeobotany, and both terrestrial and marine palynology during her 58 year research career marks Isabel as a highly influential researcher over an extremely broad scientific spectrum. She is recalled by her peers as being astute in her thinking, and being significantly ahead of her time. Isabel made the journey from undergraduate to honorary research fellow over six decades at the University of Melbourne and travelled extensively throughout her career. It is remarkable how she undertook pioneering research in palaeobotany, then went on to become the first palynologist in Australia. ICC is one of the great botanical taxonomists; she described, or jointly described, a phenomenal total of 110 genera, 557 species and 32 subspecies (or similar) of palynomorphs and plants (Tables 2–5). These taxa include 76 genera and 386 species of marine microplankton, and 29 genera and 137 species of sporomorphs (Tables 4, 5). With this taxonomic basis she, therefore, began the stratigraphical application of palynology in Australia, and is unequivocally one of Australia's most important women scientists. It is extremely unfortunate that Isabel did not live to see her pioneering work in Australian palynology develop and be used as an invaluable and precise tool in geological exploration. Her impressive list of 93 scientific publications (Online supporting data: Appendix 1) is *prima facie* evidence of her being creative, dedicated, hardworking and perceptive; furthermore, she was obviously a very good team player. ICC's scientific legacy is even more impressive when one considers that she was a woman in an extremely male-dominated world at the time, and that much of her research was undertaken under very difficult conditions and frequently with little funding. In the early part of her career particularly, she existed for long periods on short-term contracts ('soft money'), and funded herself personally after retirement. This is clear evidence of her determination, drive and fortitude.

Isabel did not have a privileged background; she supported and nursed her mother, Elizabeth Cookson, through a long illness (dementia) during the 1940s as a young woman under somewhat strained financial circumstances. She never married, and had no close relatives after the deaths of her parents; her mother died in 1947. Her scientific work was her entire life; she would routinely rise at around 04.45 h, and take the 06.00 h train from home in the suburbs to her offce at the University of Melbourne. Isabel made most of her friendships and human contacts via her research; she definitely preferred scientific collaboration to working alone. She had no domestic issues preventing her from undertaking her many extended working trips to Europe. One of us (MED) recalls that Isabel was an entertaining conversationalist, and that her thoughts were never far from her research. That speaks volumes about Isabel Cookson the consummate and dedicated scientist, who published 33 papers after her retirement when she could easily have chosen to take it easy and pursue non-scientific pastimes during a more relaxing and stress-free post-working life. Isabel was a rather private person and did not like being photographed, but had a small but close circle of friends with whom she shared an interest in music and travel. In her later years she organized her work schedule to be free to listen to the Australian Broadcasting Commission radio programmes 'Blue Hills' and ‘The Argonauts.' She could come across as being somewhat abrupt, but underneath she was very sensitive, and her feelings were easily bruised by criticism or perceived criticism.

Turner (2007, p. 190) noted that Isabel “only achieved senior lecturer status” at the University of Melbourne. Clearly, a scientist as distinguished as ICC should have been promoted beyond the rank of senior lecturer. However, sexual discrimination was endemic in Australia and elsewhere at that time (Kelly 1993, Turner 1998). Morgan (1981) also mentioned that ICC was relatively unacknowledged, and Traverse (1975, p. 239) stated that ICC was "Handicapped by her sex and by her geographic isolation in Australia, Dr. Cookson was not destined to achieve the monetary and other rewards of status a male person of her stature from, say, the U.S.A. would probably have received......”

This contribution seeks to set the record straight in certain respects. Douglas and Holmes (2006) regarded her as solely a plant taxonomist, and stated that she “never ventured into the field.” This is not the case because Isabel unequivocally was a true polymath and collected outcrop material of the Palaeozoic *Baragwanathia* flora from bushland localities near Woods Point and Walhalla in east Victoria (Lang & Cookson

1935). Furthermore, Lang (1937, p. 250) described fieldwork with Isabel to Perton Quarry in Herefordshire, England where she collected fossil plant specimens that William H. Lang described as *Cooksonia* in recognition of ICC. It has also been occasionally suggested anecdotally that ICC was not a team player possibly because her palynological collaboration with Georges Deflandre was relatively short. This is assuredly not the case. Isabel successfully ran the Brown Coal Pollen Research Unit at the University of Melbourne for many years, and the majority of her papers were joint ones; she published with 22 co-authors (Online supporting data: Appendix 1).

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**Display material captions:**

*Fig. 1.* A group of biology students at the University of Melbourne taken probably sometime between 1913 and 1917. Isabel Cookson is on the extreme right, top row. The precise date and the photographer are unknown. Reproduced with permission of the University of Melbourne.

*Fig. 2. Baragwanathia longifolia* Lang & Cookson 1935. Specimen number C115 in the Isabel Cookson collection housed in Museum Victoria, Melbourne, Australia. It is part of a well-preserved shoot 11.7 cm long with numerous long simple leaves, and is preserved as a thin carbonaceous film. The specimen was originally illustrated by Lang & Cookson (1935, pl. 29, fig. 1) and is from the Yarra Track locality, 27.36 km from Woods Point, eastern Victoria, Australia. Isabel Cookson collected this material, which is situated in rough bushland country in the upper reaches of the Yarra Valley. The beds yielding *Baragwanathia longifolia* at Yarra Track are closely associated with stratigraphically-significant late Silurian (Ludlow) graptolites.

*Fig. 3*. Fossil fungal material from Kerguelen Island and Yallourn, Victoria, described by Isabel Cookson. **A, B,** – *Notothyrites setiferus* Cookson 1947. Material from a lignite bed at Porte Jeanne d'Arc, Kerguelen Island, southern Indian Ocean. **A**, An ascoma in lateral view exhibiting the basal setae. **B**, A basal view of the covering membrane. The scale bars = 25 μm. These specimens were originally figured by Cookson (1947a, pl. 11, figs 4 and 5 respectively. **C,** – *Trichopeltinites pulcher* Cookson 1947. Material of Oligocene–Miocene age from the State Electricity Commission's open cut at Yallourn, Victoria. A thallus on the upper epidermis of *Oleinites willisii* Cookson 1947 (Oleaceae) The scale bar = 50 μm. This specimen was originally figured by Cookson (1947a, pl. 14, fig. 22).

*Fig. 4.* Seven Cretaceous, Paleogene and Neogene pollen grains (A–C, F–I) and two spores (D, E) described by Isabel Cookson. The scale bars = 10 μm. **A,** – *Araucariacites australis* Cookson 1947 ex Couper 1953. Museum Victoria specimen number P31031. The lectotype originally illustrated by Cookson (1947d, pl. 13, fig. 3), and refigured by Dettmann & Jarzen (2000, fig. 39). From a Miocene lignite at Porte Jeanne d'Arc,

Kerguelen Island, southern Indian Ocean. This species is similar to the pollen of extant *Agathis,* and is widespread in upper Mesozoic to Holocene sedimentary rocks and sediments. **B**, – *Microcachryites antarcticus* Cookson 1947 ex Couper 1953. A syntype illustrated by Cookson (1947d, pl. 14, fig. 18). Sample details as 1. This trisaccate species is similar to pollen from extant *Microcachyrs* (Podocarpaceae) and is commonly abundant in Mesozoic and Cenozoic strata throughout the Southern Hemisphere. **C**, – *Podocarpidites ellipticus* Cookson 1947 ex Couper 1953. Museum Victoria specimen number P31033. The lectotype illustrated by Cookson (1947d, pl. 13, fig. 6). Sample details as 1. **D**, – *Cyatheacidites annulata* Cookson 1947 ex Potonié 1956. Museum of Victoria specimen number P31046. The lectotype illustrated by Cookson (1947d, pl. 15, fig. 53). Sample details as 1. This species is similar to the spores of extant *Lophosoria*, a fern genus now confined to central and South America. **E**, – *Ruffordiaspora australiensis* (Cookson 1953) Dettmann & Clifford 1992. Museum Victoria specimen P22034. Illustrated by Dettmann (1963, pl. 9, figs 12, 13, 15) and Dettmann & Clifford (1992, pl. 8, figs A–C). The specimen is from the Eumeralla Formation at 804 m in the Robe Bore 1, Otway Basin, South Australia. This sample is within the *Coptospora paradoxa* spore-pollen zone of Early Cretaceous (Albian) age (Partridge 2006a). This species is one of the first Mesozoic *sporae dispersae* described by Cookson (1953b), as *Mohrioisporites australiensis*. It is the nominate species of the Early Cretaceous (Berriasian–Valanginian) *Ruffordiaspora australiensis* spore-pollen zone in Australia (Partridge 2006a). The first appearance of *Ruffordiaspora australiensis* defines the base of this zone, and corresponds to the Jurassic/Cretaceous boundary (e.g., Helby *et al*. 1987, fig. 45, Partridge 2006a). **F**, – *Tricolpites reticulatus* Cookson 1947 ex Couper 1953. Museum Victoria specimen number P31064. The holotype illustrated by Cookson (1947d, pl. 15, fig. 45), refigured by Jarzen & Dettmann (1989, pl. 1, fig. 1). Sample details as 1. This species is similar to the pollen of *Gunnera*, a genus of perennial stoloniferous herbs largely confined to the Southern Hemisphere. **G**, – *Proteacidites adenanthoides* Cookson 1950. University of Queensland Micropalaeontological Collection specimen UQY6532, housed at the Queensland Museum. Specimen illustrated by Dettmann & Jarzen (1996, figs 14a–c). The specimen is from the Paaratte Formation at 1720 m at Bridgewater Bay, Otway Basin, offshore western Victoria; this sample is within the *Tubulifloridites lilliei* spore-pollen zone of Late Cretaceous (middle–late Campanian) age (Partridge 2006b,c). This species is similar to pollen of the Proteaceae. **H**, – *Nothofagidites emarcidus* (Cookson 1959) Harris 1965. Museum Victoria specimen P17668. The holotype, illustrated by Cookson (1959, pl. 4, fig. 7) and Dettmann *et al*. (1990, pl. 3, figs 2a–c). This specimen is from a clay at the base of the Yallourn Seam of the Yallourn Formation at Yallourn, Victoria; the sample is within the *Triporopollenites bellus* spore-pollen zone of middle–late Miocene age (Partridge 2006c). Pollen of this type is produced by the *brassii* group of extant *Nothofagus*, which is now restricted to New Caledonia and Papua New Guinea. **I**, – *Nothofagidites asperus* (Cookson 1959) Romero 1973. Museum Victoria specimen P17663. A paratype, illustrated by Cookson (1959, pl. 4, fig. 2) and Dettmann *et al*. (1990, pl. 1, fig. 2, pl. 2, fig. 1). The specimen is from a mudstone underlying basalts dated as ~30 Ma (early Oligocene) at Vegetable Creek near Emmaville, New South Wales. This species is the nominate taxon of the middle Eocene to early Oligocene (Lutetian–Rupelian) *Nothofagidites asperus* spore-pollen zone for the marginal basins of southeast Australia (Partridge 2006c). Pollen of this type is produced by the *menziesii* group of *Nothofagus*.

*Fig. 5.* Isabel Cookson working at the microscope at the University of Melbourne in June 1942, during World War II. She is examining part of a Japanese "zero" fuel tank. The photograph was taken by a reporter for the Herald Newspaper. This is Australian War

Memorial photograph 136506 (http://www.awm.gov.au/collection/136506), and is reproduced with permission.

*Fig. 6.* Isabel Cookson (seated) and an unidentified woman in Isabel's office in the Brown Coal Pollen Research Unit (PRU) at the University of Melbourne in 1954. The photographer is unknown. Reproduced with permission of the University of Melbourne.

*Fig. 7.* The rather primitive (by contemporary standards) Leitz monocular microscope used by Alfred Eisenack. The camera tube was constructed by Eisenack from an old biscuit tin in order to project images into a camera. An earlier iteration of this apparatus had a plate for glass negatives at the top of the tin cylinder (see Gocht 1982, p. 151). Note the lack of both an internal illumination unit and a mechanical stage. Eisenack's photomicroscope is now housed in a display at Eberhard Karls Universität Tübingen, Germany. Photograph copyright: Wolfgang Gerber, Department of Geosciences, Eberhard Karls Universität Tübingen, reproduced with permission.

*Fig. 8.* Six Mesozoic dinoflagellate cysts described by Isabel Cookson and co-workers. These images were scanned from slides 146, 19, 167, 82, 47 and 140 of Helby & Partridge (1980), and are reproduced with permission. The scale bars in A–E and F = 50 µm and 25 µm respectively. **A,** – *Komewuia glabra* Cookson & Eisenack 1960. This species was emended by Chen (1982, p. 32, 35). The holotype (Cookson & Eisenack 1960b, p. 257, pl. 39, fig. 8), from the upper part of the Jarlemai Siltstone of the Broome Number 3 Bore, Western Australia at 317.60–305.10 m. Museum Victoria specimen number P17785. *Komewuia glabra* is a proximate, biconical cyst with two prominent polar horns and a single plate precingular archaeopyle. It is indicative of the late Kimmeridgian–Tithonian

interval in the Southern Hemisphere; it is typically common/abundant in the 'middle' Tithonian (Chen 1982, fig. 3, Riding *et al*. 2010, fig. 12). **B**, – *Ascodinium acrophorum* Cookson & Eisenack 1960. The holotype (Cookson & Eisenack 1960a, p. 5, pl. 1, fig. 19) from the Osborne Formation of the Subiaco Bore, Perth, Western Australia at 109.12 m. Museum Victoria specimen number P17251. This distinctive smooth, circumcavate peridiniacean species with a combination apical/anterior intercalary archaeopyle is a reliable marker for the latest Albian to early Cenomanian in Australia (Morgan 1980, fig. 8). Note the isolated process of a chorate cyst oriented approximately north-south in the centre-left of the endocyst of this specimen. This broken part of another dinoflagellate cyst specimen, probably a representative of *Oligosphaeridium*, settled by chance onto the specimen of *Ascodinium acrophorum* during slide production. **C**, – *Nelsoniella aceras* Cookson & Eisenack 1960. The holotype (Cookson & Eisenack, 1960a, p. 4, pl. 1, fig. 12) from the Toolonga calcilutite of the Rough Range South Number 1 Bore drilled by Wapet in the Carnarvon Basin, Western Australia at 745.85–742.19 m. Museum Victoria specimen number P17798. This characteristic subcircular, epicavate peridiniacean species lacks an apical horn/protuberance and has a slight apical concavity. It is a latest Santonian–early Campanian marker in Australasia (Helby *et al*. 1987, fig. 40, Riding *et al*. 1992), and is especially characteristic of the Santonian–Campanian transition (Marshall 1984, McMinn 1988). **D**, – *Dingodinium jurassicum* Cookson & Eisenack 1958. The holotype (Cookson & Eisenack 1958, p. 39, pl. 1, fig. 10) from the upper part of the Dingo Claystone of the Broome Number 3 Bore, Western Australia at 434.95–428.24 m. Museum Victoria specimen number P17241. Note the camocavate cyst organisation, the thin, smooth periphragm, the relatively thick spinose endophragm, the small apical horn/protuberance and the apparent lack of an archaeopyle. This distinctive form is an index species for the early Oxfordian to the earliest Valanginian of Australia; it is especially prominent in the middle to late Tithonian *Dingodinium jurassicum* Zone (Helby *et al*. 1978, figs 15, 21, Riding *et al*. 2010, fig. 12). **E**, – *Chatangiella victoriensis* (Cookson & Manum 1964) Lentin & Williams 1976. The holotype in dorsal view (Cookson & Manum 1964, p. 522, pl. 76, figs 3, 4) from the Belfast Mudstone of the Port Campbell Number 3 Bore, Victoria drilled by the Frome-Broken Hill Company at 1344.20–1341.10 m. Museum Victoria specimen number P22986. This characteristic bicavate peridiniacean form with a granulate/tuberculate periphragm, a discontinuous cingulum and an anterior intercalary archaeopyle is an index species for the Turonian/Coniacian to Santonian of Australia (Marshall 1984, Helby *et al*. 1987, figs 37, 40). **F**, – *Isabelidinium glabrum* (Cookson & Eisenack 1969) Lentin & Williams 1977. The holotype (Cookson & Eisenack 1969, p. 3, fig. 1A) in ventral view; it is from the Osborne Formation of the Balcatta Bore Number 1 at 73.15 m or 69.19–67.06 m, or the Balcatta Bore Number 2 at 67.06 m. It is not clear in Cookson & Eisenack (1969), which of these three samples the holotype is from. Geological Survey of Western Australia specimen number F6629. *Isabelidinium glabrum* is a characteristic elongate, circumcavate peridiniacean form with psilate periphragm and endophragm, prominent apical and left antapical horns, and a steno-deltaform anterior intercalary archaeopyle. It is a marker species for the early Turonian to early Coniacian of Australia (Marshall 1984, Helby *et al*. 1987, fig. 37).

*Fig. 9.* A candid photograph of Isabel Cookson relaxing in the flat of her collaborator Svein B. Manum in Oslo, Norway in early January 1960. The photograph was taken by Svein B. Manum (University of Oslo), and is reproduced with his permission.

*Fig. 10.* Two specimens of *Svalbardella cooksoniae* Manum 1960. Note the elongate ellipsoidal, bicavate/cornucavate nature of this distinctive proximate peridinalean species, which has extremely characteristic polar horns that are bluntly rounded distally. The distally rounded nature of the apical and antapical horns distinguish *Svalbardella* from the very similar genus *Palaeocystodinium,* which has distally pointed polar horns. These specimens elegantly demonstrate the intraspecific variability of this species. *Svalbardella cooksoniae* varies significantly in size, degree of elongation, low relief ornamentation and the expression of tabulation. The genus *Svalbardella* is monospecific (Fensome and Williams 2004, p. 643–644). **A**, – the holotype of *Svalbardella cooksoniae* from sample R.F.-H.260M collected from Sarsbukta, west Spitsbergen (78° 40’ N; 11° 40’ E), which is of probable Eocene age (Manum 1960). This specimen is significantly less elongate than the specimen in 10B, and exhibits a definite equatorial cingulum. Note the elongate anterior intercalary archaeopyle, and the longitudinal ridges which may represent plate boundaries. The photograph was taken by Svein B. Manum (University of Oslo), and is reproduced with his permission. **B**, – a smooth, relatively elongate and slender specimen of *Svalbardella cooksoniae* from the Eocene/Oligocene boundary interval in Hole 1411B of Integrated Ocean Drilling Program (IODP) Cruise 342, offshore Newfoundland, Canada. The photograph was taken by Jörg Pross (Institut für Geowissenschaften, Johan Wolfgang Goethe-Universität, Frankfurt am Main, Germany), and is reproduced with his permission.

*Fig. 11.* Isabel Cookson outside the University of Queensland, Brisbane, at the symposium on Mesozoic and Cenozoic palynology held in her honour in May 1971 at the 43rd Congress of the Australian and New Zealand Association for the Advancement of Science

(ANZAAS). The photograph was taken by John G. Douglas, and is reproduced with his permission.

*Fig. 12.* Cookson Place in the suburb of Banks, Canberra, ACT, Australia. **A**, – A view of Cookson Place looking east from the entry to the street; Banks is an outlying suburb, note the virgin bush in the background. **B**, – A street sign for Cookson Place at the intersection with Olive Pink Crescent. Olive Muriel Pink (1884–1975) was a prominent aboriginal rights activist and gardener (http://adb.anu.edu.au/biography/pink-olive-muriel-11428). The photographs were taken by Clinton B. Foster, and are reproduced with his permission.

*Table 1.* A tabulated synopsis of the principal career milestones of Isabel C. Cookson. ANZAAS - Australian and New Zealand Association for the Advancement of Science.

*Table 2.* A tabulated synopsis of the seven research papers principally on modern botany/mycology by Isabel Cookson and her co-workers. No new genera were established. In the 'Geography' column, SA = South Australia.

*Table 3.* A tabulated synopsis of the 22 research papers principally on palaeobotany by Isabel Cookson and her co-workers. Key to abbreviations in the 'Geography' column: NSW – New South Wales; QLD – Queensland; SA – South Australia; TAS – Tasmania; VIC – Victoria; WA – Western Australia. In the 'Comments' column: IOP = International Organisation of Palaeobotany.

*Table 4.* A tabulated synopsis of the 38 research papers principally on terrestrially-derived palynomorphs (i.e., fungal spores, megaspores, microspores and pollen) by Isabel

Cookson and her co-workers. Key to abbreviations in the ‘Geography’ column: NSW – New South Wales; NZ – New Zealand; PNG – Papua New Guinea; QLD – Queensland; SA – South Australia; TAS – Tasmania; VIC – Victoria; WA – Western Australia.

*Table 5.* A tabulated synopsis of the 33 research papers principally on aquatic palynomorphs (largely marine dinoflagellate cysts) by Isabel Cookson and her co-workers. Key to abbreviations in the ‘Geography’ column: NSW – New South Wales; PNG – Papua New Guinea; QLD – Queensland; SA – South Australia; TAS – Tasmania; VIC – Victoria; WA – Western Australia. In the ‘Age of samples studied’ column: ud – undifferentiated.

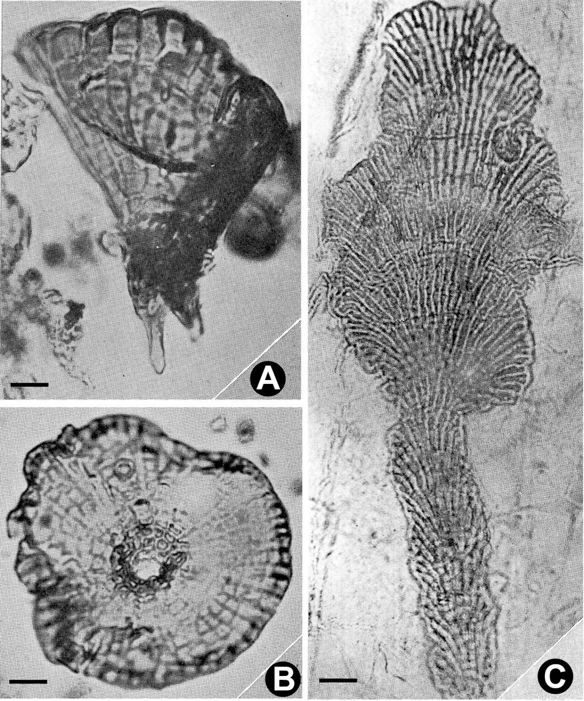
| Year(s) | **The career milestones of Isabel C. Cookson** |
|---|---|
| 1916 | Awarded a BSc degree, with first class honours, in botany and zoology from the University of Melbourne |
| 1916 | Given a Government Research Scholarship to study the flora of the Northern Territory |
| 1916 | Appointed a research student to Frederick Chapman at the National Museum of Victoria |
| 1916 | Elected a Member of the Royal Society of Victoria |
| 1917 | Began MSc research on modern fungi with Alfred J. Ewart |
| 1917 | Awarded a Government Research Scholarship to study the longevity of cut flowers |
| 1917 | Appointed a demonstrator in Botany at the University of Melbourne |
| 1917 | Appointed a tutor in Botany at Newman College, University of Melbourne |
| 1921 | The first scientific paper published (Cookson 1921), on botany |
| 1925-1926 | The first trip to Europe as a Visiting Researcher at Imperial College London |
| 1926 | Undertook grant-funded research on crown rot in the English walnut tree |
| 1926 | The first papers on palaeobotany published (Cookson 1926, Chapman & Cookson 1926) |
| 1926-1927 | Appointed a demonstrator in mycology at the University of Manchester |
| 1929 | Appointed a lecturer in Botany at the University of Melbourne |
| 1929-1930 | Awarded a grant to study the Silurian to Devonian flora of Victoria with William H. Lang at the University of Manchester |
| 1932 | Awarded a DSc degree by the University of Melbourne for research on Palaeozoic palaeobotany |
| 1933-1934 | Awarded a Grisedale Research Scholarship for collaboration on Palaeozoic palaeobotany in Manchester with William H. Lang |
| 1935 | Landmark paper on early plant evolution published (Lang & Cookson 1935) |
| 1937 | The Devonian plant genus *Cooksonia* published by William H. Lang |
| 1945 | The first paper on palynology published (Cookson 1945b) |
| 1947 | The first paper on Cenozoic palaeobotany published (Cookson 1947b) |
| 1947 | Keynote speaker at the opening of the Birbal Sahni Institue of Palaeobotany, Lucknow, India |
| 1948 | Sabbatical visit to Stockholm, Sweden to work with Gunnar Erdtman on modern Proteaceae pollen |
| 1948-1949 | Awarded a Leverhulme Research Grant for collaboration on Palaeozoic palaeobotany in Manchester with William H. Lang |
| 1949 | Appointed as the head of the Brown Coal Pollen Research Unit (PRU) at the University of Melbourne |
| 1952 | Appointed a Senior Lecturer and Research Fellow in Botany at the University of Melbourne |
| 1953 | The first paper on aquatic palynomorphs published (Cookson 1953d) |
| 1954 | Sabbatical leave to work with Georges Deflandre in Paris, France on Australasian marine microplankton |
| 1955 | The first major paper on Australasian marine palynomorphs published (Deflandre & Cookson 1955) |
| 1956-1957 | Sabbatical leave to work with Alfred Eisenack in Tübingen, Germany on Australasian marine microplankton |
| 1957 | Elected a Corresponding Member of the Botanical Society of America |
| 1958 | The first paper in collaboration with Alfred Eisenack published (Cookson & Eisenack 1958) |
| 1959 | Sabbatical leave to work in Oslo, Norway, which led to a successful collaboration with Svein B. Manum |
| 1959 | Retirement from the University of Melbourne and appointment as an Honorary Research Fellow |
| 1959 | Made a Life Member of the Royal Society of Victoria |
| 1959 | Made an Honorary Associate of the National Museum of Victoria |
| 1971 | The ANZAAS Symposium on Mesozoic and Cenozoic palynology held in Brisbane in honour of Isabel C. Cookson |
| 1976 | The inaugural Isabel C. Cookson Paleobotanical Award made by the Botanical Society of America |

| Author(s) | Year | Geography | Plant types | No. of new species | No. of new subspecies etc. | Comments |
|---|---|---|---|---|---|---|
| Ewart & Davies | 1917 | Northern Territory | angiosperms | 5 | ... | Ewart, with Cookson, described five new angiosperm species |
| Cookson | 1921 | Victoria | angiosperms | ... | ... | On floral abnormalities observed in two angiosperm genera |
| McLennan & Cookson | 1923 | Victoria | fungi | 2 | 1 | A short taxonomic study on ascomycete fungi from Australia |
| McLennan & Cookson | 1926 | SA, Victoria | fungi | 3 | ... | A further taxonomic study on SE Australian ascomycete fungi |
| Cookson | 1928 | Malawi | fungi | ... | ... | On the life cycle and morphology of the fungus *Melanospora zamiae* |
| Cookson | 1929 | Victoria | fungi | ... | ... | On fungal pathogens affecting the English walnut tree in Victoria |
| Cookson | 1937a | Victoria | fungi | 1 | ... | A description of a new species of phycomycete fungi from Victoria |

| Author(s) | Year | Age of material | Geography | No. of new genera | No. of new species | No. of new subsp. etc. | Comments |
|---|---|---|---|---|---|---|---|
| Cookson | 1926 | Devonian | Victoria | ... | ... | ... | A description of two specimens of the vascular stem *Arthrostigma gracile* |
| Chapman & Cookson | 1926 | Triassic | South Australia | ... | 3 | ... | A restudy of an important Triassic macroflora from Leigh's Creek, South Australia |
| Lang & Cookson | 1927 | Late Silurian | Victoria | ... | ... | ... | A preliminary study of the *Baragwanathia* macroflora |
| Lang & Cookson | 1931 | Late Silurian | Victoria | ... | 2 | 1 | A description of a low-diversity macroflora from Victoria |
| Cookson | 1935 | Late Silurian | Victoria | 1 | 1 | ... | A major paper on a macroflora of fragments from near Alexandra, Victoria |
| Lang & Cookson | 1935 | Late Silurian | Victoria | 2 | 3 | ... | On the *Baragwanathia longifolia* macroflora from graptolite-bearing strata |
| Cookson | 1937b | Late Silurian | Tasmania | ... | ... | ... | A description of the fragmentary *Hostimella* macroflora from NE Tasmania |
| Cookson | 1937c | Late Devonian | Victoria | ... | ... | ... | A description of a single fossil wood specimen from Mansfield, Victoria |
| Cookson | 1945a | Late Silurian-Early Devonian | Victoria | ... | ... | ... | A short paper documenting records of the *Baragwanathia* macroflora in Victoria |
| Cookson | 1947b | Paleogene-Neogene (Oligo-Mio) | South Australia, Victoria | 1 | 2 | ... | A detailed study of the Family Oleaceae based on leaves and pollen |
| Cookson | 1949 | Late Silurian-Early Devonian | Victoria | ... | ... | ... | A description of the *Zosterophyllum* macroflora from Lilydale, Victoria |
| Cookson & Duigan | 1950 | Paleogene (Oligocene) | Victoria | 1 | 6 | ... | A detailed study of the Tribe Banksieae based on fossil cones and leaves |
| Cookson & Duigan | 1951 | Paleogene-Neogene (Oligo-Mio) | NSW, SA, TAS, Victoria | ... | 3 | ... | A detailed study of the Family Araucariaceae based on macrofossils and pollen |
| Cookson | 1953a | Paleogene (Oligocene) | Victoria | ... | 1 | ... | A description of an Oligocene cycad species, *Macrozamia hopeites* , from Victoria |
| Cookson & Pike | 1953a | Paleogene (Oligocene) | Victoria | ... | 1 | ... | A new species of *Dacrydium* was described from the Oligocene of Victoria |
| Cookson & Pike | 1953b | Paleogene-Neogene (P.cene-Plio) | NSW, QLD, SA, TAS, VIC, WA | ... | ... | ... | On *Podocarpus* from the Paleogene and Neogene of mainland Australia and Tasmania |
| Clifford & Cookson | 1953 | Paleogene (Oligocene) | Victoria | ... | 1 | ... | A description of what was believed to be a new moss capsule from the Oligocene of Victoria |
| Cookson | 1954a | Neogene-Quaternary | Victoria | ... | ... | ... | Records of the leaves and pollen of *Acacia* from the Neogene and Quaternary of Victoria |
| Cookson | 1954d | Paleogene-Neogene | NSW, QLD, SA, TAS, VIC, WA | ... | ... | ... | A brief general review of the Paleogene-Neogene floras of Australia |
| Cookson & Pike | 1954a | Paleogene (Oligocene) | New South Wales, Victoria | ... | ... | ... | A study of fossil material of *Phyllocladus* and other podocarpaceous taxa from Australia |
| Boureau *et al.* | 1956 | N/A | N/A | ... | ... | ... | A review of the activities of the IOP, and an international bibliography of palaeobotany |
| Boureau *et al.* | 1960 | N/A | N/A | ... | ... | ... | A review of the activities of the IOP, and an international bibliography of palaeobotany |

| Author(s) | Year | Age | Geography | No. of new genera | No. of new species | No. of subspecies etc. | Range chart | Comments |
|---|---|---|---|---|---|---|---|---|
| Cookson | 1945b | Paleogene-Neogene (undifferentiated) | New South Wales, SA, Victoria | ... | ... | ... | ... | pollen |
| Cookson | 1946a | Paleogene-Neogene (Oligocene-Miocene) | New South Wales, SA, Victoria | ... | ... | ... | ... | pollen |
| Cookson | 1946b | Paleogene-Neogene (Oligocene-Miocene) | Kerguelen | ... | ... | ... | ... | pollen/spores |
| Cookson | 1947a | Paleogene-Neogene (Oligocene-Miocene) | Kerguelen, NSW, NZ, Victoria | 6 | 11 | ... | ... | fungal palynomorphs |
| Cookson | 1947b | Paleogene-Neogene (Oligocene-Miocene) | South Australia, Victoria | ... | 1 | ... | ... | plants/pollen |
| Cookson | 1947c | Holocene | Tasmania | ... | ... | ... | ... | pollen |
| Cookson | 1947d | Paleogene-Neogene (Oligocene-Miocene) | Kerguelen | 4 | 24 | ... | ... | pollen/spores |
| Cookson | 1950 | Paleogene-Neogene (Oligocene-Miocene) | New South Wales, SA, Victoria | 2 | 18 | ... | ... | pollen |
| Cookson & Duigan | 1951 | Paleogene-Neogene (Oligocene-Miocene) | NSW, SA, Tasmania, Victoria | ... | ... | ... | ... | plants/pollen |
| Cookson | 1952 | Paleogene (Oligocene), Holocene | New Caledonia, PNG, Victoria | ... | ... | ... | ... | pollen |
| Cookson & Erdtman | 1952 | Holocene | Southern Hemisphere | ... | ... | ... | ... | pollen |
| Cookson | 1953b | Early Cretaceous, Paleogene (undiff.) | South Australia | 1 | 8 | 2 | ... | pollen/spores |
| Cookson | 1953c | Paleogene-Neogene, Holocene | Kerguelen, NSW, SA, TAS, VIC, WA | ... | ... | ... | ... | pollen |
| Cookson & Pike | 1953a | Paleogene-Neogene (Paleocene-Pliocene) | NSW, PNG, SA, TAS, VIC, WA | ... | 1 | ... | ... | plants/pollen |
| Cookson & Pike | 1953b | Paleogene-Neogene (Paleocene-Pliocene) | NSW, QLD, SA, TAS, VIC, WA | 1 | 1 | ... | ... | plants/pollen |
| Couper *et al* . | 1953 | Jurassic-Quaternary (undifferentiated) | New Zealand | ... | ... | ... | ... | pollen/spores |
| Cookson | 1954a | Neogene-Quaternary (undifferentiated) | Victoria | ... | 2 | ... | ... | plants/pollen/spores |
| Cookson | 1954b | Cretaceous, Paleogene (Paleocene/Eocene) | Victoria | ... | ... | ... | √ | pollen/spores |
| Cookson | 1954c | Paleogene (Paleocene/Eocene) | Western Australia | ... | ... | ... | ... | pollen |
| Cookson & Pike | 1954a | Jurassic-Neogene (undifferentiated) | NSW, QLD, SA, TAS, VIC, WA | 1 | 2 | ... | ... | plants/pollen |
| Cookson & Pike | 1954b | Paleogene-Quaternary (undifferentiated) | NSW, PNG, QLD, SA, TAS, VIC, WA | 6 | 17 | 4 | ... | pollen |
| Cookson | 1955 | Late Cretaceous-Paleogene (Paleoc, Eocene) | South Australia, Victoria | ... | ... | ... | ... | Permian reworked pollen |
| Cookson & Pike | 1955 | Holocene | New Caledonia, Papua New Guinea | ... | ... | ... | ... | pollen |
| Baker & Cookson | 1955 | Late Cretaceous, Paleogene | Victoria | ... | ... | ... | ... | dino. cysts, pollen/spores |
| Cookson | 1956a | Paleogene (Paleocene-Eocene) | Tasmania, SA, Victoria | ... | ... | ... | ... | pollen |
| Cookson | 1957 | Paleogene-Neogene, Holocene | Indonesia, NSW, PNG, SA, VIC | ... | 12 | 1 | ... | pollen/spores |
| Duigan & Cookson | 1957 | Quaternary (undifferentiated) | Victoria | ... | ... | ... | ... | pollen/spores |
| Cookson & Dettmann | 1958a | Cretaceous (mainly Albian) | NSW, PNG, QLD, SA, VIC | 1 | 6 | ... | √ | megaspores and microspores |
| Cookson & Dettmann | 1958b | Early Cretaceous (undifferentiated) | NSW, PNG, QLD, SA, VIC, WA | 4 | 21 | ... | √ | spores |
| Cookson | 1959 | Paleogene-Neogene (Eocene-Pliocene) | New South Wales, SA, Victoria | ... | 10 | ... | ... | pollen |
| Cookson & Dettmann | 1959a | Cretaceous-Paleogene (undifferentiated) | Victoria | ... | ... | ... | √ | pollen/spores |
| Cookson & Dettmann | 1959c | Early Cretaceous (undifferentiated) | South Australia, Victoria | 1 | ... | ... | ... | spores |
| Cookson | 1961 | Cretaceous (Albian-Cenomanian) | Queensland, SA, WA | 1 | 1 | ... | ... | spores |
| Cookson & Dettmann | 1961 | Early Cretaceous (Berriasian-Albian) | NSW, Queensland, SA, Victoria | ... | ... | ... | ... | spores |
| Cookson & Balme | 1962 | Cretaceous (?Albian-Cenomanian) | Victoria, Western Australia | 1 | 1 | ... | ... | pollen |
| Cookson | 1965c | Cretaceous (Albian-Cenomanian) | South Australia, Western Australia | ... | 1 | ... | ... | spores |
| Harris & Cookson | 1965 | Early Cretaceous (?Val.-Albian), Paleogene | South Australia | ... | ... | ... | ... | pollen/spores |
| Cookson & Cranwell | 1967 | Paleogene (Eocene) | southern Chile | ... | ... | ... | ... | microplankton, pollen/spores |

| Author(s) | Year | Age of samples studied | Geography | No. of samples | Acritarchs | Dino. cysts | Miscellaneous MP | Pollen/spores | No. of new MP genera | No. of new MP species | No. of new MP subsp. etc. | Range chart |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | |
| Cookson | 1953d | Paleogene, Neogene, Quaternary (undiff.) | NSW, SA, VIC, WA | 15 | √ | √ | √ | ... | ... | 1 | ... | ... |
| Cookson | 1956b | Cretaceous, Paleogene (Eocene) | NSW, SA, VIC, WA | 16 | √ | √ | ... | √ | ... | 5 | ... | ... |
| Cookson | 1965a | Cretaceous, Paleogene (Eocene) | SA, Victoria, WA | 19 | √ | √ | √ | ... | 1 | 5 | ... | ... |
| Cookson | 1965b | Paleogene (Paleocene) | Dilwyn Bay, Victoria | 2 | ... | √ | ... | ... | ... | 3 | ... | ... |
| | | | | | | | | | | | | |
| Deflandre & Cookson | 1954 | Cretaceous, Paleogene, Neogene (undiff.) | NSW, Victoria, WA | not known | ... | √ | √ | ... | ... | ... | ... | ... |
| Deflandre & Cookson | 1955 | Jurassic, Cretaceous, Paleogene, Neogene (ud) | NSW, SA, VIC, WA; PNG | 18 | √ | √ | √ | ... | 5 | 45 | 1 | √ |
| | | | | | | | | | | | | |
| Cookson & Eisenack | 1958 | Middle-Late Jurassic, Cretaceous (undiff.) | NSW, QLD, SA, WA; PNG | at least 73 | √ | √ | √ | ... | 12 | 53 | 3 | √ |
| Cookson & Eisenack | 1960a | Cretaceous (Albian-Campanian) | Victoria, WA | at least 17 | √ | √ | √ | ... | 16 | 31 | ... | ... |
| Cookson & Eisenack | 1960b | Late Jurassic, Early Cretaceous (undiff.) | QLD, SA, WA; PNG | at least 29 | √ | √ | ... | ... | 6 | 25 | ... | √ |
| Eisenack & Cookson | 1960 | Early Cretaceous (?Aptian-Albian) | Queensland, SA, WA | at least 13 | ... | √ | √ | ... | 3 | 17 | 1 | ... |
| Cookson & Eisenack | 1961a | Paleogene (Early Eocene) | Rottnest Island, WA | 2 | ... | √ | √ | √ | 1 | 4 | 2 | ... |
| Cookson & Eisenack | 1961b | Late Cretaceous (Santonian) | Belfast 4 Bore, Victoria | 2 | ... | √ | ... | √ | 1 | 5 | ... | ... |
| Cookson & Eisenack | 1962a | Cretaceous (Aptian-?Campanian) | QLD, SA, VIC, WA | al least 32 | √ | √ | ... | ... | 4 | 23 | 1 | ... |
| Cookson & Eisenack | 1962b | Cretaceous, Paleogene (Eocene) | Western Australia | al least 14 | √ | √ | √ | ... | 4 | 10 | ... | ... |
| Cookson & Eisenack | 1965a | Paleogene (Late Eocene) | Browns Creek, Aire, VIC | 5 | √ | √ | ... | ... | 2 | 13 | ... | ... |
| Cookson & Eisenack | 1965b | Paleogene (Late Paleocene- Early Eocene) | Drajurk, Victoria | 1 | √ | √ | ... | ... | 1 | 7 | ... | ... |
| Cookson & Eisenack | 1965c | Paleogene (Late Paleocene- Early Eocene) | Dilwyn Bay, Victoria | 3 | ... | √ | ... | ... | ... | 5 | ... | ... |
| Cookson & Eisenack | 1967a | Paleogene (Late Paleocene-Late Eocene) | Strahan, Tasmania | 1 | √ | √ | ... | √ | ... | 4 | ... | ... |
| Cookson & Eisenack | 1967b | Paleogene (Late Paleocene-Late Eocene) | Pebble Point, Victoria | 1 | √ | √ | ... | √ | ... | 4 | ... | ... |
| Cookson & Eisenack | 1968 | Cretaceous (Albian-Cenomanian, Santonian) | Perth Basin, WA | 2 | √ | √ | ... | ... | 2 | 6 | ... | ... |
| Cookson & Eisenack | 1969 | Late Cretaceous (Turonian-Santonian) | Perth Basin, WA | at least 15 | ... | √ | ... | ... | 2 | 4 | ... | ... |
| Cookson & Eisenack | 1970a | Cretaceous, Paleogene (undifferentiated) | Victoria, WA | not known | ... | ... | √ | ... | 2 | ... | ... | ... |
| Cookson & Eisenack | 1970b | Cretaceous (?Albian-Campanian) | Eucla Basin, WA | at least 10 | √ | √ | √ | ... | 1 | 22 | ... | ... |
| Cookson & Eisenack | 1971 | 'Mid' Cretaceous (Albian-Cenomanian) | Eucla Basin, WA | 1 | √ | √ | √ | ... | 1 | 11 | ... | ... |
| Cookson & Eisenack | 1974 | Late Jurassic, Cretaceous, Paleogene | QLD, TAS, VIC, WA; PNG | at least 18 | √ | √ | √ | ... | 5 | 28 | 14 | ... |
| Cookson & Eisenack | 1979 | Cretaceous (Albian and younger) | Western Australia | at least 6 | ... | ... | √ | ... | 3 | 3 | ... | ... |
| Cookson & Eisenack | 1982 | Late Jurassic, Cretaceous, Paleogene | QLD, SA, VIC, WA | at least 21 | √ | √ | √ | ... | 2 | 23 | 1 | ... |
| | | | | | | | | | | | | |
| Cookson & Dettmann | 1959b | Cretaceous (Albian-?Cenomanian) | Queensland, SA, Victoria | at least 7 | ... | ... | √ | ... | 1 | 4 | ... | ... |
| | | | | | | | | | | | | |
| Cookson & Manum | 1960 | Early Cretaceous, Paleogene | Svalbard; PNG; WA | at least 4 | ... | ... | √ | ... | 1 | 3 | ... | ... |
| Cookson & Manum | 1964 | Late Cretaceous (Turonian-Santonian) | Victoria, WA | 6 | ... | √ | ... | ... | ... | 1 | ... | ... |
| Manum & Cookson | 1964 | Late Cretaceous (Coniacian-early Santonian) | Arctic Canada | 1 | √ | √ | √ | √ | ... | 11 | ... | √ |
| | | | | | | | | | | | | |
| Cookson & Hughes | 1964 | 'Mid' Cretaceous (Albian-Cenomanian) | southeast England | 3 | √ | √ | √ | ... | ... | 9 | ... | √ |
| | | | | | | | | | | | | |
| Cookson & Cranwell | 1967 | Paleogene (Eocene) | southern Chile | 1 | √ | √ | √ | √ | ... | 1 | ... | ... |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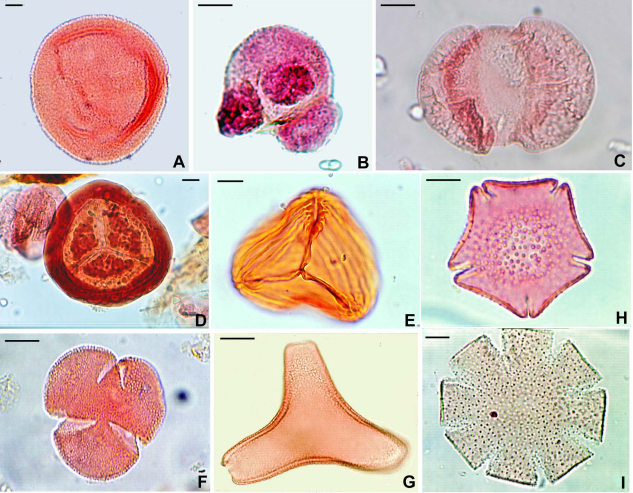
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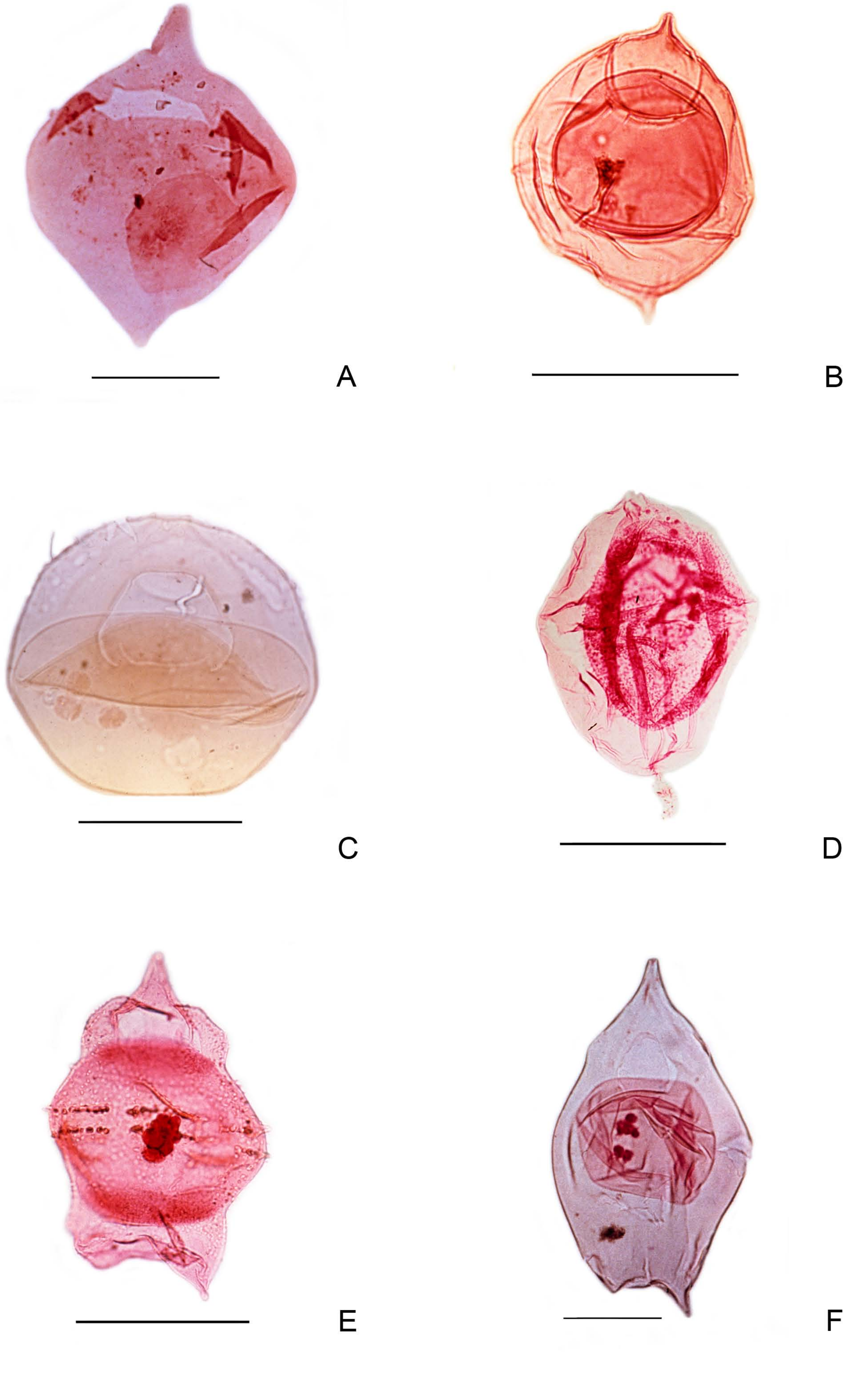
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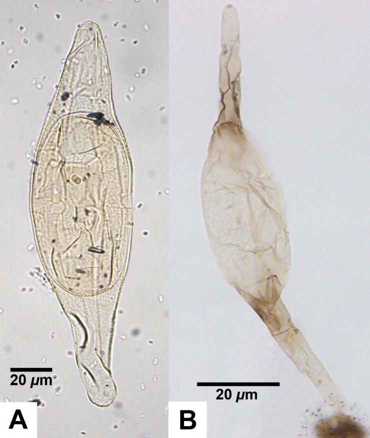
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A
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OLIVE PINK CRES
COOKSON PL