Canadian Association of Palynologists
Association Canadienne des Palynologues

NEWSLETTER

Volume 24 Number 1 May 2001

President's Message

My activities as President this year have focused on the CAP-sponsored publication *New frontiers and applications in palynology and micropaleontology: a Canadian perspective*, which I am co-editing with Alwynne Beaudoin as a planned special issue of the Elsevier journal *Palaeogeography, Palaeoclimatology, Palaeoecology*. We've had some very good manuscripts submitted, covering most microfossil groups and ranging from Silurian to the present day. This special issue is based on the CAP-sponsored symposium at last year's GeoCanada 2000 meeting in Calgary. CAP is hoping to build upon this success by sponsoring another symposium in the near future. See inside this Newsletter for details.

Onto more central matters, Gail Chmura last year completed her 4-year term as Councillor to the International Federation of Palynological Societies (IFPS). Gail has been our voice at the IFPS and has arranged the mailing of *Palynos* to our members. In this latter regard she has been helped by Victor Pospelov, and both deserve our sincere thanks for their services.

It is a pleasure to welcome Rolf Mathewes as CAP's new IFPS Councillor. Rolf will serve in this position until the end of the next International Palynology Congress, to be held three years from now in Granada, Spain. Rolf is a former president of CAP, and brings a wealth of experience to the executive. We are delighted to have him onboard.

Francine McCarthy has asked to step down as Secretary-Treasurer. Francine has done a excellent job of keeping CAP's finances and membership matters in good order over the past three years. Her presence will be greatly missed by the Executive. As a former Secretary-Treasurer myself, I know how important this position is to the smooth running of the Association. I wish Francine's successor, Marlow Pellatt, every success, but meanwhile I'm sure you will join me in thanking Francine for her time and enthusiasm in the service of CAP.

It is always extremely gratifying to learn of CAP members being honoured for their services to palynology. I am pleased therefore to report that Graham Williams (GSC-Atlantic) was recently elected an honorary member of the Palaeobotanical and Palynological Society of Utrecht (*see the interview under "People" in this Newsletter*). Graham is in good company, as previous recipients include W. R. Evitt and J. Jansonius.

Once again I'd like to end my President's message by thanking members of the CAP executive for their part in making the association run smoothly, including Alwynne Beaudoin for maintaining CAP's excellent website and Mary Vetter for the long hours she has put into this Newsletter.

Martin J. Head
President, CAP
mh300@hermes.cam.ac.uk

CAP EXECUTIVE 2001

Martin Head	President
Alwynne Beaudoin	President-Elect
Francine McCarthy	Secretary/Treasurer (Ret)
Marlow Pellatt	Secretary/Treasurer (New)
Mary Vetter	Newsletter Editor
Alwynne Beaudoin	Website Editor
Rolf Mathewes	CAP Councillor to IFPS

ISSN 1188-3596

Editor's Notes

The publication of this newsletter was delayed a month to allow inclusion of the Minutes and Reports from the CAP Annual General Meeting in late May. I know it will find many of you either away at summer activities or leaving soon, but I hope that you will have a chance to read about the upcoming events and ongoing activities. Highlights of this newsletter include news of a planned CAP-sponsored symposium at the next GAC/MAC meeting, an interview with Graham Williams, Vaughn Bryant's essay on pollen in honey, Joyce Macpherson's list of *Picea* stomata references, Roland Hall's description of the WATER lab at the University of Waterloo, and an extensive abstract of Ram Kalgutkar's and Jan Jansonius' recently published book.

As always, thanks are due to the many contributors to this issue. In addition to those people listed above, I would like to send thanks to Martin Head, Francine McCarthy, Alwynne Beaudoin, Jim Cane, Bert van Helden, Lenny Kouwenberg, for their contributions! And last but certainly not least, special thanks go to Rob Fensome and Nellie Koziel for printing and mailing the newsletter.

Please keep the Newsletter in mind if you are attending any conferences this season; reports (short or longer) of conferences are always a most welcome addition to the December newsletter! Have a good summer!

Mary Vetter
Newsletter Editor
Mary.vetter@uregina.ca

From the Bureaucrat's Desk

New Secretary-Treasurer

Dr. Marlow Pellatt, Parks Canada Western Division, has graciously agreed to serve as CAP's new Secretary/Treasurer. Thank you very much, Marlow, for taking this on!

Address Changes

Zicheng Yu will be moving to Lehigh University in August to take up a tenure-track position there—Congratulations! Please note the following new address:

Dr. Zicheng Yu
Assistant Professor
Department of Earth and Environmental Science
Lehigh University
Bethlehem, PA 1801 U.S.A.

New Members

On behalf of CAP it is a pleasure to welcome **Sarah Finkelstein** and **Jeffrey G. Richardson** as new members.

Dues Due

If your name appears below, here is a gentle reminder that **your membership subscription became due at the start of 2001**: D. Batten, J. Bourgeois, C. Chinnappa G. Chmura, T. Demchuk, F. dos Santos, J. Fernandes, M. Garneau, J. Hopkins, E. Koppelhus, H. Kurita, I. Larocque, J. McAndrews, C. Morgan, M. Pellatt, S. Tiffin, A. Traverse, C. Yansa, and S. Yazvenko.

Dues Payment

Please note that CAP membership dues are CDN $10 per year, payable annually or up to three years in advance. Please make cheques payable to "CAP". Following a reminder notice, lapsed members are removed from the CAP mailing list after one year. See also the Membership Form at the back of this Newsletter. Funds and address changes should be sent to:

Marlow Pellatt
Parks Canada
Western Canada Service Centre
300 – 300 West Georgia Street
Vancouver, BC V6B 6B4

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SPECIAL ANNOUNCEMENT

The Palynology and Micropaleontology of Boundaries

A CAP-sponsored Special Session at the GAC/MAC meeting in Saskatoon
May 26-29 2002
co-convened by Alwynne Beaudoin and Martin J. Head

Boundaries in time and space can leave distinct signatures in the palynological record. Diffuse or sharp, gradual or abrupt, boundaries can tell us much about the response of biotic systems to environmental change in both marine and terrestrial realms. Sponsored by the Canadian Association of Palynologists (CAP), this Special Session explores the identification and characterization of boundaries through palynology and micropaleontology.

CANADIAN ASSOCIATION OF PALYNOLOGISTS ANNUAL GENERAL MEETING MINUTES

12:00 p.m., May 29, 2001
Rm. AA1045, Memorial University
St. John's, Newfoundland
Present: R. Mathewes, J. Macpherson, J.-N. Haas, F. McCarthy.

Attendance at the AGM was poor again, although those present (from as far away as Austria!) accepted the President's, Secretary-Treasurer's, Newsletter Editor's, and Website Manager's Reports as circulated and discussed the matters on the agenda.

CAP-sponsored symposium/location of next AGM: We discussed the proposal by Alwynne Beaudoin for a special CAP-sponsored session at next year's GAC meeting in Saskatoon. There was unanimous approval for the concept and for the suggested theme *The Palynology of Boundaries*, but it was agreed that a meeting with a stronger Quaternary focus might be a better venue to attract existing (and hopefully new) CAP members. It was noted that many of our members are non-geologists, but rather geographer, botanists, archeologists, etc., who are more likely to attend CANQUA or other Quaternary meetings. The upcoming INQUA meeting to be held in Reno was mentioned as a possible venue.

Future of CAP: The problem of low and dwindling CAP membership was discussed, and an attempt to contact new potential members (including institutional members) via e-mail was suggested.

New Secretary-Treasurer: Marlow Pellatt was approved to succeed Francine McCarthy as Secretary-Treasurer.

Proposed President-Elect: Pierre Richard was suggested as President-Elect. Jean-Nicholas Haas was to approach him on this matter during a visit to Pierre's lab in Montréal. There were no suggestions for the newsletter editor's or website manager's positions.

The meeting was adjourned.

President's Report

See the President's Message at the beginning of the newsletter with the following addition:
I'd like to thank the GAC-MAC organizing committee, and particularly Elliott Burden, for facilitating CAP's use of this meeting room at no cost to the association. Enjoy the rest of the conference, and I hope to see you at next year's AGM.

Respectfully submitted
Martin J. Head
President, CAP

Secretary-Treasurer's Report

i) Membership Report
As of May 15, 2001, CAP had a total of 45 members in good standing. Although this number is probably slightly low, since we routinely receive a small flurry of renewals following the May Newsletter, CAP's low current membership may be a cause for concern. Over the last 5 years (1996-2000 inclusive) our membership averaged ~70, but we have been losing more long-time members than we are recruiting, and this number is less than 85% of the average membership over the previous 10 years (1986-1995 inclusive). While this trend appears to mirror the number of employed palynologists, we should examine whether we are serving our membership as well as we can.

ii) Financial Report
The balance in the CAP account was $2408.25. The balance remains healthy, and the cost of membership continues to cover our modest costs – newsletter production (thanks to Rob Fensome at the GSC-Atlantic) and mailing, IFPS dues, and bank service charges (see Financial Statement). Note, however, that the balance is $13.32 lower than the balance forward (from last year's AGM May 31, 2000). It is critical for the long-term viability of CAP that we attract and retain more members.

Financial statements are on the following pages.

Respectfully submitted
Francine McCarthy
CAP Secretary-Treasurer

Newsletter Editor's Report

We continue to publish two newsletters per year, in May and December. In general, the December newsletter is a larger issue with conference reports, but there is good response to the call for items for both newsletters. Special thanks to those members who contribute both regularly and irregularly! Also, special thanks to Rob Fensome, Nellie Koziel, and Francine McCarthy, who continue to maintain the newsletter mailing list, and duplicate and mail the newsletters. It was agreed at the last Annual Meeting that the costs associated with duplicating and mailing the newsletter should be covered out of membership fees, and those costs brought forward to the next Annual Meeting. It costs approximately $160 to mail out each newsletter issue. Rob Fensome said that his office is willing to continue to duplicate the newsletter without cost to CAP. Therefore, the average cost per member for the newsletter on an annual basis (two issues) is around $5.00. Finally, this is my third year as newsletter editor, and if anyone is interested in taking this over in 2002 I would be happy to pass the task on!

Respectfully submitted,
Mary Vetter, CAP Newsletter Editor

Website Editor's Report

I have continued to act as Editor for the CAP Website since the last AGM. The website provides a broad array of useful resources and information about CAP to the palynological community. Over the last year, it has received a steady "hit rate" of around 300 accesses each month.

I have not yet been able to make arrangements to have the website hosted at another location, as I suggested at the last AGM. Space restrictions have precluded the addition of much new material in recent months. I am still planning to move the web presentation so that it can be expanded more easily. I hope to have more positive news to report on this item at the next AGM.

I would like to ask all CAP members to make suggestions for useful material that could be included in the web presentation. I welcome contributions to the website and suggestions for new components.

The CAP website can be found at
http://www.ualberta.ca/~abeaudoi/cap/cap.htm

Respectfully submitted
Alwynne B. Beaudoin
CAP Website Editor
abeaudoi@gpu.srv.ualberta.ca

SECRETARY/TREASURER'S REPORT
FINANCIAL STATEMENT
(for the period May 31, 2000- May 15, 2001)

Credits:	
Balance forward (October 25, 1999)	$2421.57
Other credits:	
Dues and subscriptions	$662.53
Total credits:	$3084.10
Debits:	
IFPS dues, 2000	-$110.40
Cost of money order, IFPS dues	-$5.00
Registry of Joint Stock Companies	-$25.00
Prepaid subscriptions (2002-2005)(31@$10.00)	-$310.00
Service charges	-$37.65
Total debits:	-$675.85
BALANCE:	**$2408.25**

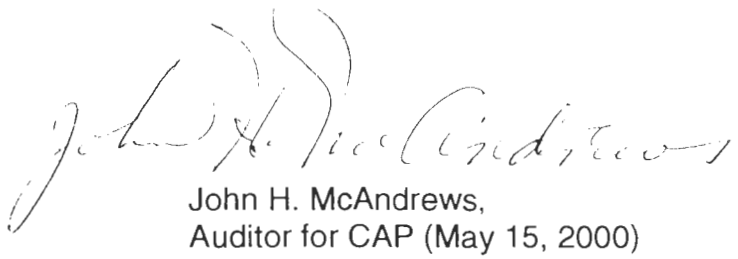
On May 15, 2001 funds in the CAP account stood at $3008.25.

Respectfully submitted by

Francine M.G. McCarthy
CAP Secretary/Treasurer (May 15, 2001)

Statement by appointed auditor

It is my opinion that the above financial statement represents a full and fair account of the financial affairs of the Canadian Association of Palynologists for the above period.



John H. McAndrews,
Auditor for CAP (May 15, 2000)

SECRETARY/TREASURER'S REPORT
FINANCIAL STATEMENT
(for the period October 25, 1999- May 30, 2000)

Credits:	
Balance forward	$2410.57
Other credits:	
Dues and subscriptions	$340.00
Total credits:	$2750.57
Debits:	
Registry of Joint Stock Companies	-$25.00
Prepaid subscriptions (2001-2004)(29@$10.00)	-$290.00
Service charges	-$14.00
Total debits:	-$329.00
BALANCE:	**$2421.57**

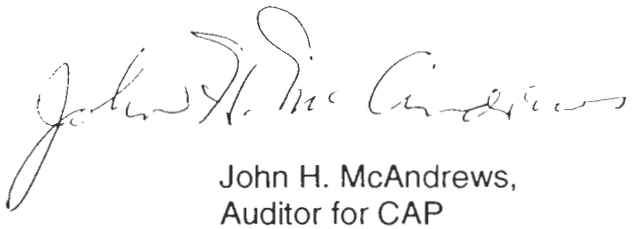
On May 30, 2000 funds in the CAP account stood at $2711.57

Respectfully submitted by

Francine M.G. McCarthy
CAP Secretary/Treasurer (May 30, 2000)

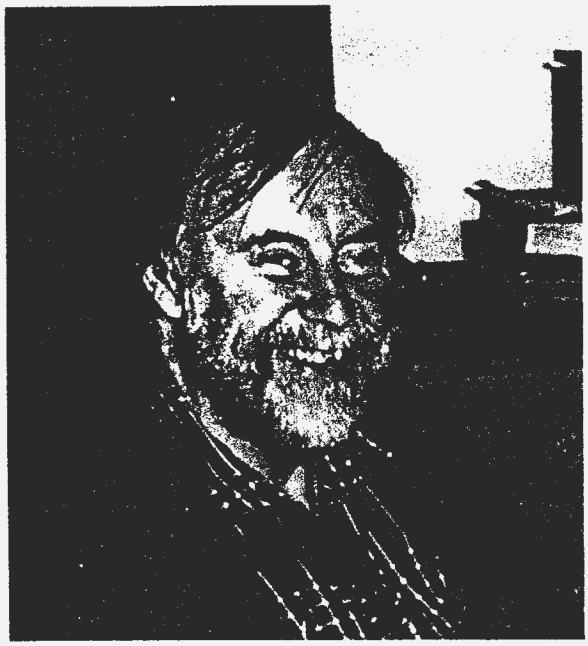
Statement by appointed auditor

It is my opinion that the above financial statement represents a full and fair account of the financial affairs of the Canadian Association of Palynologists for the above period.



John H. McAndrews,
Auditor for CAP

PEOPLE



Graham Williams

This interview was originally published in Stuifmail, *the Newsletter of the Palaeobotanical and Palynological Society of Utrecht, on the occasion of the recognition of Graham by the Society with a Honourary Membership. Special thanks to Lenny Kouwenberg and fellow editors for permission to reprint their article and photographs here!*

1. ***When and why did you start working with dinoflagellates ?***

This is an embarrassing question since it shows how old I really am. It was before any papers had been published on archeopyles. I was in the Army for two years, from 1958 to 1960. While in Singapore, I decided I needed to go back to university and be useful. So I wrote to about 20 universities in the U.K., asking if there was any possibility of doing a thesis in micropaleontology. A Dr. Downie of Sheffield replied that no, he did not supervise theses on foraminifera but that I was welcome to write a proposal regarding dinoflagellates and hystrichospheres. I had no idea what either was so went down to the main library in Singapore and read up all I could find on dinoflagellates in the Encyclopaedia Britannica. But there was nothing on hystrichospheres. I figured out they were spiny spheres but that's not a lot of help. So I wrote a proposal and every time I mentioned dinoflagellates, I wrote in hystrichospheres. Much to my surprise, I was accepted. I arrived back from Singapore on 15th September and started at Sheffield on 1st October 1960. Charles Downie told me that my research study would be the dinoflagellates and hystrichospheres of the Bajocian-Bathonian. I said I didn't want to do that; I wanted to work on the Tertiary. Luckily, Charles had a friend who had picked some forams from the London Clay. In the samples were some beautiful pyritized hystrichospheres. I later found out that they were specimens of *Hystrichosphaeridium tubiferum*. So we agreed that I would study the dinoflagellates and hystrichospheres of the London Clay. What a lucky choice that turned out to be.

2. ***Could you tell something about the research you're doing (for those non-dino people, who don't know you?)***

I am one of about twenty people in the Marine Resources Geoscience Subdivision (only the government could invent such a name), which studies the geological evolution of the sedimentary basins of offshore eastern Canada. The group was formed in 1971. I'm the only one of the original (you didn't know that I was an original) staff still working full time. Originally, it was decided to use foraminifera, ostracods and palynomorphs for bistratigraphic control in the offshore wells, but the palynomorphs won out. Now, we have two palynologists, Rob and me. We analyse mainly cuttings samples from the wells, most of which are in the Scotian Basin or the Jeanne d'Arc Basin. Offshore eastern Canada is becoming an important contributor to the oil and natural gas production of Canada. The Hibernia field in the Jeanne d'Arc Basin produces about 150,000 barrels each day. The reserves are placed at 884 million barrels. That sounds a lot until you remember that the World's consumption is about 75 million barrels a day. Another development in the Scotian Basin, the Sable Offshore Energy Project, is producing about 400 million cubic feet per day of natural gas. This morning there was an announcement that a similar sized field is going to be developed close by Sable. It's an exciting time to be doing palynology, especially as the regional

geologists and geophysicists are always looking for more biostratigraphic and paleoecologic data.

3. ***What did you want to be as a grown-up when you were a kid (and why didn't you learn any proper trade in the end)?***
When I was growing up, I wanted to be a train driver. Then my sister decided that she was going to be a doctor. I thought that sounded interesting but found out that I didn't enjoy dissecting frogs or dogfish. I also was lousy when trying to do anything that required a steady hand. So I looked around for something solid. What's more solid than rocks. That decided me, although I knew nothing about geology until I went to university. And I still don't know much.

4. ***What's your favourite dinoflagellate cyst (and why)?***
I have several but top of the hit parade is *Charlesdowniea crassiramosa*. I've always had a soft spot for the Wetzeliella (everything was group, but I really fell for the huge specimens of then *Wetzeliella tenuivirgula* var *crassoramosa*. It took me about a day to traverse the first specimen I found: it was so big. Eventually I produced, for me, a major work of art, a camera lucida drawing of both surfaces. That was a labour of love. My second favourite is *Areosphaeridium diktyoplokum*. The specimens are so spectacular and it photographs so spectacularly. Somewhere, I have one of Lew Stover's transparencies (Henk always calls these slides) that shows the duplication of the plate outline by the distal extremity of the process on the antapical plate. The third star in my list is *Homotryblium tenuispinosum*. I couldn't figure this one out at all. Then Bill Evitt's classic 1961 paper appeared and I realised what hystrichospheres were all about. It was like being hit by a thunderbolt when I first read that paper in the library at Sheffield University. I started writing to Bill and was really impressed with how he always answered both my numerous questions and my letters. Bill deserves all the credit for figuring out *Homotryblium* but he let me take all the credit. Thanks to him, I did some research and didn't simply count spines on round spheres.

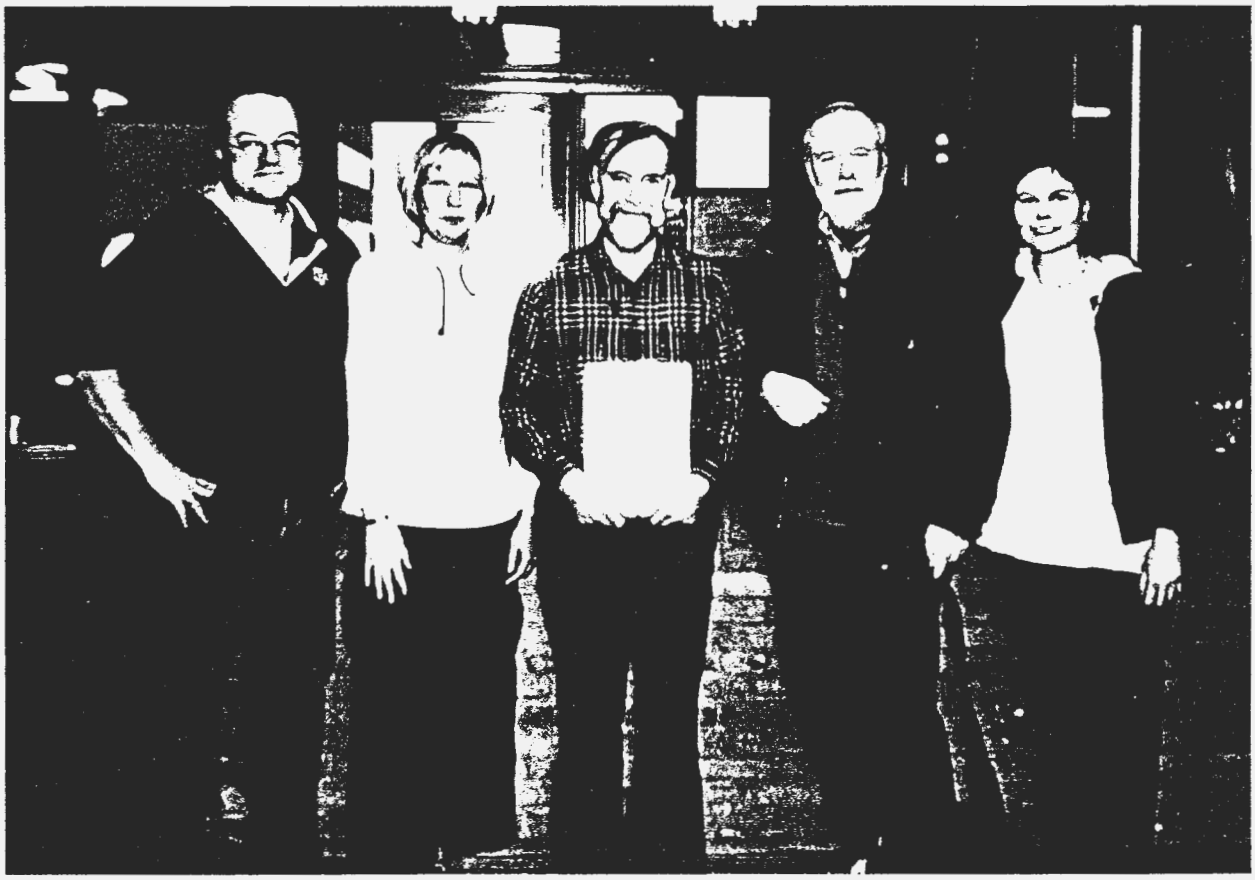
5. When and how did you get in touch with the PPGU/ the people from Utrecht?
I first met Henk at an ICP meeting in Calgary in 1981 but he didn't register. We first really got to know each other at Dino 4 in Woods Hole in 1989. Woods Hole is tiny, but it has one bar that is open all year round. Lew Stover dropped in the first night and there was this weird character telling jokes. And surprisingly, they were good jokes. That started Lew and me off and we enjoyed ourselves so much that we went back the following night. And the following night, until the end of the week. After that, Lew, Henk and I became good friends. Henk, always willing to take risks, decided that Lou, Henk and I should give a course at Utrecht on Tertiary dinoflagellates. We agreed we should also invite Sarah Damassa and decided the course would be in 1993, in conjunction with Dino 5. Sadly, Lou died in early 1993 and I told Henk that I didn't want to give the course. We agreed to present it the following year and so I paid my first visit to Utrecht in June 1994. I couldn't believe it. It rained every day and was cold (even by Canadian standards). However, I survived. Since 1994, I have been back to Utrecht so many times and made to feel so welcome that I regard it as my second home. I have even survived the dreaded one-day drive to Italy and enjoyed it. Hopefully, I shall make many more visits to the LPP group.

6. ***What do you like best about visiting the Netherlands ? And Almelo (if there's anything)?***
The natives, and the visiting students, are the best part of the Netherlands. Much to my surprise, you all have a great sense of humour and never take yourselves too seriously. I remember when I was a student at Sheffield University. I always called Charles Downie Sir or Dr. Downie. He was staff and I was a student. And students and staff did not socialise except at the annual dinner of the geological society and on field trips. At LPP, the atmosphere is friendly but dynamic. The relationship between the students and staff is something that I wish I had had when at university. Another aspect that I really enjoy is working and talking with the students. They all seem so smart and hard working but they also know how to have a good time. There's a lot of truth in the old saying that all work and no play makes Jack a dull boy or Jill a dull girl. I think the mix at LPP is perfect. I find it stimulating to learn what everyone is doing and some of the exciting research projects. I live primarily in a world of cuttings where biostratigraphy is the name of the game. It's a new experience to hear about paleoecological studies where the quantitative data is so much more important. One of the best projects I been involved in, thanks to Henk, is the Leg 189 palynology study. I'm impressed with how Henk can utilise the data to predict changes in paleocirculation and nutrient levels. And, just as significant, is that we should be able to develop the first comprehensive dinocyst zonation for the southern hemisphere

Cenozoic. Almelo has a lot going for it, although it needs a soccer team that plays in the Premier League. For me, the most memorable aspect is the tremendous hospitality of Annemie and Henk. And the theatre shows are spectacular.

7. ***How did you feel when you were declared an honourary member of the PPGU?***
I was stunned and completely taken aback. Did you notice that I didn't say much. That is my quirky way of hiding my emotions. It was an honour that I did not expect. On Friday morning when we arrived in Utrecht, Henk said that the day would be full of surprises. I couldn't figure out what he meant. Later, I asked if I could pay my LPP membership dues and Henk said that I was paid up. I suggested that I pay up for next year and was told that that was also paid. I was really surprised. Then we started having all the trouble with the projectors during the mini-symposium and I thought, this is it. But the biggest surprise was at the end when Erica gave that incredible speech. If she ever needs a job, I'll give her one as my speechwriter.

8. ***How many lumberjack shirts do you possess (and does this have anything to do with question 3)?***
I have a confession. If an article of clothing is in fashion, I don't want to wear it. That's why I've never had a pair of blue jeans. Although lumberjack shirts are not as popular here as in western Canada, they are too popular for me.



From left to right: Dr. Henk Brinkhuis, Dr. Rike Wagner (chairwoman of the PPGU), Graham, Prof. Dr. Henk Visscher and Erica Crouch (former PPGU treasurer)

ESSAYS

POLLEN CONTENTS OF HONEY

VAUGHN M. BRYANT, JR.
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Texas A&M University
College Station, Texas 77843-4352

Introduction

There are four natural resources required by honeybees for survival: water, resin, nectar, and pollen (Seedley, 1985). Water is used to cool the hive and to dilute the honey fed to the larvae. Resin is utilized to reinforce the hive, seal off decaying wood, and plug up holes. Nectar is the major source of carbohydrates from which honeybees obtain their energy. Nectar is collected by foraging worker bees and is carried back to the hive in their honey stomachs. Upon returning to their hive, the nectar is usually transferred to hive workers for processing into honey, although it can be fed directly to the brood or to the adults (Winston, 1987). Enzymes from the bee's hypopharyngeal glands are added to the nectar in the bee's crop. These enzymes break down the nectar into simple forms of sugars, which are easier for the bees to digest. These enzymes, in addition to the high sugar content, also protect the stored honey from bacteria. The water in the nectar is then evaporated off of the worker's tongue. The nectar is placed into cells and fanned to further reduce water in it. Through this process, the water content in the nectar is reduced to less than 18% (Winston, 1987). Once the evaporation process is complete, the nectar is considered "ripened" and is called honey. The cell is capped with wax until the honey is needed for feeding to the larvae or the adults.

Some statistics about honeybees and the production of honey are important to note. Years of observation and research have revealed a number of facets about this subject. For example, it is estimated that to make one pound of honey, honeybees must visit about two million flowers, fly a total of about 50,000 miles, and carry about 37,000 loads of nectar back to the hive. According to the British entomologist, Arthur Thomson, during the main flower blooming periods it is common for the bees from a single hive to visit as many as 250,000 flowers during the course of a single day (Teale 1942). Some flowers, such as the ones of a tulip tree (*Liriodendron tulipifera*) each produces about a teaspoon of nectar. Other flowers, such as the ones of white clover (*Trifolium repens*), produce only enough nectar to cover 1/20 of a pinhead (Crane 1975).

Each worker bee is able to carry a load of nectar equal to one-half its total weight and during her lifetime one worker will collect enough nectar to produce about 1/12 of a teaspoon (add mg equivalents of this amount?) of honey. During nectar gathering, a honeybee consumes 0.5 mg of ripe honey per kilometer of flight. To produce one liter of surplus honey the worker bees of a hive will consume eight additional liters of ripe honey as food. Ripened honey and pollen stored in a hive are the food sources eaten by the bees. Feeding a bee larva from the egg to maturity requires about 142 mg of honey (Winston, 1987).

Where does the pollen in honey come from?

Pollen is the bee's major source of proteins, fatty substances, minerals, and vitamins (Gary, 1975). It is essential for the growth of larvae and young adult bees (Dietz, 1975). Honeybees remove pollen from an anther by using their tongue and mandibles. While crawling over flowers, pollen adheres to their "hairy" legs and body. The honeybee combs pollen from her head, body, and forward appendages, mixes it with pollen from her mouth, and transfers it to the *corbicula*, or "pollen basket", on her posterior pair of legs. When "loaded" with pollen, she will return to her hive. Once at the hive, workers pack the pollen into the comb. To prevent bacterial growth and delay pollen germination, a phytocidal acid is added to the pollen as it is packed into the comb. Other enzymes produced by worker bees are also added which prevent anaerobic metabolism and fermentation thereby enhancing the longevity of the stored pollen. Once completely processed for storage, the pollen comb is referred to as "bee bread" and is ready for later consumption by the bees. The protein source needed for rearing one worker bee from larval to adult stage requires approximately 120 to 145 mg of pollen (Alfonsus, 1933; Haydak, 1935). An average size bee colony will collect about 20 to 57 kg of pollen a year (Armbruster, 1921; Eckert, 1942). In most cases the primary foraging areas for pollen are the various insect-pollinated plants bees visit for nectar. However, honeybees will also visit a number of species of wind-pollinated plants for which their only purpose is to collect pollen. Wind pollinated

species of *Salix* (willow), *Quercus* (oak), *Celtis* (hackberry), and many species of grasses (Poaceae) as well as some of the wind-pollinated types of composites (Asteraceae) are considered important pollen sources for foraging honeybees.

Melissopalynology is the study of pollen in honey. For over 100 years the literature pertaining to the study of pollen in honey has been termed or spelled several ways, including: mellissopalynology, mellittopalynology, and melittopalynology. According to *Paxton's Botanical Dictionary* (1868), both "melissa" and "melitta" mean "a bee." The scientific name of the honeybee is *Apis mellifera* L. The word "melliferous" comes from the Latin word *mellifer* (honey) and the suffix -ous meaning "having, full of, or characterized by." The International Commission for Bee Research uses "melissopalynology", which is the term used throughout this essay.

Pollen can be incorporated into the honey produced in a beehive in a number of ways. When a honeybee lands on a flower in search of nectar, some of the flower's pollen is dislodged and falls into the nectar that is sucked up by the bee and stored in her stomach. At the same time, other pollen grains often attach themselves to the hairs, legs, antenna, and even the eyes of visiting bees. Later, some of the pollen that was sucked into her stomach with the nectar will be regurgitated with the collected nectar and deposited into open comb cells of the hive. While still in the hive the same honeybee might groom her body in an effort to remove entangled pollen on her hairs. During that process pollen can fall into open comb cells or the pollen can fall onto areas of the hive where other bees may track it into regions of the hive where unripe honey is still exposed in open comb cells. Some worker bees also collect pollen for the hive. The smooth, slightly concave, outer surfaces of the hind tibia in worker bees are fringed with long hairs that curve over the tibia surface to form a hollow area. This hollow area is called the "pollen basket" or orbicular. The worker bees collect pollen with their front and middle legs and then deposit it in their cubicula (Snodgrass and Erickson 1992). In the process of depositing collected pollen into special comb cells some of it can fall into the hive or into open honeycombs. It is also noted that occasionally worker bees might add pollen to the nectar they are transforming into honey.
Airborne pollen is another potential source of pollen in honey. Many types of airborne pollen produced mostly by wind-pollinated plants that are not usually visited by honeybees can enter a hive on wind currents. These airborne pollen grains are usually few in number, when compared to the pollen carried into the hive by worker bees, nevertheless, those pollen types regularly enter a hive on air currents and can settle out in areas where open comb cells are being filled with nectar. Sometimes airborne pollen is deposited into ripened honey when it is being removed from a hive by the beekeeper. Although the *pollen rain* for various regions consists mainly of airborne pollen, and those data are often used in forensics, archaeology, and ecology to identify a specific geographic region, those pollen data are not always as useful in melissopalynology because they generally form only a minor (?) fraction of the total pollen spectrum found in a honey sample.

Pollen is an essential tool in the analyses of honey. Taxa of pollen are used to indicate the floral nectar sources utilized by bees to produce honey (Lieux 1975, 1977, 1978; Moar 1985; Louveaux et al. 1970; Sawyer 1988; Van der Ham et al. 1999). Thus, the relative pollen frequency is often used to verify and label a honey sample as to the major and minor nectar sources. This information has important commercial value because honey made from some plants commands a premium price (i.e., sourwood, tupelo, buckwheat, or citrus honey). Even non-premium grades of honey require certain types of verification because they must be correctly labeled before being marketed. Identifying and quantifying the pollen in honey samples is one of the best ways to determine the range of nectar types used to produce a honey, and therefore label it correctly based on actual foraging resources. Another reason that pollen analyses of honey are often required is to identify the geographical source of origin. The combination of wind and insect-pollinated taxa found in a honey sample will often produce a pollen spectrum that is unique for the specific geographical region where it was produced. Because of trade agreements, import tariffs, and legal trade restrictions, most of the leading honey-producing nations of the world require accurate labeling of honey before it can be sold. This is especially true for the EEU that has had strict labeling regulations for honey products since 1974 (EEU 2001).

The history of melissopalynology: a brief overview
At the end of the nineteenth century, Pfister (1895) examined the pollen contents of various Swiss, French, and other European honeys. Through his

analysis, he demonstrated the possibility of determining the geographical origin of honey from the pollen within it. He was able to identify many of the pollen grains he found because of earlier studies of pollen morphology, structure, and identification of European pollen types by botanists including Guillemin in 1825, Fritsche in 1832, Mohl in 1834, and Fischer in 1890 (Woodehouse, 1935).

The history of the scientific investigation of U.S. honey begins in the early 1900s when a researcher working for the United States Department of Agriculture (USDA), W.J. Young, published a brief report on the analysis of domestic honey produced in the United States (Young, 1908). One of the reasons that Young says he examined the pollen content of honey was to determine if pollen studies could be used in the future to "judge the adulteration of a sample" (Young, 1908). His hypothesis was that if honey was adulterated with sugar syrup, this could be detected by finding a reduction in contents of the pollen. However, the method he used to determine the pollen concentration values of his samples is not considered accurate by today's standards. Currently, most melissopalynologists use larger amounts of a honey sample (10 g) and ratios of pollen grains per gram of honey based on counts derived from comparing the pollen to percentages of introduced "tracer" spores added to each sample before analysis. Young, on the other hand, determined his published pollen concentration ratios for 19 of his 100 honey samples by extracting only one gram of honey from each sample, diluting it with water, and then counting a small portion. He doesn't explain why he did not attempt pollen concentration studies for the other 81 samples in his study. When deriving his concentration values, Young relied on identifications of pollen types that still contained their pollen's cytoplasm, waxes, or surface lipids. By failing to process the honey samples in order to remove those components from the pollen, Young's ability to make precise identifications of pollen types was probably difficult. Young states that he used the pollen concentration value for each of his 19 samples as a basis for predicting the expected pollen concentration values for future studies of each type. Based on his work, Young determined that the range of pollen concentration values varied from a low of 123 pollen grains /g to a high of 5,410 grains /g of honey.

The second reason Young examined the pollen contents of his 100 samples was to determine the identity of "the pollen from a large number of flowers known or suspected to be visited by bees in different sections of the country" (Young, 1908). Ninety of the 100 honey samples had a purported source that was provided by the beekeeper, such as "melon honey, clover honey, or cotton honey," etc. The other 10 honey samples were listed as being from mixed floral sources. Thus, for each of the 100 samples the major pollen types were compared to see if they corresponded with the suspected honey source. For example, each of his pollen analyses reported first the sample number followed by the type of purported honey based on the report provided by the beekeeper that collected the sample. Next, Young listed the state in which the honey was collected and then the pollen types he found in the sample. Each of his entries is listed such as this one: "sample 61. Melon (Illinois). Clover, Melon, Cruciferous, *Polygonum*, Alfalfa, Basswood, Composite (two kinds), and Ellipsoidal types." Unfortunately, Young provides no explanation as to how many pollen grains he counted for each sample, nor the percentage of each pollen type he identified. He also does not say if the pollen list for each sample is based on the descending order of pollen frequency of each type found in the sample.

Although Young's report focused mainly on the chemical aspects of honey and honeydew samples, he was one of the first to examine the pollen contents of honey. He made a key to the pollen grains commonly found in U.S. honey, discussed the importance of protecting honey samples from airborne contaminants, and discussed the various kinds of structures (insect parts, fragments of the comb, fungal spores, dust, pollen, etc.) that are likely to be encountered when examining honey. Nevertheless, his actual pollen data are of little research value to melissopalynologists today. Unfortunately, Young provides no explanation as to how many pollen grains he counted for each sample, what was the relative percentage of each pollen type he listed, or even which pollen types were the most or least important in each sample.

In 1911, Fehlman published his work on the pollen spectra found in various examples of Swiss honey (Maurizio, 1951; Maurizio and Louveaux, 1965; Lieux, 1969). Fehlman's work was significant because he was the first European to use pollen as a way to identify and differentiate honeydew from nectar honeys, and to demonstrate that pollen contents were the key to determining the nectar sources in honey samples.

In the United States during the 1920s Parker (1923) conducted a study of bees and the honey they collect. His research remains an important contribution for a number of reasons. First, he described 28 different kinds of pollen collected by honeybees, and included photographs of the 12 most important ones. Second, like others before him, Parker was convinced that the pollen content in honey was a valuable tool for identifying the foraging sources used to make it. Third, he recognized that if bees were trapped on their return to the hive, the pollen recovered from the nectar in their honey stomach would identify the foraging areas being utilized by the hive.

Other research advancements in melissopalynology during the 1920s were made by Betts and Allen, who worked separately on English honey. Betts (1923, 1925) made sketches of 15 different kinds of pollen sources found in English honey types and she suggested that flowers from herbarium specimens could be used as a source of pollen to make comparative reference samples. These taxonomically-correct pollen reference samples, she reasoned, would speed the identification of unknown types found in English honey and it would also enable researchers to add another level of precision to their identification of pollen recovered in honey samples. A few years later, Allen (1928a) noted that some pollen grains remain on the surface of the honey, instead of becoming mixed with the honey like other types of pollen. Allen reasoned that some pollen grains "floated" on the surface of honey because they must be lighter and less dense than the honey. He was also the first to report that pollen found mixed with nectar could come from sources other than the nectar plant's own anthers and pollen (1928b). For example, Allen observed that accidental contamination of nectar and eventually the honey it was used to produce could occur through several means. First, he noticed that bees that had visited one type of flower might move to flowers of a different plant species in search of new nectar sources. If that occurred, then pollen adhering to the body of the bees could accidentally fall into, and thereby contaminate the nectar of the second flower type with pollen from previously visited plants. Allen also noted that airborne pollen could easily contaminate honey when combs were being removed from hives and also during the subsequent honey extraction process. Regardless of the causes and types of pollen contamination, however, Allen reasoned that contamination was usually a minor problem and that pollen in honey mostly reflected the actual floral sources used to make the honey.

By the end of the 1920s Allen (1929) was focusing on some of the problems of conducting accurate melissopalynology analyses. He was the first researcher to caution about some of the pitfalls and difficulties of pollen identification in melissopalynology. For example, Allen noticed that dried pollen on herbarium sheets and fresh pollen collected in flower anthers looked very different from the pollen he recovered in honey. As a result of his observations, he was the first to question the accuracy of pollen identifications reported from other previous melissopalynology studies. Allen published a series of articles in *Bee World* (1928a, 1938b, 1928c, 1928d; 1929) where he illustrated that many of the pollen types found in honey samples look nearly identical and that various pollen genera could easily be mistaken for other pollen types because many of them looked superficially similar. Finally, he noted that because the predominant types of mounting media fixed both pollen reference material and pollen recovered from honey samples in permanent positions on a microscope slide, the pollen grains could not be rolled over in order to search for a critical aperture or morphological feature that would confirm the type's true identity. The final contribution of Allen's work (1928a, 1938b, 1928c, 1928d; 1929) was his proposed pollen classification system for English honey. In one article, for example, he cautioned that, "one should doubt the origin of a honey sample as being English if the sample contains six-grooved pollen grains". Today, we know that those pollen types are common among the genera in the family Lamiaceae and include taxa such as *Mentha* (mint), *Thymus* (thyme), and *Salvia* (sage). Introduced species of many of those plants now grow in English gardens, thus Allen's initial conclusions would no longer be valid.

During the 1930s and 1940s one name stands out as being the leader in melissopalynology research. Zander's (1935, 1937, 1941, 1949, 1951) five-volume work, published over a span of nearly two decades, laid the foundation for melissopalynology research in Europe. In his various analyses and reports he includes descriptions, drawings, and photographs of pollen that he found in various types of European honey. He also includes several studies of other types of material that are sometimes recovered in honey, such as fungal spores and hyphae. Because of his long and dedicated works in the field, Maurizio and Louveaux (1965) refer to him as the "leader in melissopalynology research in Europe."

In the United States the period of the 1930s represented a time when no research in melissopalynology was being conducted even though some additional research continued on plants used as honey sources. It was during the early 1930s that two valuable books on honey plants were first published: *American Honey Plants* (Pellett, 1930) and *Honey Plants of Iowa* (Pammel et al., 1930). Later, in 1939, Oertel published the results of his seven-year study on the sources and blooming periods of plants thought to be principal honeybee nectar sources in various regions of the United States (Oertel 1939).

During the early 1940s two scientists working for the USDA in California, Frank Todd and George Vansell, began searching for the relationship and importance of pollen in honey (Todd and Vansell 1942). Their research began when they discovered that bee colonies would survive, but would not reproduce if they were fed only sugar syrup. Once pollen was added to the feeding syrup egg laying in the hive began with 12 hours. Their multi-year study represents the next major study in melissopalynology in the United States after Young's 1908 initial examination of pollen grains found in domestic honey. Todd and Vansell restricted their pollen and nectar research to plants and honey produced in California, because that is where their laboratory was located and they could get assistance in their study from experts at the University of California. The two researchers began their study by collecting and examining over 2,600 individual samples of nectar. One of their goals was to try to determine the number of pollen grains one should expect to find in 1cc of nectar from each different plant species. Next, they wanted to determine if the number of pollen grains found naturally in nectar samples matched the number of pollen grains found in the honey stomachs of bees that foraged on those same nectar types. Third, they wanted to discover how efficiently bees could remove pollen from the nectars they collected.

The Todd and Vansell (1942) study was virtually ignored when it was first published, but the importance of their work has now been recognized as significant because of the information they collected and the implications their data provided about pollen counts in honey. Nevertheless, Todd and Vansell admit that some of their research ideas came from a study in Wisconsin by Whitcomb and Wilson (1929), who had been studying dysentery in honeybees when they noticed that many of the pollen grains sucked into a bee's honey stomach along with nectar were quickly removed through a process of filtering. Whitcomb and Wilson noted that once nectar enters a bee's honey stomach it is filtered and within 10 minutes most of the pollen in the nectar is removed leaving mostly pure nectar in the honey stomach. They concluded that the ability of a bee to filter nectar in her honey stomach is one way of removing unwanted debris from nectar, such as pollen and fungal spores, which might germinate and spoil future honey made from the gathered nectar.

The honeybee's filtering process, as described by Snodgrass and Erickson (1992) is rapid and effective. The bee sucks nectar into a slender tube that ends in the bee's abdomen where it becomes an enlarged thin-walled sac called the *honey stomach.* This thin-walled sac is greatly distensible and can expand to hold large amounts of nectar. Once in the honey stomach, the nectar flows over the proventriculus which serves as a regulatory apparatus that filters and controls the entrance of food into the bee's stomach. The anterior end of the proventriculus, also called the *honey stopper*, projects into the bee's honey stomach like the neck of a bottle and at its anterior end is an x-shaped opening consisting of four, thick, triangular-shaped, muscle-controlled lips. The nectar in the honey stomach is drawn back and forth into the funnel-shaped proventriculus where it is filtered to remove debris such as pollen grains and the fungal spores of foul brood. The posterior end of the proventriculus extends into the anterior end of the ventriculus that is part of the bee's alimentary canal (mid gut) where digestion and food absorption occurs. A valve at the bottom of the proventriculus prevents the filtered nectar from entering the bee's digestive system and it ensures that the nectar is returned to the honey stomach. However, this same valve will open to allow debris removed from the nectar to pass into the bee's alimentary canal and then pass into the intestines where it is stored in the rectum until it is excreted. From time to time people get alarmed about a phenomenon referred to as "yellow rain" (Newman 1984). Yellow rain is nothing more than bee feces. When large numbers of bees forage on nectar sources containing high quantities of pollen, the rapid removal of those pollen grains from their honey stomachs quickly fills their rectums. The result can be rapid defecation by those swarms of bees as they return to the hive. If the flight path of the bees happens to be over urban areas, their feces, or "yellow rain", may leave hundreds of tiny yellow spots on cars, sidewalks, or buildings.

The development and use of pollen coefficients in melissopalynology

One of the primary goals of Todd and Vansell (1942) was to determine how effectively honeybees could remove pollen from their honey stomachs, how long that pollen removal process took, and if all pollen types were removed equally well by the filtering process of a bee's honey stopper. In one experiment they fed a laboratory beehive diluted unifloral star thistle (*Centaurea*) honey that had been produced by bees foraging in the wild. The star thistle pollen concentration in the honey-water mixture was measured as being 5,200 pollen grains per cc. Later, the sealed honeycomb cells produced by caged honeybees feeding on this honey-water source were removed and examined. Todd and Vansell found that instead of an average of 5,200 star thistle pollen grains per cc, the produced honey contained an average of only 1,200 pollen grains per cc. Even though Todd and Vansell had expected the pollen concentration of the newly produced honey to remain constant, they found that it did not. In another experiment Todd and Vansell mixed three grams of pure pollen (the pollen type they used is not mentioned) with 100 cc of water-diluted syrup. When measured, they found the pollen concentration of the diluted syrup solution was 750,000 pollen grains per cc. After allowing honeybees to feed on that mixture as frequently as they wanted, the researchers removed honeycomb cells made from that syrup and discovered that the pollen concentrations of the new honey were only 25,000 pollen grains per cc. In other words, the honeybees drank a diluted syrup solution containing a pollen concentration of 750,000 pollen grains per cc, then, using their internal honey stomach filtration system those bees removed most of the pollen before emptying their honey stomachs into new comb cells. The result was a newly produced honey containing only 1/30th of the original pollen concentration of the diluted syrup. Although these researchers' goals were not to develop pollen coefficient tables, their pioneering effort led others to use their ideas and experimental data to compile lists of plants that are over or under represented by their pollen in honey samples (Maurizio 1949, 1955, 1958; Berner 1952; Pritsch 1957; Deans 1957; Demianowicz 1961, 1964; and Sawyer 1988) and propose pollen coefficient tables for various types of nectar-producing plants.

Demianowicz (1961, 1964) is one of the early melissopalynologists who worked tirelessly for many (13) years trying to solve the problem of accurate unifloral honey classification based on pollen contents. After examining many honey samples Demianowicz realized that the relative pollen count in honey did not always reflect the primary floral and nectar sources. Demianowicz's summarized data appear in her 1964 publication where she attempts to identify the pollen characteristics of 45 different types of unifloral honey that are common to various regions of Europe. For each unifloral type she used caged bees in small hives of only 300-400 workers and one queen. The bees in each caged hive were allowed to feed on the flowers of only one plant species. Thus, the honey each hive produced was considered to be a valid representation of the expected *absolute pollen concentration* (APC) for the flower type being tested. Based on that research, she developed 18 different categories of plants based on whether their APC values in honey are under or over represented. For each category she assigned an "average number" that she called her "pollen coefficient classes." She believed that the newly established pollen coefficient values could be used as a guide for determining the true unifloral nature of a honey sample, regardless of the data represented by the relative pollen concentrations.

In Demianowicz's table of values she says that the expected APC of pollen types in a "class 1 unifloral type" should not be expected to be higher than 740 pollen grains per 10 g of honey. Her key example of an under represented type in class 1 is *Asclepias* (milkweed) which has an assigned pollen coefficient value of 32. Each additional class is represented by APC values that are up to twice as high as the previous category. Thus, in her class 2 of unifloral honey types she says that genera in this group should contain between 750-1,500 pollen grains per 10 g of honey. Plant examples in this second category include *Robinia pseudoacacia* (white acacia, locust), *Cucumis* (cucumber), and *Chamaenerio (Epilobium)* (fireweed). The last of her coefficient categories is class 18, which is characterized by prolific pollen types, such as *Myosotis* (forget-me-not), which produce unifloral honeys containing between 98,304,001 to nearly 200 million pollen grains/10 g.

Many melissopalynologists have worked on the problem of trying to discover how to use pollen contents to classify various types of unifloral honey even though experimental data (Todd and Vansell 1942) show that plants produce different amounts of pollen and that bees will remove vast amounts of pollen from collected nectar on their flights back to the hive. Nevertheless, a number of scientists have

produced tables and charts noting what they believe should be the "expected" percentages of relative pollen in unifloral types. Moar (1985) offers one of the clearer discussions about the process that he used to establish pollen coefficient tables for various types of unifloral honey in New Zealand. Moar points out that since 45% of a single pollen type is the universal "minimal" amount needed for a honey to be classified as unifloral, one must determine what value must be used to correct an under represented unifloral pollen type to the 45% level. Next, he points out that he and others believe that the relative pollen values for white clover (*Trifolium repens*) are the best standard upon which all other types in honey samples must be judged. Therefore, it is chosen to be the standard pollen type for determining the coefficient values of all other pollen types. Moar notes that the expected absolute pollen concentration of *Trifolium repens* pollen should be approximately 23,116 grains per 10 g of honey. However, Moar fails to explain exactly how he determined this figure to be the APC value for *T.repens*. For example, Demianowicz's (1964) research with caged bees revealed that 18,000 should be considered the APC for a unifloral honey of *T.repens*. Perhaps the differences between these two researchers derive from their different methods of calculating the APC value for *T. repens*. One of the most widely used calculation methods is to add a known number of "tracer spores" to 10 g of honey and then determine the ratio of tracer spores to pollen in the honey. Once this ratio is known for a sample, then the APC for any pollen taxa in the sample can also be determined. Demianowicz's calculation method is different. For each of her honey samples she began with a known amount of honey that was diluted with a known amount of water. From that mixture she extracted a small portion and counted the pollen. From that count she then predicted what the total APC for each pollen type should be per 10 g of honey.

In his 1985 article on the honey of New Zealand, Moar explains how he calculated the minimum percentage of unifloral honey types. For his example of an under represented type he used thyme (*Thymus*) pollen. He says his first task was to find examples of honey that was produced by hives located close to fields of blooming thyme. If the honey from those hives had the color and taste of thyme honey, then they were assumed to be unifloral examples of thyme honey. Moar found four samples of honey that fit these criteria. When he conducted a pollen study of these, he found that the relative pollen percentage averaged 42%, even though the totals varied slightly in each sample. He also averaged the pollen concentration values in the four thyme samples and found that the APC of thyme pollen was 5,415 pollen grains per 10 g of honey. Because the relative pollen percentage of thyme was less than the minimum of 45% needed for a unifloral classification, Moar multiplies the thyme's APC by 0.45 and then divides by the average relative pollen frequency, (0.42) of thyme in the four samples. That math calculation produced the number 5,801, which Moar points out should be considered as the appropriate "corrected" APC for thyme pollen at the minimum unifloral level of 45%. Nevertheless, because thyme pollen is an under represented taxon in honey (i.e., any taxon with an APC lower than the APC of white clover), a further calculation was needed to determine the minimal percentage of thyme pollen in the relative pollen count of a honey sample before the sample could be classified as being unifloral thyme. Moar then notes that because the APC of white clover is considered the standard, the ratio of thyme's APC of 5,801 to the APC (23,116) of white clover must be determined. This is calculated by dividing the APC for thyme (5,801) by the combined APC of thyme and white clover (5,801 + 23,116). That number (0.2), two-tenths, is then multiplied by 100 to convert it to a percentage (20%). As Moar explains, the use of these calculations reveal that for New Zealand, a relative pollen percentage of only 20% thyme pollen in a honey sample would qualify that honey as being a unifloral thyme honey.

One of the foremost melissopalynologists in the United Kingdom (U.K) is Rex Sawyer who began his lifelong interest in pollen studies during the 1930s after meeting Harry Godwin, the British pioneer of pollen analysis. Later, Sawyer began a study of beekeeping and helped Deans (1957) compile a detailed pollen study of honey types produced in the U.K. After years of melissopalynology research Sawyer published several books on pollen and honey (Sawyer 1981, 1988). In one of them (Sawyer 1988) he includes a chapter on pollen coefficients and lists a table of numerical pollen coefficient (PC) values that he developed and believes can be applied to the relative pollen percentages of various pollen types in honey samples. The table is impressive, yet Sawyer fails to explain exactly where or how he arrived at the precise PC values that he published. His only reference to this is a note saying that his values are based on APC data from his own research and from various other studies including the research of: Todd

and Vansell (1942), Demianowicz (1961, 1964), Maurizio (1949, 1955, 1958), Berner (1952), and Pritsch (1957).

The primary difference between the PC values used by Sawyer and those published by other melissopalynologists is that Sawyer's values are not expressed as the expected APC per gram of honey for each taxon whereas others all use APC values per 10 g of honey. Nevertheless, by using Sawyer's formula and applying his PC numbers to the relative pollen percentages of a honey sample one can determine the "*actual*" floral identity and characteristics of almost any honey sample. Sawyer notes that once the expected relative pollen percentages for key pollen taxa are determined for a honey sample, it is possible to use his formula and PC values to calculate the "corrected percentages" for nearly all pollen types found in both unifloral and mixed floral honeys. He also notes that since he did not calculate the PC values for all known pollen types in honey, he recommends using a PC value of 50 for all unidentified pollen types and pollen taxa that appear in sporadic or low frequencies.

The result of Sawyer's research led to the establishment and use of his table of pollen coefficient numbers for honey types in the UK as well as elsewhere. As Sawyer and others have argued, through the use of pollen coefficient tables analysts can confirm unifloral honey samples produced from plants with low pollen yields or plants which produce pollen types that seem to be most quickly removed by the filtering actions of a honeybee's honey stopper during her return flight to the hive. As noted in Sawyer's list, some of the weakest-represented pollen types are aided by the use of pollen coefficient values. These would include fireweed (*Epilobium*), basswood (*Tilia*), alfalfa (*Medicago*), sourwood (*Oxydendron*), orange blossom (*Citrus*), buckwheat (*Eriogonum*), and locust (*Robinia pseudoacacia*). When pollen coefficient tables are applied to correct the normally low relative pollen percentages, of up to 20%, for these types in honey samples, the result becomes a validation that the honey should indeed be classified as a unifloral product of those plants.

An example of how pollen coefficient tables developed by Sawyer (1988) can be used is seen in Table 1. The data in Table 1 represent the analysis of a typical fireweed honey sample from central Alaska. Note that based on the relative percentages of pollen, this sample would initially be classified as a "uniflora" canola honey. Note also that the relative percentage of fireweed pollen in this sample is only 6.3%. When these relative pollen percentages are adjusted using Sawyer's pollen coefficient values, it suggests that the actual nectar sources used to produce this honey were really 95% from fireweed flowers, and only 2% from rapeseed (canola) flowers. These pollen data suggest that in spite of the low relative pollen percentage of fireweed, the dominant nectar resource that produced this honey came from blooming fireweed flowers. Note also in this example (Table 1) that the 28.3% relative pollen percentage of clover suggests that actually less than 2% of the nectar source of this honey came from clover.

TABLE 1
Pollen analysis of a honey sample produced in central Alaska.*

Pollen Type	Relative Pollen %	Coefficient Value	Relative Quantity	Adjusted %
APIACEAE	00.6	50.0	00.012	00.5
Brassica	62.8	150.0	00.419	01.9
Epilobium	06.3	0.3	21.000	95.9
Melilotus	28.3	75.0	00.377	01.7
Taraxacum	00.6	10.0	00.060	00.27
Unknown	01.4	50.0	00.028	00.128
Total	100.0%		21.896	100%

* To use pollen coefficient tables to determine the actual or expected nectar composition of each plant taxon in a honey sample, the relative pollen spectrum must first be calculated. Next, the relative percentage of each pollen type must be divided by its pollen coefficient value (Sawyer 1988). The resulting value for each pollen type is what Sawyer calls the taxon's "relative quantity." Finally, the percentage of each pollen type's relative quantity is used to determine what percentage of the honey is derived from the nectar represented by each taxon.

One of the main problems of using pollen coefficient tables is that not all melissopalynologists agree on precisely what values should be assigned to each plant and pollen type used by bees to produce honey. For example, if we examine the same data listed in Table 1, but instead use those relative pollen percentages with the pollen coefficient values developed by Demianowicz (1964), we find that the adjusted percentages of nectar sources for each taxon is different from those of Sawyer's (Table 2).

TABLE 2

In the example below we have used the same relative pollen percentages shown for taxa in Table 1. As Sawyer (1988) recommends, we have used the baseline PC value of *Trifolium repens* for unknown pollen types or pollen types for which no PC values were determined by Demianowicz (1964). In the formula below, "A" represents the adjusted percentage for each pollen taxon.

$$Aa = \frac{a/PCa}{(a/PCa + b/PCb + c/PCc + d/PCd + \cdots n/PCn)}$$

$$Aa = \frac{.000033}{(.000033 + .000872 + .005600 + .000393 + .000033 + .000077)}$$

$$Aa = \frac{.000033}{.007008}$$

$$Aa = .005 = .47\%$$

Taxon	Relative %	Demianowicz's Adjusted %	Sawyer's adjusted %
a=APIACEAE	00.6	00.47	00.50
b=*Brassica*	62.8	12.44	01.90
c=*Epilobium*	06.3	79.90	95.90
d=*Melilotus*	28.3	05.60	01.70
e=*Taraxacum*	00.6	01.09	00.27
f=unknown	01.4	00.47	00.12
Total	100%		

When examining the "adjusted percentages" calculated using Sawyer's data and those derived from Demianowicz's data we can see minor differences; nevertheless, both sets of data offer the same conclusion. In terms of over or under representation, both sets of data indicate the same general conclusions for each pollen taxon. For example, using Sawyer's PC values it appears that over 95% of the actual nectar source came from fireweed flowers, but when using Demianowicz's values it appears that only 80% of the nectar source came from fireweed flowers. There is a difference of 15% between the two calculations, yet both sets of data emphasize that fireweed is a pollen type that is highly under represented in honey samples. Similar conclusions can be reached for each of the other pollen types as well.

It is difficult to know which of these PC data sets (Sawyer vs. Demianowicz) is more nearly accurate. Demianowicz's PC values are based on more than 13 years of research in which she used caged bees and forced each hive to feed only one type of flower. From those data she constructed her APC and PC values. We are not sure which data Sawyer used to construct his PC values. However, based on her published reports we do know the method Demianowicz (1961, 1964) used for calculating pollen concentration values in her study and we also know that her method is subject to more potential calculation errors than most of the currently-used pollen concentration techniques. Demianowicz's method for determining pollen concentration values relied on collecting small amounts of honey (often less than 5 grams) and then diluting her sample with

water. From the diluted solution she then placed one drop on a microscope slide and counted a portion of the pollen on the slide. Using that information she then projected what the expected APC values for each pollen taxon should be in 10 g of honey. By contrast, today most melissopalynologists calculate pollen concentration values by comparing the ratio of pollen grains found in 10 g of honey against the ratio of a know number of tracer spores that are added to the honey before counting begins. Depending on the number of tracer spores added and the number of pollen grains counted, this system is considered to provide more nearly accurate data than the system used by Demianowicz.

Other melissopalynologists (D'Albore 1998; van der Ham et al. 1999) have not proposed pollen coefficient tables but do list a wide variety of plant types, which they place into various categories depending on the "expected" pollen, yield of those plants in various types of honey. For example, van de Ham et al. (1999) mentions that honey types can be considered unifloral examples if they contain a minimum of: 1) *Borago* [borage] 10%; 2) *Robinia* [white acacia, locust], *Tilia* [linden, basswood], and *Carduus* [distel, thistle] 20%; and 3) *Crambe* [krambe, sea kale] and *Calluna* [heather] 30%. They also state that for some plants the APC of their pollen is so prolific in honey that one should not consider those honey types as unifloral unless they contain significantly more than the normally required minimum of 45%. Some of those over-represented pollen types they mention include: 1) *Salix* [willow] 70%; and 2) *Phacelia* [bluebells], *Myosotis* [forget-me-not] and, *Castanea* [chestnut, chinkapin] each at 90%.

D'Albore (1998) does not give lists of percentage levels that he believes should be used as a guide for determining unifloral honey in the Mediterranean region based on the under or over-representation of pollen taxa. Nevertheless, he offers some practical advice about a number of plant taxa and how the pollen from those taxa is likely to be represented in honey samples. He notes that most of the plant group that produces large pollen grains (>40 µm) will be significantly under represented in honey produced from those nectar sources. The two reasons he gives for this are: 1) most plants that produce large pollen grains generally do not produce large quantities of nectar, and 2) honeybees are much more efficient at filtering out large pollen grains than small ones from the nectar in their honey stomach during their return flights to the hive. D'Albore adds that the opposite is true for tiny pollen grains, which are most often over represented in honey. Tiny pollen grains from species including *Echium* [gran canaria], *Eucalyptus* [gum], *Amorpha* [indigo], *Castanea* [chestnut, chinkapin], and *Tamarix* [salt cedar], he notes, are often produced in larger numbers and those tiny grains are only partially filtered out of the honey stomach of honeybees returning to the hive. In his book he also lists a large number of plants in the Mediterranean region that produce pollen, which tends to be either over or under represented in honey samples for a variety of reasons. The reasons he lists include: 1) plants that normally produce small amounts of pollen (i.e., *Citrus, Robinia, Salvia*); 2) plants that are monoecious and thus only one half of the flowers produce pollen (i.e., *Citrullus* [watermellon], *Cucumis* [cucumber], *Cucurbita* [pumpkin or gourd], *Bryonia* [bryony]); 3) plants that have flowers that are morphologically unfavorable for pollen collection by honeybees (i.e., *Asphodelus* [affofill], *Epilobium* [fireweed], *Abutilon* [mallow], *Datura* [datura], *Digitalis* [foxglove]); and 4) plants that present special pollen and nectar gathering problems for honeybees or have plants that are difficult for honeybees to enter (i.e., *Agrostemma* [corn cockle], *Cestrum* [cestrum], *Nicotiana* [tobacco], *Medicago* [alfalfa]).

Todd and Vansell's (1942) research revealed other important variables that will determine the amounts and types of pollen recovered from honey samples. In one experiment they starved a group of honeybees and then allowed them to drink freely from solutions of sugar syrup mixed with various amounts of pollen. After feeding a control group of bees was immediately trapped and dissected. The content of their honey stomach was removed and examined for pollen. Bees that fed on the syrup-pollen mixture had an average of 248,666 pollen grains per cc of fluid in their honey stomachs. Forty-eight other bees that fed on the same syrup-pollen solutions were allowed to fly around freely for 15 minutes after feeding before being caught and dissected. The same procedure was used to determine the pollen concentration values of the fluid in their honey stomachs. As noted in those tests, almost one-half of the honeybees were able to remove and excrete more than 90% of the pollen they had consumed when feeding on the syrup-pollen

solutions. The other bees that were tested in that experiment also removed much of the pollen. These data suggest that even though all 48 of the bees in this experiment collected nectar containing the same amount of pollen, some of them were much more effective at removing pollen with their honey stoppers than were others from the same hive. This variable makes the reliability of using a standard set of numbers for pollen coefficient tables difficult. For any given honey sample the accurate calculation and use of corrective PC values are nearly impossible unless the melissopalynologist knows how many honeybees collected nectar for each source, how many of those honeybees removed what percentage of the pollen from the nectar they collected, and how long each honeybee took on her return flight to the hive after filling her honey stomach full of nectar. Since these types of nectar gathering data can only be estimated for any hive or any type of honey a hive produces, the use of PC tables could vary the results greatly from one sample to the next even if all examined honey samples were produced from the same nectar sources, but for some samples those sources were located at different distances from the hive.

Todd and Vansell repeated this same experiment with different pollen concentrations in a sugar syrup solution that they fed to honeybees. In all their tests they found that the amount of pollen still present in the honey stomachs of bees allowed to fly freely for 15 minutes after feeding was drastically reduced. Although the results varied from bee to bee, Todd and Vansell reported that many of the bees had an ability to remove at least 90% of the pollen from the fluid in their honey stomach during a 15-minute interval after feeding on nectar containing pollen.

Another contribution of the Todd and Vansell (1942) study was the development of a table revealing how many pollen grains occur naturally in the nectars of certain plants. Because flower nectar sources are usually close to the dehiscing anthers of those same flowers, some of the anther pollen falls into the nectar that is later gathered by honeybees. Todd and Vansell carefully collected the nectar from more than 2,600 samples representing 73 different plant species that grow in California. Some of those samples were collected from the honey stomachs of bees that were captured and dissected immediately after they fed on the nectar of a specific plant. Other samples were carefully collected by hand from the nectar of actual flowers. After all the samples were examined and the pollen concentrations of each nectar source were averaged, the authors produced a list of some of the major California nectar sources and the amount of pollen that one might expect to find in the nectar of those plants. That list is important because it offers a perspective as to which nectar types are known to contain vast amounts of pollen and which nectar sources do not. For example, Todd and Vansell report that they captured and dissected 30 honeybees immediately after each had finished feeding on orange blossoms (*Citrus sinensis*) and they also collected a set of 32 bees immediately after each had fed on cotton flowers (*Gossypium hirsutum*). To their amazement, they could not find **one single pollen grain** in the honey stomachs of any of those 62 honeybees. At the other extreme, they found an average of 7,100 pollen grains per cc of fluid in the honey stomachs of 38 bees captured immediately after each had completed feeding on the nectar of rabbit brush (*Chrysothamnus nauseosus*).

In another experiment Todd and Vansell examined what happens to pollen between the time it is collected as part of the nectar from a flower until it becomes honey sealed in the comb chamber of a hive. They deprived the honeybees in a hive of stored honey but allowed them to feed from trays placed in the hives that were filled with a solution of sugar syrup mixed with pollen. They repeated the same experiment in a different hive using a tray of diluted star-thistle honey placed in the hive. Measurements of the pollen in the feeding trays revealed a pollen concentration value of 750,000 pollen grains/cc for the tray of syrup mixed with pollen and 5,200 pollen grains/cc for the feeding tray of diluted star-thistle honey. During both experiments the bees were not allowed to feed on any other sources of food. Honey produced in the sealed comb cells made from these two solutions revealed a pollen concentration of 25,300 pollen grains/cc for the honey made from the syrup-pollen solution and 1,200 pollen grains/cc for the honey made from diluted star-thistle honey. Todd and Vansell concluded from these experiments that only 3.1% of the pollen placed in the syrup-pollen feeding trays actually appeared in the honey made from that source. For the honey made from the feeding tray of diluted star-thistle honey, only 23% of the pollen from the tray appeared in the new combs of honey. In both experiments the feeding trays were

placed in the hives; therefore, the probable time between each bee's feeding time and when she regurgitated the contents of her honey stomach into comb cells was probably minimal. In spite of that suspected short period, it appears that most of the honeybees in both hives were able to remove vast amount of pollen from the fluids they ingested before those fluids were used to make honey.

Following up on this experiment Todd and Vansell tested actual nectar sources from the flowers of important bee-foraging plants and found an average of 2,500 pollen grains per cc in purple sage (*Salvia leucophylla*), an average of 200 pollen grains per cc in fireweed (*Epilobium angustifolium*), an average of 2,000 pollen grains per cc in avocado (*Persea americana*), and an average of 41,000 pollen grains per cc in white sweet clover (*Melilotus alba*). What those data reveal is that the pollen of some plants will always be either under or over represented in honey even if 90% (i.e., average efficiency of pollen removal by most bees based on experimental data by Todd and Vansell) of the pollen is removed from the honey stomach of a honeybee returning to the hive. What these data suggest is that one cc of nectar from sweet clover should be over 200 times better represented by its pollen in a honey sample than will an equivalent cc of nectar from fireweed plants.

In recent years the intended purpose of producing and using data that list over and under-represented pollen types in honey (D'Albore 1998; van de Ham et al. 1999), or lists that detail the actual pollen coefficient number for each taxon (Sawyer 1988; Demianowicz 1961, 1964), is to allow individuals to use the relative pollen percentages from a honey sample to re-calculate the probable (actual?) percentages of each nectar source used to produce that honey sample. The main advantage of using these data is to verify unifloral honey types that command premium prices on the world market even though the relative pollen counts from such honey samples probably do not contain the internationally accepted minimum pollen percentage of 45%.

Tables of under and over represented pollen types and pollen coefficient tables also help to explain why certain popular bee foraging plants are routinely represented by minimal amounts of pollen in honey that may be dominated by pollen from other types of over represented bee-foraging plants such as *Melilotus* and *Brassica*. Research on developing better pollen coefficient tables continues, but some melissopalynologists do not believe that these types of "correction" tables will ever become universally accepted. Arguments against the adoption of a standard set of pollen coefficient tables focus on several factors, which are rarely known for any given honey sample. For example, as early as the 1920s scientists knew that the longer nectar remains in a honeybee's honey stomach, the greater is the potential for that honeybee to remove most or all of the pollen in that nectar, regardless of the pollen type (Whitcomb and Wilson 1929). Therefore, knowing the time period between when a honeybee begins to forage and when she returns to the hive becomes critical because it will influence the amount of pollen that remains in the nectar of her honey stomach. That information is important because it determines the amount of potential pollen from each floral source that can be included in the honey produced from each nectar source. The second variable focuses on the size and shape of the pollen grains being collected along with the nectar from a floral source. Experimental data reveal that bees are much more efficient at removing large pollen grains from the nectar in their honey stomachs than they are for smaller pollen grains (Demianowicz 1961, 1964; D'Albore 1998). The third variable centers on determining *precisely* what the corrective PC value for each pollen type should be. The published data presented by various melissopalynologists state different APC or PC values for the same or similar plants. Often these values are somewhat similar, but depending on which APC or PC values a researcher selects to use, the actual percentage of a single pollen type needed for a honey to gain a unifloral classification will vary.

Summary

The use of corrective pollen values is important for beekeepers, honey distributors, and for the customer who buys honey for his or her own use. Unfortunately, much of the existing research in this area of honey studies suffers from one or more major flaws. Some previous researcher have not provided critical information on how they gathered, processed, or counted the pollen in the honey samples they used to establish their APC or PC tables. Others offer full explanations of their research and thus reveal the flaws of their methodology. Even the research conducted by Demianowicz (1961, 1964), which is

among the best studies of APC and PC values yet completed because she used caged bees that ate a restricted diet, there are flaws in her technique which could have altered her results.

What is needed most in the field of melissopalynology is a new series of tests to determine the precise PC values that can be used with certainty for validating the floral sources of premium types of honey. This type of research, however, will need to be conducted under controlled conditions that will satisfy skeptics and produce PC data that will be accepted by melissopalynologists.

For each floral type a separate experiment will need to be conducted. First, an isolated hive of bees will need to be caged to prevent outside contamination, similar to the technique reported by (Demianowicz 1964). The caged bees should then be allowed to feed freely on the flowers of only one type of plant until the hive produces a measurable amount of honey from that single floral source. During the experiment selected numbers of bees should be trapped immediately after they have fed on nectar and the contents of their honey stomach must be examined to determine the APC in the nectar. At various times during the experiment the opening for bees returning to the hive should be sealed for short periods of time ranging from 5-15 minutes. Before allowing the bees to re-enter the hive, some of the bees should be captured and the contents of their honey stomachs should be examined to determine how effective those bees have been at removing pollen from the nectar they are collecting. Finally, once honey has been produced from the experimental feeding process, several honey samples must be collected, processed, and their pollen contents counted.

Processing of the collected honey from these caged experiments must include either a filtration process similar to the one described by Lutier and Vaissiere (1993), or it must use an alcohol-dilution technique similar to the one first described by Jones and Bryant (1996). Later experimental tests conducted by Jones and Bryant (1998) confirmed that both the filtration and alcohol-dilution techniques are comparable in the amounts of pollen they recover from honey samples. Their tests revealed that both the filtration and alcohol processing methods increased pollen recovery from honey samples by an average of more than 200% over the various types of water-dilution processing methods that are currently in use by melissopalynologists. Finally, a large quantity of tracer spores must be added to each honey sample before it is processed. The original ratio of tracer spores to pollen should be nearly equal in each honey sample to ensure that the construction of APC tables for pollen types are as accurate as possible. Finally, when counting the recovered pollen from each honey sample, the ratio of tracer spores to pollen must be based on high pollen counts in excess of 1,000 pollen grains per sample.

This type of proposed research will be expensive and time consuming. However, if these research efforts are completed successfully, the resulting data can be confidently used to construct APC values that should be accepted by even the most ardent skeptics. In addition to the APC values, these same honey samples can serve as unique opportunities for chemical testing to determine sugar types and the ideal ranges for sugar isotopic levels.

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Picea Stomata in Lake Sediments

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The topic of presence/absence of conifer stomata in lake sediment arose recently in discussion. The Quaternary discussion group provided the following references in response to my request; CAP members may find it useful.

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Charlotte Sweeney (charlotte.sweeney@geo.uu.se) has a picture of *Picea* stomata on her web page www.kv.geo.uu.se/cas.html and hopes to have the key drafted by July this year.

Gardening for Native Bees in North America

Editor's Note: In the December, 2000, Newsletter, Jim Cane's essay on bee gardening was published. However, I accidentally left out the last page of the list of North American Garden Plants for Native Bees. *That page follows.*

North American Garden Plants Useful to Bees (sorted by genus)

[remainder of the list that was missing in the December 2000 newsletter]

FAMILY	*GENUS*	COMMON NAME	*Notes*
Boraginaceae	*Sympytum*	comfrey	can be weedy
Portulacaceae	*Talinum*	flame flower	
Apiaceae	***Tanacetum**	**tansy**	
Bignoniaceae	*Tecoma*	yellow trumpet bush	
Lamiaceae	*Teucrium*	germander	
Fabaceae	*Thermopsis*	false lupine, golden pea	
Lamiaceae	*Thymus*	thyme	
Tiliaceae	*Tilia*	basswood	
Asteraceae	***Tithonia**	**Mexican sunflower**	
Lamiaceae	*Trichostema*	bluecurls	
Fabaceae	*Trifolium*	clover	
Ericaceae	***Vaccinium**	**blueberry,cranberry, huckleberry**	acid soils required
Valerianaceae	*Valeriana*	valerian	
Verbenaceae	*Verbena*	verbena	not red
Asteraceae	*Verbesina*	golden crownbeard	
Scrophulariaceae	*Veronica*	speedwell, veronica	
Caprifoliaceae	*Viburnum*	arrowood, snowball bush	
Fabaceae	*Vicia*	vetch	
Asteraceae	*Viguiera*	showy golden-eye	
Violaceae	*Viola*	violets	not pansies
Asteraceae	*Wyethia*	mules ear	
Asteraceae	*Zinnia*	zinnia	not doubled

**** these genera are widely cultivated & broadly attractive**

Lab Scenes

WATerloo Environmental-change Research Laboratory (WATER Lab) Department of Biology, University of Waterloo

The WATER lab combines analyses of sediment cores, lake surveys and field-based experiments to address research questions at the interface of neo- and paleo-limnology, as well as fundamental paleoecology. Currently, we are engaged in two areas of research. The first area attempts to quantify the unique and interactive effects of multiple stressors (e.g., acidification, climatic variability, nutrient enrichment) on aquatic communities in potentially-sensitive Precambrian Shield lakes. For example, one MSc student is analyzing diatoms in sediment from lakes, with and without extensive wetlands, to assess the unique and interactive roles of acid deposition and inter-annual climatic variability on aquatic communities. The second area uses a multi-proxy approach to reconstruct Holocene changes in climatic conditions, terrestrial vegetation and their effects on aquatic ecosystems. At present, we are focusing on two geographic areas. In northern Sweden (in combination with CIRC and colleagues at Umea, Lund and Bergen universities; see Lab Scenes in CAP Newsletter Vol. 23(1) May 2000), we are developing the use of diatoms and chironomids to reconstruct mean July air temperatures and ecological conditions in lakes. In northern Alberta, we are developing the use of diatoms to quantify past changes in flood regimes and ecological changes in small lakes and wetlands. We collaborate extensively with scientists at other institutions to combine data from our aquatic indicators (diatoms, chrysophytes, chironomids) with information from pollen, plant macrofossils, stable isotopes, and fossil algal pigments, among other paleoecological indicators. Two postdoctoral researchers, one graduate student and one technician currently work in the WATER lab. We anticipate taking on two new students within the next 8 months.

The WATER lab includes a microscope room dedicated to microfossil analyses, a lab room for handling cores and preparing samples, and a cold-room for sample storage. The microscope room contains two new Zeiss Axioskop II compound light microscopes fitted with phase and differential-interference optics, and both are hooked up to a digital camera and imaging computer workstation for development of taxonomic databases. We are well equipped with fieldwork and coring equipment, including an arsenal of gravity-, freeze-, piston- and Russian- corers.

The University of Waterloo presents tremendous potential for collaborative multi-proxy research, as there are a number of faculty and researchers with active programs in paleoenvironmental research with whom we interact. Drs. Tom Edwards, Brent Wolfe, Ramon Aravena and Sherry Schiff (Dept. of Earth Sciences) use stable isotopes to assess paleohydrological, paleoclimatic and related environmental changes. Dr. Barry Warner (Depts. of Geography and Biology), an expert in wetlands ecology, uses a variety of paleolecological methods to assess wetlands development and past environmental conditions. Within the Department of Biology there are six faculty members with active research programs in aquatic ecology (Drs. Dave Barton, Hamish Duthie, Stephanie Guildford, Robert Hecky, Ralph Smith, Bill Taylor). Future research plans include collaborative projects with Dr. Hecky, UNU (United Nations University) Chair Professor in Great Lakes Limnology, to work at the interface of neo- and paleo-limnology on water-quality issues in the African Great Lakes.

Website:
http://www.science.uwaterloo.ca/biology/faculty/hall.html

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ON THE SHELF

RECENT PUBLICATIONS BY CANADIAN AND OTHER PALYNOLOGISTS – 15

Atkinson, D.E.; Alt, B.; and *Gajewski, K. 2000. A new database of High Arctic climate data from the Polar Continental Shelf Project archives. Bulletin of the American Meteorological Society 81(11):2621-2529.

Bennett, J.R.; *Cumming, B.F.; Leavitt, P.R.; Chiu, M.; *Smol, L.P.; and Szeicz, J. 2001. Diatom, pollen, and chemical evidence of postglacial climatic change at Big Lake, south-central British Columbia, Canada. Quaternary Research 55(3): 332-343.

Campbell, I.D., Campbell, C., *Yu, Z.C., Vitt, D.H., and Apps, M.J. 2000. Millennial-scale rhythms in peatlands in the western interior of Canada and in the global carbon cycle. Quaternary Research, 54: 155-158.

*Chmura, G.L; Coffey, A.; and Crago, R. 2001. Variation in surface sediment deposition on salt marshes in the Bay of Fundy. Journal of Coastal Research 17(1): 221-227.

Fritz, S.C., Ito, E., *Yu, Z.C., Laird, K.R., and Engstrom, D.R. 2000. Hydrologic variation in the northern Great Plains during the last two millennia. Quaternary Research, 53: 175-184.

*Garneau, M.; and Alt, B.T. (eds.). 2000. Environmental response to climate change in the Canadian High Arctic. Geological Survey of Canada, Bulletin 529. 416 p.

*Hallett, D.J.; *Mathewes, R.W.; and Foit. F.F. Jr. 2001Mid-Holocene Glacier Peak and Mount St. Helens: tephra layers detected in lake sediments from southern British Columbia using high-resolution techniques. Quaternary Research 55(3): 242-292.

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Laird, K.; *Cumming, B.; Nordin, R. 2001. A regional paleolimnological assessment of the impact of clear-cutting on lakes from the west coast of Vancouver Island, British Columbia. Canadian Journal of Fisheries and Aquatic Sciences 58(3): 479-491.

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Lim D.S.S.; Douglas, M.S.V.; *Smol, J.P.; and Lean, D.R.S. 2001. Physical and chemical limnological characteristics of 38 lakes and ponds on Bathurst Island, Nunavut, Canadian High Arctic. International Review of Hydrobiology 86(1): 1-22.

Mandryk, C.A.S.; Josenhans, H.; Fedje, D.W.; and *Mathewes, R.W. 2001. Late Quaternary paleoenvironments of Northwestern North America: implications for inland versus coastal migration routes. Quaternary Science Reviews 20(1-3): 301-314.

Reavie, E.D.; and *Smol, J.P. 2001. Diatom-environmental relationships in 64 alkaline southeastern Ontario (Canada) lakes: a diatom-based model for water quality reconstructions. Journal of Paleolimnology 5(1): 25-42.

*Smol, J.P.; and *Cumming, B.F. 2000. Tracking long-term changes in climate using algal indicators in lake sediments Journal of Phycology 36(6): 986-1011.

Williams, J.W.; Webb, T.; *Richard, P.J.H.; and Newby, P. 2000. Late Quaternary biomes of Canada and the eastern United States. Journal of Biogeography 27(3): 585-607.

Wolfe, A.P.; Frechette, B.; *Richard, P.J.H.; Miller, G.H.; and Forman,S.L. 2000. Paleoecology of a >90,000-year lacustrine sequence from Fog Lake, Baffin Island, Arctic Canada. Quaternary Science Reviews 19(17-18): 1677-1699.

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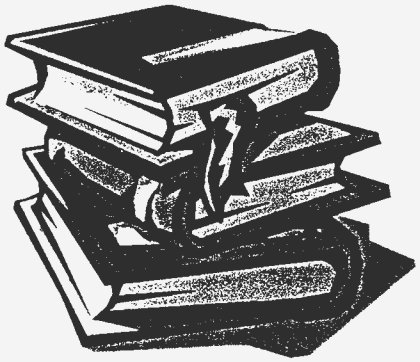
*Yu, Zicheng, Vitt, D.H., Campbell, C., and Campbell, I.D. 2000. Pattern and processes of peat accumulation in continental rich fens: hypothesis and preliminary results. Proceedings of the 11th International Peat Congress, Edited by L. Rochefort and J.-Y. Daigle, Quebec City, Quebec, pages 208-215.



NEW BOOKS

SYNOPSIS OF FOSSIL FUNGAL SPORES, MYCELIA AND FRUCTIFICATIONS
R.M. Kalgutkar & J. Jansonius.
PUBLISHED BY THE AMERICAN ASSOCIATION STRATIGRAPHIC PALYNOLOGISTS FOUNDATION, CONTRIBUTIONS SERIES NUMBER 39, December 2000.

SUMMARY/abstract
In this Synopsis we bring together some 950 validly published names of species, attributed to some 230 genera (plus some 70 names of extant genera, as well as many nomina nuda, and junior synonyms and homonyms). We propose twelve **new genera**: *Axisporonites*, *Biporipsilonites*, *Disparidicellites*, *Hilidicellites*, *Kumarisporites*, *Mathurisporites*, *Mossopisporites*, *Multicellites*, *Ramasricellites*, *Saccisporonites*, *Trihyphites* and *Varmasporites*. We propose one **new species**: *Ctenosporites sherwoodiae*. Transfers of species to more appropriate genera resulted in 31 junior homonyms, for which we provided the following **nomina nova**: *Dicellaesporites largelongatus, D. perelongatus; Dictyosporites paradkarii; Didymoporisporonites gigas; Diporicellaesporites macellus, D. minifusiformis; Diporisporites pergranulatus; Dyadosporites antarcticus, D. neoconstrictus; Fusiformisporites duenasii; Hilidicellites dubius, H. trivedii; Hypoxylonites kumarii; Inapertisporites clarkei, I. edigeri, I. neopunctatus, I. triporatus; Kutchiathyrites canadensis; Monoporisporites doubingerae, M. mathurii, M. nemagnus, M. neoglobosus, M. perpsilatus, M. singularovalis; Multicellaesporites? songii; Pluricellaesporites cooksoniae, P. edigeri, P. malevisus, P. mexicanus; Scolecosporites modicus; Staphlosporonites billelsikii*. The names of one genus and several species, not validly published in their respective protologues, are here validly published "**ex Kalgutkar & Jansonius**": *Asterinites* Doubinger & Pons (with *A. colombiensis, A. tellezii*), *Biporipsilonites bellulus* (Ke & Shi), *Cercosporites torulosus* (Trivedi & Verma), *Dicellaesporites longus* Trivedi & Verma, *Diporisporites planus* Martínez-Hernández & Tomasini-Ortiz, *Microthyriacites baqueroensis* Martinez, *Palambages colonica* Trivedi & Verma, *Pluricellaesporites dentatus* Trivedi & Verma, *P. minutus* Trivedi & Verma and *P. planus* Trivedi & Verma. Our transfers also resulted in some **350 new combinations**: too many to list in this abstract.

While we tried to include all papers of interest particularly to (paleo)palynologists, this Synopsis will also be of benefit to mycologists who find the literature on fossil remains not easily accessible. The latter also may appreciate a brief survey of megascopic remains reported in the literature. Still,

we did not cover many of the earlier (nineteenth century) publications.

We give a summary introduction into paleomycology, as well as some mycological fundamentals, for palynologists; a brief section on palynological practices may be of benefit to mycologists. The discussions dealing with the morphology of fungal spores are concluded with a section "**Description of fungal spores**," which provides a checklist of features to be observed and reported on. Technical terms are explained in a Glossary.

The main part of this Synopsis is the systematics section, where the descriptions of genera and species are given in alphabetic order; junior synonyms and homonyms are included, with cross-references to new names or combinations. The types of nearly all species are illustrated with a line drawing. In an Appendix we list all specific epithets together with, in capitals, the names of genera to which they are now attached, and those used in earlier binomials, in lower case.

Organization of this Synopsis

In this volume we compile the more recent worldwide literature on fossil fungal remains, as far as known to us. Although some papers as old as the beginning of the 19th century have been consulted, we have no illusion that our survey is complete (see below). We document the wide diversity of all those fossil fungal palynomorphs, mycelia and fructifications, of which the names had, or have, been validly published. For a small number of genera and species their names are here validly published for the first time. We include a small number of generic nomina nuda, that have been (or might be) considered as validly published.

This publication provides an immediate and quick reference to the names of genera and species, furnished with descriptions and figures. It aims to stimulate the interest of mycologists in the ancestral forms of living fungi, as well as to guide palynologists to a better understanding of the morphology, classification and biostratigraphic application of fossil fungi. We do not include forms described in "open nomenclature" (e.g. "*Inapertisporites* sp. A," or "*Pluricellaesporites* sp. 2"). Superseded binomials are listed, and are provided with cross references to the correct names. For the species, only the locations of types are cited, except in instances involving synonymy or emended/enlarged concepts. For each taxon, we cite the original diagnosis (for genera) or description (for species), as well as later emendations. We also cite supplementary comments of the original authors, generally verbatim (without changing the nomenclature they used, into the rationalized nomenclature presented in our Synopsis). For some entries, we provide a "diagnosis as here emended," and/or add "our remarks"; we always clearly identify our own opinions or contributions.

Because we did not see most of the original material, we refrained from emending species concepts. However, the grouping of species into (more or less artificial) genera is a more subjective exercise. We have rationalized some past practices, which makes for more coherent generic circumscriptions and groupings. Nevertheless, we have not split these groupings farther than absolutely necessary; that task will remain for future mycologists/palynologists, after they have studied the original (or additional new) material.

In the heading of each species we cite the page and figure number of the type specimen, in the original paper (protologue). Centered on the next line, we give, in bold, the plate and figure number of our own illustration of the species. A professional illustrator made the majority of line drawings in the Synopsis. These were augmented by illustrations borrowed from the Genera File of Fossil Spores (Jansonius & Hills, 1976 et seq.); those too simplistic for the present purpose were upgraded by Jansonius. All drawings were scanned, and then sized by computer to a uniform magnification. Most spores are at 700x magnification, some small forms at 1000x. Most microthyriaceous fruiting bodies are at 500x; others at a variety of magnifications. Computer-produced scales allow a quick resolution of the actual, and relative, sizes.

We received slides, negatives and photographs from some authors whose original descriptions seemed to be at odds with their original photographs, or whose published illustrations did not sufficiently show the necessary detail. Descriptions adjusted as a result of that, have been so identified.

The plates are arranged in a morphological order: first the inaperturate unicellate (aseptate) spores, which are followed by mono-aperturate, di-aperturate and multi-aperturate amerospores. Next the inaperturate dicellate spores, the mono-aperturate ones, etc. Then, *mutatis mutandis*, the same for pluricellate spores, where curvature of linear forms, and manner of aggregation of non-linear forms play a role. These are followed by the spherical aggregations, and aggregations with more than one axis. Next are the sporangia of the mycorrhizal fungi, the fruiting bodies of the microthyriaceous fungi and those of the Paleozoic *Sporocarpon* group, as well as a miscellany of various fruiting structures, including some mushrooms. Some late additions had to be accommodated onto the last two plates.

The "Glossary" may help palynologists to better understand the mycological descriptions. Our comprehensive "Bibliography" may include references not directly cited in our text. We do not provide references to the works in which modern genera were published to which fossil species have been assigned; neither do we cite the diagnoses of such modern genera.

Fossil Plants and Spores - Modern Techniques. Edited by T. P. Jones (Cardiff University, UK) & N. P. Rowe (Universite de Montpellier, France) April 1999 Available in Hardback (ISBN 1-86239-041-X) and Paperback (ISBN 1-86239-035-5).

(A lengthy and detailed review by Dr Jan Jansonius can be found on the CAP website at http://www.ualberta.ca/~abeaudoi/cap/reviews/review19.htm)

In recent years the study of fossil plants, spores and pollen has produced an abundance of new methods and modifications of old ones. This volume provides the first comprehensive collection of these practical methods - balancing the techniques that have been perfected over decades of research with the very latest methods and ideas.

Fossil Plants and Spores: modern techniques demonstrates that the study of fossil plants is a modern science and one increasingly applied in many disciplines to address such issues of current concern as evolution, environmental change and occurrence of fossil fuels. It is essential reading for palaeobotanists, palynologists, palaeontologists and academics teaching at undergraduate and postgraduate levels in earth and life science university departments. It will be used as both a laboratory manual and a source of inspiration for what can be discovered from the fossil plant record.

Paperback Hardback, ISBN: 1-86239-041-x ISBN: 1-86239-035-5, List price: £29.00 / $48.00 List price: £75.00 / $125.00

Part One – Extraction techniques: Locating and collecting fossil plants and spores; Extraction of lignitic and fusainized plant fragments from unconsolidated sandy and clay-rich sediments; Extracting plant mesofossils and megafossils by bulk acid maceration; Small palynomorphs; Large palynomorphs and debris; Palynomorph extraction from peat, lignite and coals
Part Two— Morphology: Surface preparation of macrofossils
(dégagement); Plant and spore compression in sediments Macrophotography; Light microscopy of fossil pollen and spores; Light microscopy of cuticles; Scanning electron microscopy of megafossils and mesofossils
Part Three—Anatomy: The acetate peel technique; Embedding techniques: adhesives and resins; Thin sections and wafering; Polished blocks and reflected light microscopy; Opaque petrifaction techniques; Lignified and charcoalified fossil wood; Fabric analysis and plant anatomy; Biomechanical analysis
Part Four— Ultrastructure: The ultrastructure of fossil cuticle; Plant cell Walls; Megaspore ultrastructure; The ultrastructure of fossil pollen and spores
Part Five—Geochemistry: Collection and storage of fossil plant remains for organic geochemical analyses; Carbon stable isotope analysis of fossil plants; Pyrolysis and chemolysis of fossil plant remains: applications to palaeobotany; Solid-state 13C nuclear magnetic resonance of fossil plants and

spores; Isolation, identification, and authentication of DNA sequences derived from fossil material; Mineralogical and geochemical analyses; Spore colour measurement; Bulk geochemistry as a guide to provenance and diagenesis
Part Six—Conservation, databases and protocols; The plant fossil record on the internet; Taxonomic and nomenclatural alternatives; Curation in museum collections
Part Seven—Sedimentology, taphonomy and stratigraph: Experimental sedimentology; Palynofacies analysis; Particle orientation and palaeoenvironments; Coal ball sampling and quantification; Taphonomy: field techniques in modern environments; Palaeosols; Plant macrofossil biostratigraphy; Spore and pollen biostratigraphy
Part Eight—Palaeoclimatology: Fossil leaf character states: multivariate analyses; Palaeobotanical databases and palaeoclimate signals; Fossil tree-ring analysis: palaeodendrology; Stomatal density and index: theory and application; Stomatal density and index: the practice; The nearest living relative method
Part Nine—Palaeoecology: Palynology/ecology interfaces; Techniques for analysing uncompacted lake sediments; Collection and analysis techniques for palaeoecological studies in coastal-deltaic settings;. Calcareous algae: analytical techniques; Archaeobotany: collecting and analytical techniques for sub-fossils; Dendrochronology; 14C dating sub-fossil plant remains; 13C/12C in growth rings and leaves: carbon distribution in trees; Techniques in the study of plant-arthropod interactions; Plants and animal diets
Part 10—International laws; International laws: collecting transporting and ownership of fossils: AUSTRALIA, BELGIUM, CANADA, CHINA, FRANCE, THE NETHERLANDS, SOUTH AFRICA, UK, USA
References; Glossary of terms; Appendix: list of commonly used chemicals, equipment, and suppliers; Index

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PALYNOBYTES

www.uni-muenster.de/GeoPalaeontologie/Palaeo/Palbot/ebot.html

This website received this comment from CAP member Jan Jansonius: "It is one of the best organized that I have seen, and full of useful info, links, and color illustrations of fossil plants."

The Directory of Paleontologists of the World and the Directory of Fossil Collections of the World

The Directory of Paleontologists of the World has gone through several editions. The present edition is entirely electronic. Paleontologists are urged to enter their personal information into the database at the URL shown below. It will take about five minutes to do so. Please ask your colleagues to enter information about themselves too. At present the directory has information on some 1,200 paleontologists. It needs to be about five times that size to be useful, so we shall appreciate very much all efforts to help the directory grow.
http://ipa.geo.ukans.edu/Directory/directory.html
The IPA also publishes the Directory of Fossil Collections of the World. This directory was originally prepared by Barry Webb in 1989. The present, second edition is available as an electronic database at:
http://ipa.geo.ukans.edu/Fossil/fossil.html

This is a brand new database with entries from only 5 museums. If you are in charge of a collection of fossils, no matter how large or how small, please refer to the web site and enter information about your collection. Please urge colleagues to do so, to. Completing the necessary forms will take a bit longer, but the whole thing can still be done in less than 15 minutes. Please help IPA make this directory a useful tool for paleontologists.

Roger L. Kaesler, Paleontological Institute, The University of Kansas, 121 Lindley Hall
Lawrence, Kansas 66045-2911
(785) 864-3338 = telephone
(785) 864-5276 = FAX
http://www.ukans.edu/~paleo/

sounds interesting!

http://crimeandclues.com/pollen.htm

Canadian Botanical Conservation Network (CBCN)

I would like to invite everyone interested to visit the Web site of the Canadian Botanical Conservation Network (CBCN). Next month our Web site will have been in operation for six years. Featured are all of our past newsletters, proceedings from our first workshop, contacts with other organizations, upcoming events and listings of positions available, as well as topical articles on plant conservation issues and a growing database on species at risk. The Web site has just been redesigned for greater readability and ease of navigation. I would be very grateful for your suggestions and comments on the site, so that we can serve our readers better. We also always welcome submissions of notices, articles and other items related to conservation and biodiversity issues. Our Web site address is http://www.rbg.ca/cbcn

We are gradually developing our pages in French, but at present most of the site content is in English. If anyone may be willing to volunteer to prepare text in French, please let me know! David A. Galbraith, Ph.D., Coordinator, Botanical Conservation Office, Royal Botanical Gardens, Hamilton/Burlington, Ontario, Canada
Tel: (905) 527-1158, ext. 309
Fax: (905) 577-0375
Email: dgalbraith@rbg.ca mailto:dgalbraith@rbg.ca

DIGITAL PHOTOS

Colleagues: I have put a number of digitized photos on my web site that were taken from the air. They are available free for noncommercial educational use. Point your browser to:
http://www.geology.wisc.edu/~maher/air.html
The photos include: Badlands, Black Hills, Devils Tower, Great Sand Dunes, San Juan Mtns and Basin, Mesa Verde, Shiprock, Hopi Buttes, Meteor Crater, Sinkholes of Chevelon Fork, San Francisco Peaks, Canyons of Little Colorado, Colorado, and San Juan Rivers, Rainbow Bridge, Arches, Bingham Copper Mine, Bonneville beaches on Stansbury Island, Craters of the Moon, Yellowstone Park, Tetons, Moraines along the Wind River Mtns, Sheep Mtn folds, Mammoth Cave area, Lake Michigan shores and raised beaches, Midwestern rivers and glacial landscapes, Tornados and floods, Baraboo area, and others. Look over the 640-pixel-wide index photos. If you see any you would like, record the ID number. There is a provision for downloading 2000-pixel-wide versions from our ftp site that are suitable for slides or video projectors. Because of the size and number of the digital files, the above-listed web site is best visited via a fast internet link. If there is sufficient interest, it may be possible to make the whole set available on CD-ROM; distribution cost would depend on the production run. You can contact me from the web site.

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INVITATION TO JOIN THE NEW PALEOCLIMATE DISCUSSION LIST

You are cordially invited to help launch the new Paleoclimate list-server, which is designed to provide a forum for Internet discussions and announcements among Paleoclimatologists throughout the world. The list is primarily for use by paleoclimatic researchers

and scientists. Of primary emphasis are periods of the recent past where data from the paleoclimatic record are of particular value to the modern climate community. Thus the time periods of primary emphasis are Quaternary, especially the Holocene, although discussions of earlier periods are not discouraged.
Appropriate subjects for discussion might include:
--> new proxy and historical data availability
--> national and international meetings and symposia
--> national and international programs and program news
--> funding opportunities
--> employment opportunities
--> new paleoclimate-related publications
--> announcements of paleoclimatology or related courses
--> paleoclimate research initiatives
--> controversial topics in paleoclimatology
--> recent reports on paleoclimate research
--> paleo in the news
At this time, this is an unmoderated list and is also available as a weekly digest (see below.) However, only subscribers may post messages to the list. We encourage vigorous discussions and controversial topics as well as respectful "netiquette". To Subscribe to the Paleoclimate-List, please send an e-mail message to listproc@lists.colorado.edu, with the following message (only!) in the body of the text:
subscribe paleoclimate-list <your-full-name>
We also offer a weekly digest version which you can sign up for immediately by sending listproc@lists.colorado.edu the following message:
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Once you subscribe a more detailed message will be sent to you explaining in more detail the digest options, how to unsubscribe, etc. If you have any questions, check out Web site at: http://www.ngdc.noaa.gov/paleo/listserv-invitation.html or send e-mail to: paleolist.help@noaa.gov. We're really excited about the potential for this list and welcome your participation and ideas on how to "cross-pollinate" between the many disciplines and backgrounds in the paleo world.
Mark McCaffrey
C. Mark Eakin
John Keltner

Announcements

FOR SALE

American Association of Stratigraphic Palynologists (AASP) Publications: Geoscience & Man (vol #1 to #7) and *Palynology* (volumes #1 to #23); all 30 volumes for US$200

Out of print volumes of *Geoscience & Man* (vol.9 1974, & vol.15 1976), *Palynology* vol.#3, #4, #5, #6 (1979 to 1982) *Contributions Series* vol. #4 (1975); all 7 publications for US$45

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SHORT COURSES IN ENVIRONMENTAL PALAEOECOLOGY FOR MSc AND PhD STUDENTS 2001/2002

I would like to draw your attention to Short Courses in Environmental Palaeoecology to be held at the Environmental Change Research Centre (ECRC), London, during the academic year 2001-2002. Full details of all courses, as well as on-line registration, can be found on our website (http://www.geog.ucl.ac.uk/ecrc/teaching.stm). If you would like more information about any of the courses or a registration form, please contact me using the contact details below:
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fax: +44 (0)20 7679 7565

QUANTITATIVE ENVIRONMENTAL PALAEOECOLOGY
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(Dr. J.A. Holmes)
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INTRODUCTION TO PLANT MACROFOSSIL ANALYSIS
(Dr. H.H. Birks)
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INTRODUCTION TO PALAEOCEANOGRAPHY
(Dr. M. Maslin)
25th February - 1st March 2002 Course Tuition Fee: £300

NUMERICAL ANALYSIS OF BIOLOGICAL & ENVIRONMENTAL DATA
(Prof. H.J.B. Birks & Dr. M. Kernan)
4th - 15th March 2002 Course Tuition Fee: £650

STABLE ISOTOPES IN THE LACUSTRINE & MARINE ENVIRONMENT
(Dr. M. Leng, NERC Keyworth & Dr. M. Maslin)
18th - 22nd March 2002 Course Tuition Fee: £180 + Keyworth Visit Costs

MEETING CALENDAR

2001

July 10-13 2001. Global Change Open Science Conference Amsterdam, The Netherlands. Sponsored by the International Geosphere Biosphere Programme, along with the World Climate Research Programme and the International Human Dimensions Programme. Website: http://www.sciconf.igbp.kva.se

August 20-24 2001. CANQUA (Canadian Quaternary Association) meeting Whitehorse, Yukon. Details: John Storer (jstorer@gov.yk.ca) Website: http://www.mun.ca/CANQUA

August 23-28 2001. 5th International Conference on Geomorphology Tokyo, Japan. E-mail: 5icg@c-linkage.ca.jp Website: http://wwwsoc.nacsis.ac.jp/jgu/icg_hopa/indexicg.html

September 18-22 2001. PAGES - PEP III Conference. Le Centre de Congres, Aix-en-Provence, France. PAGES - PEPIII is concerned with studies of past climate variability in Europe and Africa. Key aims are to assess variability on different time-scales, to assess the impacts of past climate change on natural ecosystems and human society, and to provide a firm basis for the verification and testing of climate models. There will be a number of plenary lectures from invited speakers plus a series of poster sessions open for all participants, plus a post-conference excursion to the Massif Central, France

(subject to interest). Details: Dr Catherine E. Stickley, Environmental Change Research Centre, University College London, 26 Bedford Way, London, WC1H 0AP, England, UK E-mail: C.stickley@ucl.ac.uk Website: http://www.geog.ucl.ac.uk/ecrc/pep3

September 22-24 2001. 11th Canadian Paleontology Conference (CPC-XI) London, Ontario. Details: Jisuo Jin, Chair, CPC Organizing Committee, Department of Earth Sciences, University of Western Ontario, London, Ontario, Canada, N6A 5B7, Tel. (519) 661-4061, Fax (519) 661-3198, E-mail: jjin@julian.uwo.ca

November 5-8 2001. Geological Society of America, Annual Meeting. Boston, Massachusetts, U.S.A. Details: GSA HQ, Box 9140, 3300 Penrose Place, Boulder, Colorado 80301, U.S.A. Tel: (303) 447-2020, X133, E-mail: meetings@geosociety.org

2002

May 26-29 2002. GAC/MAC Meeting Saskatoon, Saskatchewan, Canada Website: http://www.usask.ca/geology/
Note: CAP will be sponsoring a special session at the GAC/MAC meeting; see page 3 for details.

Date: TBA. 7th International Association for Aerobiology Congress Quebec, Canada

August 29 - September 2 2002. 6th European Palaeobotany - Palynology Conference Athens, Greece. Details: Prof. D. Evangelos Velitzelos, Organizing Committee, 6th European Palaeobotany-Palynology Conference, Department of Historical Geology-Palaeontology, Faculty of Geology, University of Athens, Panepistimioupolis, Zografou, 157 84 Athens, Greece. Tel./Fax: +30-1-7274162, E-mail: velitzel@geol.uoa.gr

September 5-7 2002. CIMP Symposium and Workshops Lille, France. Details: Thomas Servais (thomas.servais@univ-lille1.fr) or Ludovic Stricanne (ludovic.stricanne@univ-lille1.fr), University of Lille

September 11-13 2002. (Proposed) Joint Meeting of AASP, BMS and NAMS (American Association of Stratigraphic Palynologists, British Micropalaeontological Society, North American Micropaleontology Section of SEPM) University College London, England, UK. Details: James Powell, Dinsystems, 105 Albert Road, Richmond, Surrey TW10 6DJ,England, UK, Tel: +44 20 8948 6443; Fax: +44 20 8940 5917, E-mail: ajp@dinosystems.co.uk.

October 27-30 2002. Geological Society of America, Annual Meeting. Denver, Colorado, U.S.A. Details: GSA HQ, Box 9140, 3300 Penrose Place, Boulder, Colorado 80301, U.S.A. Tel: (303) 447-2020, X133, E-mail: meetings@geosociety.org

2003

Date: TBA. GAC/MAC Meeting Vancouver, British Columbia, Canada

Date: TBA. CANQUA Meeting Halifax, Nova Scotia, Canada (proposed).

Date: TBA. INQUA XVI Congress Reno, Nevada, USA

March 29 - April 2 2003. 3rd International Limnogeology Congress Tucson, Arizona. Theme session proposals to Andrew Cohen, General Chair of the Congress (acohen@geo.arizona.edu). Field trip proposals to David Dettman, field trip coordinator for the Congress (dettman@geo.arizona.edu).

November 2-5 2003. Geological Society of America, Annual Meeting. Seattle, Washington, U.S.A. Details: GSA HQ, Box 9140, 3300 Penrose Place, Boulder, Colorado 80301, U.S.A. Tel: (303) 447-2020, X133, E-mail: meetings@geosociety.org

2004

Dates: TBA. XI IPC (International Palynological Congress) Granada, Spain
Website: http://www.ugr.es/local/bioveg

2005

Date: TBA. GAC/MAC Meeting Halifax, Nova Scotia, Canada

Have you paid your dues? See the list on page 2!