Protist, Vol. 153, 221–222, September 2002 © Urban & Fischer Verlag
http://www.urbanfischer.de/journals/protist
Published online 13 September 2002

Protist

PROTIST WEB ALERT

The Ciliates Among Us

The ciliated protists are among the most fascinating eukaryotic organisms that exist, mainly due to their size and accessibility, diverse habitats, motility and behavior, cellular organization of the motile cilia and novel genomic organization into micronucleus and macronucleus. Several basic biological phenomena were discovered using ciliates such as telomerase RNA, self-splicing introns or ribozymes and bioelectric control of ciliary movement. In particular *Tetrahymena* and *Paramecium* have proved to be elegant experimental models and are in the process of entering the genomic age.

Micrographs of Ciliates

(http://ebiomedia.com/gall/ciliates/index.html)

Biomedia Associates and Bruce Russell have provided a nice collection of photomicrographs of various ciliates. The use of mouse-over to give a second image is a nice touch. Must warn you however that the promised downloadable video clip about ciliate diversity is a broken link!

(http://www.broward.cc.fl.us/~ssimpson/JMDelvecchio-Paramecium.htm)

Another site whimsically entitled "Paramecium, the Lowly Fellers", shows images and explanatory notes of Paramecium which are taken from a variety of original sources. It also has some images of *Didinium*, that fantastic predator ciliate that can swallow with ease a Paramecium twice its size! Must warn the viewer that 14 of the 21 links to other web sites are broken (a common problem due to the dynamic nature of the web and to the benign neglect of the web masters, my own mea culpa notwithstanding)!

The Unsolved Mystery of the Inheritance of Kineties in *Paramecium*

Cilia in Paramecium are arranged in parallel rows called kineties in which all the cilia bend in the same direction. Tracy Sonneborn (http://www.nap.edu/html/biomems/tsonneborn.html) was a truly great and currently unappreciated geneticist and protistologist who made major advances in our knowledge of ciliates. He showed that the macronucleus determines the phenotype of the cell and the micronucleus is used for meiotic replication. He also introduced the concept of non-Mendelian inheritance in studies of the cytoplasmic "kappa" factor. And finally he showed in a beautiful series of subcellular grafting experiments that the form and arrangement of preexisting ciliary kineties determine the form and arrangement of new kineties and that this is somehow inherited. This thought provoking discovery was recently noted in an article by Marc Abrahams in the "Annals of Improbable Research" entitled "Sonneborn and the Persistently Shapely Paramecia" (http://www.improb.com/airchives/paperair/volume6/v6i2/sonneborn-6-2.html).

Science, for good reason, tends to ignore discoveries that do not fit into a conceptual framework, but this is a phenomenon waiting to be explored with modern techniques.

Calcium Channels and the Behavior of *Paramecium*

My deceased colleague and close friend, Roger Eckert (http://sunsite.berkeley.edu:2020/dynaweb/teiproj/uchist/inmemoriam/inmemoriam1987/@Generic_BookTextView/770), opened a new field of research in the 1960's when he and his colleagues showed that *Paramecium* membranes contain both mechanically- and voltage-activated Ca^{++} and K^{+} channels similar to those in neuronal membranes and that the animal's behavior can be explained by the spatial segregation and function of these channels. Mutants with defects in locomotion allowed the genetic dissection of the bioelectric control of ciliary movement. Ching Kung has followed up on these seminal experiments using *Paramecium* with a combination of elegant genetics and electrophysiology (http://www.molbio.wisc.edu/kung/para.html).

1434-4610/02/153/03-221 $ 15.00/0

The Struggle to Enter the Genomic Age

There is a *Paramecium* Genomic Consortium and a number of Genome Survey Sequences nicely presented at http://paramecium.cgm.cnrs-gif.fr/ . But this is a web site waiting for sequence data. I wish it luck but it probably would rather have funds to do the work.

Tetrahymena – The Ciliate Workhorse

Tetrahymena is definitely the most used ciliate experimental system, as evidenced by the 35 laboratories listed in http://ua1vm.ua.edu/~hsmithso/prof/tweb.shtml, including such luminaries as the Tom Cech Lab (http://petunia.colorado.edu/), the Liz Backburn Lab (http://biochemistry.ucsf.edu/%7Eblackburn/) (I especially like Liz's "Monster Cell Gallery" at http://biochemistry.ucsf.edu/%7Eblackburn/MonsterCellGallery.html and the Eduardo Orias Lab (http://www.lifesci.ucsb.edu/mcdb/emeriti/orias/index.html), among others.

In the 1980's Tom Cech discovered that an intron in the *Tetrahymena* rRNA gene was able to catalyze its own splicing and the rest is history. The concept that RNA can be an enzyme is truly one of the most significant discoveries of modern molecular biology. Around the same time, Liz Blackburn discovered that the ends of the many telomeric ends of the minichromosomes in the maconucleus of *Tetrahymena* contained a short repeating sequence. This was followed by Blackburn and Carol Greider discovering the existence of the RNA-containing telomerase enzyme, which was finally isolated and the gene cloned in 1998 by Cech and Joachim Lingner , using another ciliate, *Euplotes*.

Tetrahymena is also rapidly becoming a "genomic organism". There is a nice web site at http://lifesci.ucsb.edu/~genome/Tetrahymena/ with genomic maps (http://www.lifesci.ucsb.edu/~genome/Tetrahymena/GenomMaps.htm) and a lot of empty space for genomic sequences. The good news is that I recently heard on the grapevine that *Tetrahymena* was one of the lucky organisms chosen to be on the NIH genome sequencing "wish list".

Gene Scrambling in Hypotrich Protists

I am used to hearing people call the phenomenon I study, uridine insertion RNA editing in trypanosomes, "bizaare", but that is nothing compared to the gene scrambling results obtained by David Prescott using several hypotrich protists such as *Oxytricha* and *Stylonychia* (http://mcdb.colorado.edu/faculty/prescott99.html). Prescott discovered that the genes in the inherited micronucleus are in scrambled pieces and there is a reordering of gene fragments to form the transcriptionally active genes in the somatic macronucleus. The mechanism of this fantastic rearrangement is being studied on the theoretical and experimental level by Laura Landweber (http://www.princeton.edu/~lfl/washpost.html). Again, this is a biological problem crying out for more people to work on.

Odds and Ends

If you are interested in learning how many Paramecia would it take to fill up the Universe, check out the "Imperialistic *Paramecium*" site at http://www.lazylabs.org/paramecium.html. Of course the author used the unrealistic division time of 1 minute, so don't believe his conclusion that they would fill up the Universe in 4 hr and 52 minutes.

The Lowly Fellers are also used as fish food, but if you run out of *Paramecium* you can substitute *Tetrahymena pyriformis* (http://zebra.biol.sc.edu/methods/tetra.html).

Paramecium research labs like to hold meetings in nice places like Hawaii (http://www.pbrc.hawaii.edu/membio/paramecium/). They did however make the mistake of posting a group photo which the IRS can use to check out travel deductions!

Finally, be sure not to confuse *Paramecium* research with the "Paramecium Doom Death Metal Band" from Australia (http://www.paramaecium.com/)!

Larry Simpson
HHMI-UCLA, 6780 MacDonald Research Laboratories,
675 Charles E. Young Dr. S.,
Los Angeles, CA 90095-1662, USA

fax 1310 206 8967
e-mail simpson@kdna.ucla.edu