

opmental processes which have occurred in the two masses of tissue." Waddington suggested that the terms epigenetic constitution or epigenotype be used to refer to the "set of organizers and organizing relations to which a certain piece of tissue will be subject during development." These terms in hand, he then urged that we consider "the appearance of a particular organ [as] the product of the genotype and the epigenotype, reacting with the external environment." Thus, in this manner, Waddington drew the original concept of epigenesis closer to those of genotype, phenotype, and development.

With regard to the quotation from Wright that Rubin mentions, I would also agree. We must keep in mind the context in which a gene works and that, as we broaden our understanding of the gene, the boundary of the gene might become less obvious. By way of thanks, I append a quotation from a paper published by H. J. Muller in 1938. Its focus, the phenomenon of position effect, differs from the issue addressed by Wright, but its flavor seems reminiscent of Wright's message.

In the production of phaenotypic effects the gene must begin by interacting with cellular substances so as to produce a highly

specific product or products, which must diffuse out from the locus of activity of the gene and in turn cause (or affect) further physiochemical changes. In the course of one of these chains of reaction, that has its origin in an individual gene, there will be many opportunities for interaction with other chains of reaction present in the complicated mixture; thus, the reactions will really form a kind of multi-dimensional net, rather than a simple chain. The final phaenotypic manifestations lie at the ends of the net furthest removed from the inner gene ends, and their quality depends upon the character and strength (including speed) of all the intermediate reactions and interactions (3, 1938, p. 588).

C.-TING WU

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4. I thank M. Green at the University of California, Davis, for alerting me to Waddington's 1939 discussion of epigenetics.

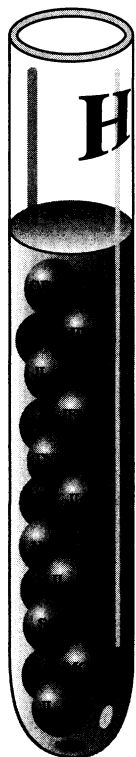
Speciation and Centromere Evolution

A NEW MODEL FOR THE ORIGIN OF SPECIES IS

proposed by S. Henikoff and co-authors in their review "The centromere paradox: Stable inheritance with rapidly evolving DNA" (special issue on Epigenetics, 10 Aug., p. 1098). Referring to the research in *Drosophila* to illustrate their idea, Henikoff *et al.* suggest that concerted evolution of centromeric satellite DNA and the centromeric histone protein centromere identifier (Cid) in isolated populations should result in a loss of compatibility between these elements in the hybrids. This should lead to chromosome nondisjunction (the failure of homologous chromosomes to segregate properly during meiosis) in the hybrids, and their sterility. Therefore, "speciation is an inevitable consequence of centromere evolution."

The authors suggest several tests for their model, but there is a simple test that should be definitive. If the model is correct, then the genes for hybrid sterility must be located predominantly at centromeres or the sites of Cids (or both). Alas, the mapping data from *Drosophila* and mouse indicate that they are not.

Reference Reagents for Murine and Human Cytokines



The Biological Resources Branch (NCI), the Division of Microbiology and Infectious Diseases (NIAID), and the National Institute for Biological Standards and Control (UK) have made available reference reagents for murine and human cytokines. The reagents are available in small amounts (~1 µg/sample) for use in the calibration of *in vitro* bioassays and in-house standards and are not to be used for experimental purposes.

Human Reference Reagents Available: IFN-α; IFN-β; IFN-γ; EGF; FGF (basic); G-CSF; GM-CSF; GRO-α; IL-1α; IL-1β; IL-2; IL-3; IL-4; IL-5; IL-6; IL-7; IL-8; IL-9; IL-10; IL-11; LIF; MCP-1; M-CSF; MIP-1α; NGF; RANTES; SCF; TGF-β1; TNF-β.

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In formulating their model, the authors appear to have overestimated the role of chromosome nondisjunction in hybrid sterility. This type of malfunction of the chromosome segregation machinery accounts for only a minor part of gametogenic failure in hybrid animals. The major causes are the inability of hybrid germ cells to enter meiosis or to proceed through meiotic prophase. Another cause of hybrid sterility is the formation of nonfunctional gametes resulting from disruptions of the process of postmeiotic modifications (1). None of these events is associated with chromosome nondisjunction. Thus, apparently DNA satellite/Cid divergence takes place after the speciation event and is a consequence rather than a cause of speciation.

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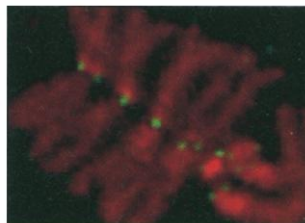
Response

BORODIN RAISES THE IMPORTANT ISSUE OF THE connection between hybrid sterility and sex chromosome nondisjunction that we dis-

cussed in our review. He points out that nondisjunction is not expected to result in spermatogenic failure. However, the actual situation is more complex. In *Drosophila*, nondisjunction of the *XY* pair caused by alterations in centromeric *X* heterochromatin is correlated with failure of sperm development (1), and failure occurs whether or not the *X* and *Y* chromosomes had been paired at meiotic prophase (2). To explain these puzzling observations, McKee and colleagues (3) have proposed the existence of a meiotic checkpoint that aborts spermatogenesis when proper orientation of the centromeres is not achieved. Metaphase checkpoints that monitor tension on spermatocyte kinetochores (the attachment point of microtubules to the centromere) are well known (4), and unequal pulling on *X* and *Y* centromeres should trigger such a checkpoint. The operation of an early checkpoint is consistent with postmeiotic defects, because failures in the early steps of meiosis can cause sperm dysfunction at much later stages of gamete de-

velopment (5). Therefore, both nondisjunction and sperm dysfunction would result from unequal pulling on *X* and *Y* centromeres.

Borodin also questions the agreement of our model with current mapping data. However, in established species, such as those cited by Borodin, mapping of a locus involved in an initial speciation event is complicated by the accumulation of complex secondary hybrid incompatibilities (6). These secondary incompatibilities would be indistinguishable from the primary one. To map primary speciation loci, one should use incipient species, such as the 150,000-year-old Bogotá population of *Drosophila pseudoobscura* (6). In this case, very few incompatibilities were detected. As Borodin suggests, we expect that an initial hybrid sterility determinant should map to the *cid* gene encoding the centromeric histone, or to another gene that alleviates unequal pulling on centromeres. Candidate proteins that might alleviate this imbalance include the *Drosophila* DNA binding protein



The centromeric protein Cid is revealed by antibody labeling (green) in these *Drosophila melanogaster* prometaphase chromosomes.

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Tapping Science's Women for the Podium

Prod, which binds to a species-specific satellite DNA during mitosis (7). Another is the protein encoded by the *Drosophila mauritiana* hybrid sterility gene, *Odysseus*, which might affect centromere imbalances by binding to satellite DNA through its adaptively evolving homeobox sequence (8). Because such proteins from one species will become incompatible with multiple centromeres from the other species, we do not necessarily expect that hybrid sterility will map to any particular centromere. Therefore, the simplest test of our model is the examination of Cid and other candidate proteins in incipient species.

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ONE OF THE FINDINGS FROM THE SALARY AND job survey of life scientists conducted by the American Association for the Advancement of Science (publisher of *Science*) was that women scientists were less satisfied in their work than their male counterparts in a number of areas including job security, salary and compensation, promotion opportunities, and prestige ("General contentment masks gender gap in first AAAS Salary and Job Survey" by C. Holden, 12 Oct., p. 396).

For any scientist's career advancement, visibility is critical. A resource for meeting organizers that helps this issue for women biologists is the Speakers Resource Bureau (SRB) (accessed at www.ascb.org) established in 1997 by the Women in Cell Biology Committee of the American Society for Cell Biology. The SRB members are accomplished women scientists who have volunteered to provide advice to meeting organizers in selecting women speakers from a large number of different scientific fields, even beyond those usually considered to be in the area of cell biology, who are skilled at communicating about those disciplines.

Through their knowledge about their senior and junior, U.S. and international women colleagues, SRB members provide a way for meeting organizers to tap the talents of many scientists who might otherwise have escaped notice. And for the speakers, such opportunities and visibility can contribute to greater job satisfaction.

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CORRECTIONS AND CLARIFICATIONS

PERSPECTIVES: “Where has all the carbon gone?” by S. C. Wofsy (22 Jun., p. 2261). The first sentence should have read, “Emission rates of CO₂ from combustion of fossil fuel have risen almost 40% in the past 20 years, but the annual increase in the atmosphere has stayed level, or even declined slightly.” And the end of the last sentence of the figure legend on p. 2261 should have read, “...20 to 40% of U.S. fossil fuel emissions,” not 20 to 40% of fossil fuel emissions worldwide.

II ONCE INTERNATIONAL AID AWARDS FOR RESEARCH AND DEVELOPMENT INTO TECHNOLOGIES FOR THE BLIND

DEADLINE FOR PRESENTATION OF PROJECTS EXTENDED

Projects can now be presented until March 31st, 2002

The deadline for presentation of projects to the II ONCE International Aid Awards for Research and Development into Technologies for the Blind, organised by the Spanish National Organisation of the Blind (O.N.C.E.), has been extended until the 31st of March, 2002.

The II ONCE International Research and Development Awards are aimed at relevant research and projects in the fields of information technology, telecommunications, biotechnology and engineering. The objective of the awards is to ensure that these projects are carried through to a successful conclusion. Projects should involve some type of innovation or progress in the aforementioned fields and should include social adaptation and normalisation for the blind and visually impaired.

Participants may be individuals or legally registered organisations (companies or institutions), and they may present their projects either individually or collectively. Entry is open to all sectors of research, both public and private, and entries will be accepted from researchers and working groups which are already established or which may be established in the abovementioned fields of investigation.

Therefore, entries will also be accepted from research projects which are already underway, regardless of the stage of development they may be in, on condition that the jury considers the project to have a practical future application.

There are no rules concerning the structure and length of the documents presented, although the following documents must be presented:

- Written document addressed to the **Secretariat of the II ONCE International Aid Awards for Research and Development into Technologies for the Blind**, to present the **entry officially**.
- Written report explaining the project, **study, breakthrough, innovation or advance which is being entered**. Special emphasis should be placed on the implications of the entry in terms of innovation.
- Written explanation of the benefits to the blind and visually impaired which the **practical application of the project** would imply.
- Declaration from the participant or participants that they are the authors of the **work presented**, that the work presented is original, and that the work began before the date of call for entries.

Entries should be presented in either English or Spanish, and if the project is being entered by members of a research centre it must be authorised by the competent authorities.

The authors of the winning entries shall be expected to assign intellectual property rights, although given the varying circumstances and characteristics of the projects entered the terms of such assignment shall be agreed between the ONCE and the authors of each of the winning entries.

The economic aid packages for these awards are as follows:

First prize – 30 million pesetas (180,303 Euros).

Two special prizes – 10 million pesetas (60,101 Euros) each.

These should be used principally to ensure that the research is successfully completed according to agreements reached in each case.

Projects should be sent before the 31st of March 2002 to:



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