

# ***The Signal***

Monthly newsletter of the W. M. Keck Center for Behavioral Biology  
at North Carolina State University  
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***THE SIGNAL WISHES ALL ITS READERS  
A SPOOKY HALLOWEEN!***



***This Issue of The Signal Contains the Traditional Halloween Story.***

# Ritual and the Theatrical Landscape in Early Human Society

by Allison Nolker

The tradition of excellent speakers at the W. M. Keck Center for Behavioral Biology distinguished seminar series was unbroken by the addition of Dr. Charles Stanish, director of the Cotsen Institute of Archaeology and Professor of Anthropology at UCLA. Dr. Stanish captivated audiences with his broad research interests both at the Keck Center lecture on campus and at the evening presentation at the North Carolina Museum of Natural Sciences.

Dr. Stanish received his B.A. from Pennsylvania State University and his A.M. and Ph. D in Anthropology from the University of Chicago. He then took a postdoctoral research fellowship at the University of Illinois at Chicago. He worked as an Assistant and Associate Curator at the Field Museum of Natural History before taking his current position at UCLA. Stanish has received numerous awards and honors including being elected to the National Academy of Sciences in 2010 and serving as the Lloyd Costen Chair in Archaeology at UCLA.

Select faculty and students had the pleasure of meeting with Stanish throughout the day on October 4<sup>th</sup>, including a lively lunch at McDaid's Irish Pub. Topics of discussion ranged from how the advent of human speech led to a new paradigm of social organization to the need for more transparency and forthrightness among scientific bodies when disseminating information to the public.

Lunchtime conversation proved a good warm-up for Dr. Stanish's departmental seminar. His talk, "Emergence of Complex Human Society from a Game Theory Perspective", was quite engaging, as evidenced by the audience's copious questions. Stanish posed the question "why give up a hunter-gatherer lifestyle for settlement, domestication, and agriculture?" and then set out to answer it using economic theory along with traditional archeological evidence. Stanish boldly stated that the typical timeline of cultural evolution that cites a coercive rationale for the transition from hunter-gatherers to modern society is, though tidy and elegant, wrong, especially concerning pre-Bronze Age civilizations. Rather, ritual and the perceived need for ceremonial centers were the driving force behind increasingly complex socioeconomic paradigms.

Stanish cited many examples of monuments and ritual sites that predated state societies. These, he postulated, are clear evidence for the existence of non-kin economic strategy selection and economic logic that kept non-genetically related groups together. These civilizations were not being shaped by agricultural or population pressure, but rather sought



*Dr. Charles Stanish*

to create theatrical landscapes in order to increase and maintain the number of people in their faction.

Dr. Stanish also presented an evocative seminar at the Nature Research Center's Daily Planet Theater at the Museum of Natural Science in downtown Raleigh. This talk, "Unlocking the Mysteries of the Ancient NASCA People of Peru", focused on the Nasca lines and their recently-discovered relationship to the Paracas civilization. Elements of this presentation were shared with his Keck Center lecture, but it was clearly tailored for a broader audience. Major themes included the hyper-rational use of pyramids and platform mounds as solstice markers in order to create ornate pictures of one faction's power and culturally dictated "ritual calendar" as well as the role of the Nasca lines, ancient avenues in the landscape which seem not to have been created to mark time like the pyramid structures, but rather to promote commerce. Stanish showed compelling photographs of nearly perfectly preserved baskets and textiles from his dig sites that put a lovely bow on both of his talks.

Dr. Stanish will continue his work in Peru, collecting artifacts and empirical evidence to bolster his claims about the beginnings of human civilization. His broad and unique mix of economic strategy, game theory, cultural evolutionary theory, and traditional archaeology will certainly result in unprecedented and important discoveries.

# Hail to the Heir Apparent

by Angela Bucci

On October 8th, the W. M. Keck Center for Behavioral Biology hosted its third speaker of the year, Dr. Raghavendra Gadagkar, as part of its distinguished seminar series. Gadagkar is renowned for his extensive work in the areas of insect behavior and ecology.

Gadagkar earned both a B. Sc and M. Sc in Zoology from Bangalore University in India and a Ph. D. in Molecular Biology from the Indian Institute of Science, also in Bangalore. His 200+ papers rank him among some of today's most notable scientists. In recognition of his contributions to entomology and ecology, and his successes in promoting the sciences in India, Gadagkar has been the recipient of dozens of awards, including the Third World Academy of Sciences Award in Biology, H. K. Firodia Award for Excellence in Science & Technology, and the Swami Pranavananda Saraswathi Award in Environmental Science and Ecology.

Interestingly, Gadagkar was able to achieve all this without any expensive equipment. His work, thus, serves as an inspiration to scientists in many parts of the world, where expensive technology is not currently obtainable. It is for reasons such as this that he has been chosen as a fellow of the National Academy of Sciences (India), the Indian Academy of Sciences, the Academy of Sciences for the Developing World (TWAS), the Indian Academy of Entomology, and the Indian National Science Academy. Gadagkar is also a Foreign Associate of the National Academy of Sciences of the USA.

The major theme throughout Gadagkar's talk was the process of science. "The process of science is as important as the product," he stated. He presented his life's work as a series of questions and answers, with simple observations as the driving force behind his success. Specifically, he discussed his work with the tropical, social wasp *Ropalidia marginata*. What is so unique about this insect system is that the queen wasp is morphologically identical to the workers. However, the queen is non-aggressive and the only wasp in the hive to lay eggs. Through hours of observation and elegant experiments, Gadagkar was able to determine how the queen maintains her status. He found that this involves a non-volatile pheromone, which the queen distributes throughout the nest at regular intervals.

Following up on these findings, Gadagkar and his research team then sought to discover how such a docile female could become queen. More observations, coupled with queen removal and experiments in which the colony was separated in two



*Dr. Raghavendra Gadagkar*

parts, one with and one without a queen led to the conclusion that removal of the queen leads to high aggression in the hive, with the most aggressive worker becoming the new queen. Once established as the new queen, her aggression level drops before she can lay eggs. These outcomes, in turn, lead to even more questions about queen pheromone production and perception by workers.

A central question is: what determines who will become the next queen? Gadagkar showed that the wasps know their heir apparent and a challenge for the future is to find out, how do they know?

Decades of work sprung forth from one simple question about queen behavior. By keeping an open mind and not getting too far ahead of himself, Gadagkar and his team were able to define a wide range of behaviors within *Ropalidia marginata*, including queen succession. Very little was known about this wasp prior to Gadagkar's work, but, because of his persistence, this insect's life history strategies have provided a wealth of new information about the organization of social insect societies.

Gadagkar has shown through his work that asking simple questions about a system can lead to some pretty tremendous findings, but perhaps more importantly, he has shown that good science can be produced also in countries where there is no or limited access to the latest technologies and without abundant financial resources.

# The Spirit of Paracelsus

by Robert Anholt

With the last chords of Wagner's Rheingold still reverberating in his ears, he slowly ambled down the white marble stairs of the university's small opera house. When he reached the middle of the stairs, he stopped, leaned against the elegant wrought iron bannister and watched the glow of the full summer moon cast comically distorted shadows over the steps, elongated reflections of the departing audience, men dressed in black and white tuxedos like penguins descending from an iceberg and troops of mostly elderly women with their long evening gowns and inappropriate fur coats dragging over the ground. It was a peaceful moment, the transition between the mystical world of the Nibelung and the warm mid-western summer night. Johannes Tessel took his time taking in the magical impressions of the warm summer evening as the voice of Alberich slowly drifted from his memory. He adored Richard Wagner and already had attended the performance of Das Rheingold three nights in a row. After he watched the last opera patron leave, he slowly descended down the stairs. He was a small elderly gentleman, well-aged, with grey whiskers and a well-developed mustache. He limped slightly on his left leg, the result of an old injury from a bicycle accident. Carefully he strolled down the rocky path through the woods, crossed the little stone bridge over the creek and headed for the old chemistry building.

"Let's just check," he mused to himself, as he made his way to his laboratory. He knew very well that there was nothing to check on. Everything would be in order, the same way he had left it earlier that evening. But he could not bear to make the harsh transition from Wagner's enchanted mystery world to his lonely bachelor's apartment. Visiting his laboratory on the way home would soften the transition.

Johannes Tessel, although successful by any objective criterion, could not be described as a happy person. Ever since he was a child, he had been shy and withdrawn, too serious for his age, preferring study over play. He had become the type of person who would never dare complain to the waiter that the steak was overcooked or that the beer was flat. In the airplane he never had the courage to insist on a window seat. Worst of all, he was a proverbial klutz around ladies, feeling ill-at-ease and flustered in the presence of attractive women and uncomfortable when it came to making ordinary everyday conversation. As a result he had remained a bachelor devoted to his profession and had spent his life with himself as only companion. He was painfully aware of his sociopathy, but was at a loss of how to solve his problem and, rather than facing



it, had adjusted to it, finding solace and consolation in his scientific accomplishments and in his inner world of rich dreams and glamorous fantasies. He imagined that one day he, the obscure Johannes Tessel, the little professor that nobody paid attention to, would do something spectacular. He had no idea of what that miracle would consist of, but he thought of it as a great scientific discovery of such astounding impact and of such enormous benefit to mankind that the name "Johannes Tessel" would forever become engraved in history.

"Hello, Aureolus Philippus Theophrastus Bombastus von Hohenheim," he said as he entered his laboratory. It was his own little joke and referred to the elaborate name of the ancient alchemist, better known as Paracelsus, whose picture, a reproduction of the famous painting of Quentin Metsys, hung on the wall across from the laboratory's fume hood. Tessel was fond of the picture and felt secure under the familiar eye of Paracelsus who against a background of a bucolic Italian renaissance landscape benevolently looked down at him, one hand leaning on the frame and in the other clasping a little book which no doubt contained the unknown secrets of life. Like Wagner's Rhine nymphs, gnomes and legendary gods, the picture of Paracelsus had become an integral part of Tessel's private fantasy world. How he admired the old alchemists! How he despised his colleagues who believed that modern quantum mechanics provided

them with complete knowledge and all necessary insights! They understood no more about the essence of matter than Paracelsus who believed in the unity of the body and the universe, in purification through fire, and in transmutation of the elements. Tessel viewed Paracelsus as a genius, far ahead of his time, and at the same time as a philosopher, who combined knowledge with true wisdom. He was particularly fascinated by the old alchemists' quest for the transmutation of lead into gold. Gold has been the fascination of men since time immemorial. To the old alchemists this shining, glowing, precious metal, soft to the touch, and unaffected by strong acids or bases, represented the embodiment of incorruptibility, the personification of eternal youth, the panacea for all cures. Tessel understood them, the old alchemists, and he respected them. Often he wished he had lived in the fifteenth century. He would have been one of them, striving to discover the secret of the transmutation of lead into gold.

"Strange," he thought, "the course of history. A hundred years ago, they would declare you crazy for even suggesting that transmutation of metals was possible. Yet, that is exactly what happens when a radioactive chemical decays! And nobody jokes about radioactivity!"

As he reflected on the process of radioactive decay he walked up to the fume hood and inspected a few vials of radioactive chromium which were shielded by a wall of lead bricks. He noticed some moisture dripping from the ceiling of the fume hood.

"Droplets of sulfuric acid, better be careful," he thought.

The sulfuric acid arose from crystals which he was drying under an infra-red lamp on a filter paper and which gave rise to sulfur vapors that condensed against the roof of the hood as droplets of sulfuric acid.

"Only a few more days," he reflected, "then the crystals will be dry."

He turned around. Now he was ready to go home.

"Good night, my friend," he said softly to the picture of Paracelsus and closed the door behind him.

The next morning would be the beginning of a memorable day for Johannes Tessel. When he opened the door and greeted Paracelsus in his customary way, he smelled the familiar sulfuric odors of his crystals wafting into the room from underneath the fume hood.

"Better close the window a little more," he mumbled, "the fan in that old hood doesn't work too well. Better call "Maintenance".

He walked up to the hood and immediately was struck by the odd appearance of the brick wall which shielded his radioactive chromium. The lead bricks had a dark yellow glow in which the face of Paracelsus from across the wall was strangely reflected. Tessel touched the bricks with his fingertips. He stood for a moment confused. It did not feel like lead. The metal had softened. He took a small razor blade from the lab

bench and scarred the top of one of the bricks. There was no doubt about it.

"Gold," he murmured, "My God, I HAVE MADE GOLD!"

He scraped a few thin strips off the top of one of the yellow bricks in some test tubes and quickly performed a few simple reactions which beyond any doubt confirmed the identity of the metal.

"Incredible," he thought, "when the lead is exposed to radioactive chromium and vapors of sulfuric acid the infra-red light catalyzes the transmutation!"

He stood for a while with his fists pressed down on the lab bench, not certain about what he should do and not knowing whether the events he was experiencing were real or whether they were figments of his fantasy. He left the laboratory, made his way down the stairs, stepped outside the building and walked into the gardens. There was no doubt about it. Everything was real. He smelled the flowers and listened to the noise of the traffic in the distance; there was Professor Hodgkins, his professional enemy; yes, all was real. He re-entered the building, climbed back on the stairs and stepped once again into his laboratory wondering whether he would perhaps this time see the ordinary wall of lead bricks.....

They were still yellow.

It was real. He had turned the lead into gold.

"Holy shit," he said to himself, "holy shit, Tessel, what are we gonna do?" There were sixteen bricks, each worth a fortune. One brick would provide him with enough money to carry him comfortably through his retirement. And, of course, he could make more, as many as he wanted!

"Holy shit," he kept repeating, "holy shit, Tessel, you can cure hunger and poverty in the world! You can really help mankind! Holy shit, Tessel, you've done it this time! THIS IS BIG! HOLY SHIT!!!"

What to do next? He had to tell somebody! The dean, perhaps! No, not the dean; he would tell it personally to the Chancellor, Dr. Lawrence Bellamy, who had never even said "Good Morning" to him and who had tried to force him into early retirement "to make room for the young generation." Yes, first he would tell Bellamy. Johannes Tessel had suddenly forgotten that he was shy and introverted. He dialed Bellamy's number and confidently informed the secretary that he urgently needed to speak to the Chancellor. When she informed him that the Chancellor was in a meeting, he insisted uncharacteristically that she fetch him right away.

"The future of the university is at stake!" he proclaimed, "tell Dr. Bellamy that he should come to my laboratory in the Chemistry Building at once! I have made a discovery that will shock the world!"

Eventually he convinced her and she informed him that the Chancellor with two of his administrators, Archibald Jones and Will Haines, would be there shortly.

Boiling with excitement Johannes Tessel walked in circles around his laboratory anxiously awaiting their arrival and hoping that meanwhile the gold bricks would not mysteriously transmutate back into lead. Finally, the door swung open and the Chancellor with his assistants entered.

"Alright, Tessel," he said with instant hostility, "this better be good! You pulled me out of an important meeting with the alumni organization!"

"Dr. Bellamy, gentlemen," Tessel spoke with unusual flair and self-confidence, "Please, be so good to look at the lead bricks underneath that fume hood."

He pointed at the yellow bricks.

"Please, note," he could now no longer contain his excitement, "THAT I HAVE TRANSMUTATED THEM INTO GOLD! YES, CHANCELLOR! GENTLEMEN! GOLD! I AM RICH! YOU ARE RICH! THE UNIVERSITY IS RICH! NO MORE POVERTY IN THE WORLD! WE'LL ALL BE RICH! 'CAUSE I CAN MAKE AS MUCH GOLD AS YOU LIKE!!!"

Dr. Bellamy and his companions approached the fume hood and with astonishment observed the shiny glowing bricks. Carefully they touched them, then Bellamy pulled up a chair, sat down and stared intently at the wall of golden bricks in front of him while Johannes Tessel his arms crossed in front of his chest stood smiling under the picture of Paracelsus. He expected them to be baffled and to be speechless for a while.

But that "while" lasted longer than he expected.

For a long time Bellamy just sat there thoughtfully nodding his head while gazing at the gold. Tessel was waiting anxiously for an enthusiastic outburst of congratulatory approval. Instead the Chancellor just sat and stared at the bricks. Finally, he said in a somber voice:

"This is VERY serious."

"Very serious," Jones echoed.

"Yep," Haines agreed.

"Do you have ANY idea what you have done?" Bellamy asked Tessel with an accusatory voice.

Tessel not prepared for anything but a joyful reception of his discovery did not know how to respond. Sensing that something was not going right, his confident posture slowly collapsed, his shoulders sagged and he hung his head like a school boy expecting a reprimand from the master.

"This is a serious situation, Tessel!" Bellamy repeated.

"Very serious," Jones said.

"Yep, very serious," Haines joined in.

"Have you ever thought of how this might affect the economy, Tessel?" Bellamy inquired, "If you start throwing gold around, the value of gold worldwide is going to plummet! We'll be in a crisis of unimaginable proportions! And it will all be blamed on OUR university!"

"It's VERY serious," Jones mused.

"Yep," Haines agreed.

Bellamy put his hands in his hair, shook his head, looked at Tessel and said to him:

"Tessel, I cannot believe how you can possibly have been so THOUGHTLESS! You're a chemist! You're not supposed to be out to destroy the infrastructure of our economy and disgrace the university in the process! We kept you on, Tessel, so you wouldn't have to retire early. So you could continue to puddle along in your lab! But that wasn't good enough for you, was it! We paid you a decent salary, but you became greedy! Yes! Tessel had to make gold! GOLD, GOLD!! Never mind the financial chaos that is going to cause! YOU ARE AN IMMORAL, INDECENT PARASITE, TESSEL, YOU'RE A DISGRACE! Jones, make sure these bricks get confiscated and stored away. AND YOU, TESSEL, YOU'RE FIRED!"

And with these harsh words, Bellamy briskly walked out of the room followed by his assistants.

Tessel heard their voices down the corridor:

"It's very serious," Jones said.

"Yep," Haines replied.

That balmy summer night a peculiar lonely figure roamed outside the opera house. He was wearing a long black cloak and a hood covered his head. He walked with a slight limp and pushed a heavy wheelbarrow. As he came to the creek, he had to strain to push the wheelbarrow up the little stone bridge. He paused a moment, threw back his hood and wiped the sweat of his brow. He looked over the bridge down at the water in the creek. Then he heaved a heavy object out of the wheelbarrow and tossed it in the water. It went "ploink" and sank immediately. He lifted another brick, and another, and another, and threw them all over the bridge. There was a golden reflection in the water sparkling in the light of the full moon. Johannes Tessel threw all his gold bricks, one after the other in the creek. After he tossed the last brick from the bridge, he sighed and leaned across the rail, letting his tears drown in the golden reflection of the water. The music of Wagner's Rheingold drifted in from the distance. He knew the aria well. It was Alberich bemoaning the loss of his treasure.



## Grants

**Lisa McGraw** is co-PI on a 5-year NSF RCN grant to support interactions among investigators in the genomics of social behavior through an annual meeting, technical workshops, and laboratory exchanges.

## Seminars

On **November 7**, 3:30 pm, Dr. Lee Dugatkin from the Department of Biology at the University of Louisville, will present a seminar titled “The interaction of genetic and cultural transmission in shaping mate choice in animals and humans.” The seminar will be in 101 David Clark Laboratories.

On **November 7**, 7:00 pm, Dr. Dugatkin will deliver a public lecture at the North Carolina Museum of Natural Sciences titled “Mr. Jefferson and the Giant Moose: When Natural History and History Collide.”

On **December 5**, 3:30 pm, Dr. Martin L. Chalfie from the Department of Biological Sciences at Columbia University will present a seminar titled “Transduction and modulation of touch sensitivity in *C. elegans*.” The seminar will be in 101 David Clark Laboratories.

## Publications

The following publications from the W. M. Keck Center for Behavioral Biology have appeared in print:

Anholt, R. R. H. and Carbone, M. A. (2013) A molecular mechanism for glaucoma: Endoplasmic reticulum stress and the unfolded protein response. *Trends Mol. Med.* **19**: 586-593.

Hunt, J. H. and Richard, F.-J. (2013) Intracolony vibroacoustic communication in social insects. *Insectes Sociaux* **60**: 403-413.

Schmidt, A. C., Wang, X., Zhu, Y. and Sombers, L.A. (2013) Carbon nanotube yarn electrodes for enhanced detection of neurotransmitter dynamics in live brain tissue. *ACS Nano*. **7**: 7864-7873.

Husseneder, C., Garner, S. P., Huang, Q., Booth, W. and E. L. Vargo, E. L. (2013) Characterization of microsatellites for population genetic analyses of the fungus-growing termite *Odontotermes formosanus* (Isoptera: Termitidae). *Environ. Entomol.* **42**: 1092-1099.

Kobayashi, K., Hasegawa, E., Yamamoto, Y., Kawatsu, K., Vargo, E. L., Yoshimura, J. and Matsuura, K. (2013) Sex ratio biases in termites provide evidence for kin selection. *Nature Comm.* **4**: 2048.

Jacobson, A. L., Booth, W., Vargo, E. L. and Kennedy, G. G. (2013) *Thrips tabaci* population genetic structure and polyploidy in relation to competency as a vector of Tomato spotted wilt virus. *PLoS One* **8**: e54484.

Perdereau, E., Bagnères, A.-G., Bankhead-Dronnet, S., Dupont, S., Zimmermann, M., Vargo, E. L. and Dedeine, F. (2013) Global genetic analysis reveals the putative native source of the invasive termite, *Reticulitermes flavipes*, in France. *Mol. Ecol.* **22**: 1105-1119.

Vargo, E. L., Leniaud, L., Swoboda, L. E., Diamond, S. E., Weiser, M. D., Miller, D. M. and Bagnères, A. - G. (2013) Clinal variation in colony breeding structure and level of inbreeding in the subterranean termites *Reticulitermes flavipes* and *R. grassei*. *Mol. Ecol.* **22**: 1447-1462.

Meitzen, J., Luoma, J. I., Boulware, M. I., Hedges, V. L., Peterson, B. M., Tuomela, K., Britson, K. A., and Mermelstein, P. G. (2013) Palmitoylation of estrogen receptors is essential for neuronal membrane signaling. *Endocrinol.* **154**: 4293-4304.

Riesch, R., Martin, R. A. and Langerhans, R. B. (2013) Predation's role in life-history evolution of a livebearing fish and a test of the Trexler-DeAngelis model of maternal provisioning. *The American Naturalist* **181**: 78-93.

Langerhans, R. B. and Riesch, R. (2013) Speciation by selection: a framework for understanding ecology's role in speciation. *Curr. Zool.* **59**: 31-52.

Plath, M., Pfenninger, M., Lerp, H., Riesch, R., Eschenbrenner, C., Slattery, P. A., Bierbach, D., Herrmann, N., Schulte, M., Arias-Rodriguez, L., Rimmer-Indy, J., Passow, C. and Tobler, M. (2013) Genetic differentiation and selection against migrants in evolutionary replicated extreme environments. *Evolution* **67**: 2647-2661.

## Of note...

**Robert Anholt** presented a webinar on oral scientific presentation at the 2013 Knovel Virtual Conference for engineers.

**David Dorris** participated in the "Optical Microscopy and Imaging in the Biomedical Sciences" course at the Marine Biological Laboratory in Woods Hole, MA.

**Fred Gould** gave a seminar on genetic pest management at The Ohio State University. He also led a discussion on genetically engineered foods at the Irregardless Restaurant in Raleigh, NC.

**Jim Hunt** led a workshop on large-scale demographic, network and behavioral trait analyses of sociality at the National Evolutionary Synthesis Center, Durham, NC.

**Lisa McGraw** gave a seminar in the Department of Biology at the University of North Carolina Greensboro. As a result of a 2009 Workshop at the Georgia Institute of Technology entitled "Microbes to Metazoans: Regulation, Dynamics, and Evolution of Social Behavior", Lisa McGraw is a co-PI on a recently funded initiative to coordinate a National Academies Keck Futures Initiative (NAKFI) meeting on "Social Behaviors" to be held in November 2014. Undergraduate students **Gabrielle Schroeder** and **Nicole Webbie** from the McGraw lab presented their research at the annual South Eastern Population Ecology and Evolutionary Genetics (SEPEEG) meeting at Mountain Lake Biological Station in Charlottesville, VA.

**John Meitzen** gave a seminar to the Behavioral Neuroscience course at Elon University, Elon, NC.

**Heather Patisaul** is serving on the National Academy of Sciences panel to review the EPA's state of the science paper on non-monotonic dose response in toxicity testing. She also presented a Science Cafe entitled "What's in My Water" for the North Carolina Museum of Natural Sciences.



To contribute to The Signal, to be placed on our mailing list or for information about the W. M. Keck Center for Behavioral Biology, contact Dr. Robert Anholt, Department of Biology, Box 7617, North Carolina State University, Raleigh, NC 27695-7617, tel. (919) 515-1173, anholt@ncsu.edu.

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