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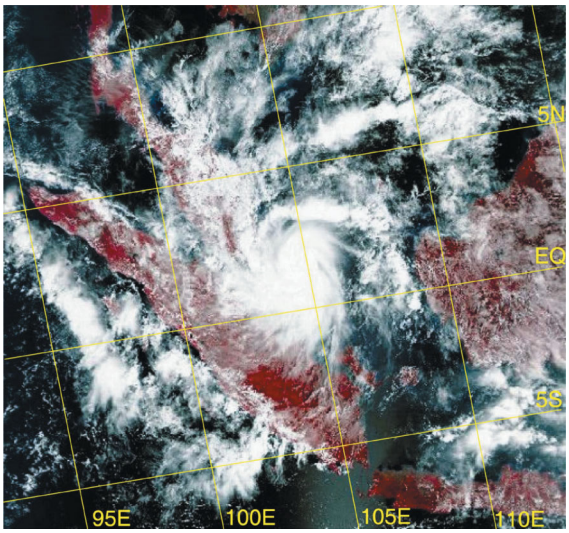
U.S. and Taiwan Researchers Unravel the Riddle of Equatorial Typhoons

The U.S. National Science Foundation (NSF) reported on the findings of a U.S.-Taiwan research team concerning the rare phenomenon of equatorial typhoons in its News Highlights of May 2003. In their research project on "Typhoon Vamei," the team's analysis of typhoon formation is likely to spur the rewriting of today's meteorology textbooks. The team includes Prof. C.P. Chang of the Naval Postgraduate School in Monterey, California, and the NSC-supported researchers Prof. Liu Ching-hwang of the Chinese Culture University Department of Atmospheric Sciences and Prof. Kuo Hung-chi of the National Taiwan University Department of Atmospheric Sciences.



Meteorology textbooks generally state that typhoons never form within 300 kilometers of the equator, because the Coriolis effect is weak even absent in this zone. Since typhoons usually get their spin from the Coriolis effect, which is generated by the Earth's rotation, no typhoons can form near the equator. As a consequence, throughout history sailors have felt secure from typhoons and hurricanes when in the vicinity of the equator. This longstanding belief was shaken when Typhoon Vamei formed near Singapore — within 1.5 degrees of the equator — in late December 2001. Typhoon Vamei's storm winds straddled the equator and damaged two ships in an US carrier fleet that happened to be in the area.

The U.S.-Taiwan research team relied on detailed satellite images and other meteorological data, along with an analysis of the physical mechanisms involved, to study the equatorial birth of Typhoon Vamei. Their conclusion was that the typhoon had been created through the interaction between commonly seen tropical thunderstorms and a winter monsoon cold surge from the South China Sea. As a persistent thunderstorm system remained near the southern end of the South China Sea in the narrow stretch of ocean between the Malay Peninsula and Borneo, a strong and sustained monsoon cold surge blew into the same area from the waters near Taiwan and southern China. The strong northeast wind accompanying the cold surge crossed the equator and interacted with the thunderstorm system, provided the spin that transformed the originally weak tropical disturbance into Typhoon Vamei.

The *Geophysical Research Letter*'s paper that published this research was highlighted by the American Geophysical Union and widely reported internationally. Science magazine published an interview with the authors on its news website, Science now. NASA's Jet Propulsion Laboratory included the findings in its Earth Science News Spotlight, and many major news media in U.S. and Asia reported the story.

Science magazine's interview article quoted the researchers as saying that while the tropical disturbances and cold surges in the South China Sea that caused Typhoon Vamei are common winter phenomena, the specific conditions that formed the typhoon may recur only once in a century. Moreover, the very strong cold surge was able to cross the equator only because of the unique geography of East Asia and the South China Sea; similar conditions are unlikely to occur in other equatorial regions.

Taiwan's meteorologists are focusing particular attention on typhoon research, and the NSC is providing priority support to this field. Scientists affiliated with National Taiwan University, National Central University, Chinese Culture University, and the Central Weather Bureau of MOTC are currently taking part in typhoon research work, which includes basic theoretical studies, aircraft observations, and numerical modeling and forecasting. Besides researching problems of direct concern to the nation, Taiwan's scientists are also participating in cooperative international projects exploring the basic science of typhoons. The Typhoon Vamei study is an excellent example of how international research projects can expand the perspectives of local scientists and raise their profile in the academic world.

New Scientific Discovery: Submarine Volcanoes Found Near Turtle Island

A group of deep-sea submarine volcanoes has been found in waters near Turtle Island, off Taiwan's Northeast Cape. Prof. Lee, Chao-shing of the National Taiwan Ocean University, Institute of Applied Geophysics has been researching these volcanoes since 1999 with assistance from the NSC. Work done over the last four years has verified that there are as many as 60 to 70 submarine volcanoes, of which 11 are active. Fortunately, the chance of a catastrophic eruption is very small.

According to Prof. Lee, the volcanoes are distributed in a band stretching 100 km to the east of Turtle Island. The volcano cluster is located roughly at latitude 25° N and from longitude 122° E to 123° E. Approximately 100 km long and 50 km wide, this area constitutes part of the Okinawa Trough. This is the largest and most active group of submarine volcanoes near Taiwan.

Prof. Lee first proved the existence of the deep-sea volcanoes in a 2001 cooperative project with Japan and France. This work confirmed that the volcanoes are frequently active, and are accompanied by many deep-sea vent systems constantly venting heat and gases. The fact that Turtle Island was erupted from volcanic magma some seven thousand years ago shows that plate subduction is spawning volcanoes in the waters east of Taiwan, including the new volcano cluster observed by Prof. Lee.

Current evidence suggests that the eruptive magma near Taiwan are located at deep-sea levels, and while earthquakes are frequent, the chances of catastrophic tsunamis are probably slim, but caution is still required. On the plus side, the geothermal energy and nutrients released by the hydrothermal vents have created a unique undersea ecology. The area is known for its rich fisheries, and the many cetaceans frequenting these waters have encouraged the development of whale-watching tours.

While the submarine volcanoes off Taiwan's Northeast Cape hopefully will not erupt in the near future, volcanic intrusions from this source are affecting the main island of Taiwan. Among the many signs of volcanic activity in northeastern Taiwan include the hot springs of Turtle Island and Ilan, spots of rapid ground subsidence, and the geological problems encountered during work on the Pínlín-Suào Tunnel. The government should heed these warnings from nature, and researchers must continue monitoring and observation.

Use of Dioscorea to Improve Sperm Function in Men

Dioscorea spp. — also known as Chinese Yam — is widely used as a health-enhancing herbal medicine in Eastern countries. A recent NSC-sponsored study in the laboratory of Professor Chang Suejoan, National Cheng Kung University Department of Biology, indicates that consumption of *Dioscorea alata* for eight weeks significantly decreases plasma homocystein level in rats with hyperhomocysteinemia (HHcy).

Prof. Chang's study suggests that HHcy is a cause of oxidative stress and results in oxidative damage to cells. Oxidative stress has been implicated in decreased sperm function, such as impaired sperm motility, sperm chromatin damage, decreased spermoocyte penetration due to reduced ATP production, and deteriorated signal transduction during spermoocyte penetration.

According to Prof. Chang, cellular studies indicate that the adverse effects of the H_2O_2-induced oxidative stress include cellular dysfunction and even apoptosis. This oxidative stress exerts its damaging effects via mitochondrial membrane potential (MMP) abnormalities and subsequent increased intracellular calcium influx. The antioxidant effect of *Dioscorea* explored by Prof. Chang's laboratory may protect sperm against oxidative damage caused by lipid and DNA peroxidation, which are the major causes of sperm dysfunction.

Sperm dysfunction plays an important role in male infertility. Prof. Chang has therefore proposed a three-year project to develop the *Dioscorea* as a functional agricultural product capable of enhancing sperm function. This project will be sponsored under the NSC's National Science and Technology Program for Agricultural Biotechnology.

Due to its great potential academic and economic value, Prof. Chang's project has already received the NSC's support. The project's first-year goal is to screen different strains of *Dioscorea* exhibiting optimal effects on human sperm *in vitro*. The goal for the second year is to conduct an *in vivo* animal study testing sperm function in animals fed the optimal *Dioscorea* strain resulting from screening during the first year. The goal for the third year is to conduct an *in vivo* human study determining the best dosage of *Dioscorea* for enhancing sperm function. Functional indicators of sperm will include (1) sperm mortality and velocity, and related factors such as

intracellular levels of ROS ATP and MMP, and (2) sperm-oocyte penetration and related factors such as intracellular calcium and sperm chromatin structure (SCSA).

Prof. Chang hopes that her research results will increase *Dioscorea*'s international profile, make it an internationally competitive economic crop, and fully realize its potential in improving male reproductive ability and curing infertility due to impaired sperm function. Thanks to its antioxidant properties, *Dioscorea* is also beneficial in fighting aging and preventing cardiovascular disease. More research must be conducted on these topics, not only to develop *Dioscorea* into health-promoting food, but to exploit its curative properties as well.

Taiwan's Second Phase of Space Program to Begin in 2004

The National Space Program Office (NSPO) held a satellite plan announcement meeting on July 17. This meeting gave the NSPO a chance to gather the views of industry, government, academia, and the research community on how Phase II of the "Long-term National Space Technology Development Plan" will mesh with the needs of the nation and its industries and institutions.

The first phase of the national space program began with the establishment of the National Space Laboratory Provisional Office as the program's implementing agency in 1992. After several years of hard work by the National Space Laboratory Provisional Office, the country successfully launched its first satellite — the "ROCSAT-I" — on January 27, 1999. Though it has now exceeded its design life, the ROCSAT-I is still operating and performing important missions four and a half years after launch. The follow-up ROCSAT-II and -III programs are proceeding as planned, and are scheduled to be launched in late 2003 and 2005 respectively. The launching of the ROCSAT-III satellite fleet will mark the formal completion of Phase I of the space program.

Phase II of the National Space Technology Development Plan will be carried out over the 15-year period from 2004 to 2018. This phase will promote key programs including a broadband communication satellite program, a remote sensing satellite program, a scientific sub-orbital research program, self-reliant micro-satellite development programs, international cooperation programs on space science, and a technology development program..

Academician Lee Lou-chuang, president of the National Applied Research Laboratories (NARL) and concurrently director of the NSPO, has pointed out that the mission of the second phase of the Space Technology Plan will be to apply and extend space technology. The NSPO will build on the results of Phase I, continue to implement satellite programs, strengthen promotion of academic research and industrial development, and strengthen Taiwan's space technology capabilities. Among the goals of Phase II are the harnessing of the energies of industry, government, academia, and the research community for the sake of raising Taiwan's space technology to international levels; the establishment of a domestic space industry, satellite technology capabilities, and related facilities; the completion of scientific research, satellite application, and commercially developed satellite plans; and the upgrading of the Space Program Office as the nation's self-reliant space technology development and integration center.

Academia Sinica Building Taiwan's Genetic Database

The publication of the human genome draft sequence in February 2001 ushered in the era of genetic technology, and world nations have been pouring large amount of resources in the search for human disease genes, including Taiwan. Under the leadership of Dr. Chen Yuan-tsong (Academia Sinica academician and Director of Institute of Biomedical Sciences, Academia Sinica), and Dr. Chen Ding-shinn (academician and Dean of National Taiwan University College of Medicine), large scale genetic research to decode major diseases endemic to Taiwan is being conducted in conjunction with local medical and academic communities. The ultimate goals are to achieve better diagnosis and improved therapy of various local common diseases, with successful identification of disease genes.

As Dr. Y.T. Chen indicated, to create a control group database representing the majority of the Taiwanese people, the Institute of Biomedical Sciences in Academia Sinica is building an integrated and representational national genetic database under the support of the National Science Council, dubbed the "Super Control Genetic Database." The expectation is that by objectively comparing patients' genotypes with those in the database, variations in the gene susceptibility for diseases can be identified to reveal

the "true causes," the disease genes.

Except in Iceland where the medical information collection is done nationwide under legislation, this is currently the first genetic database in the world being built on a large scale. Since the commencement of this database project in November 2002, more than 2000 blood samples have been collected island-wide, including both sexes and covering all age groups over 20. Dr. Y.T. Chen wishes to complete the collection of all 3312 samples before the end of this year so that the database can be made available to all research institutions, serving as the objective standardized control in the search for important disease genes.

According to Dr. Y.T. Chen, Academia Sinica has already utilized the allele frequency provided by the database to successfully scan the entire genome for a psoriasis family, and has located the familiar psoriasis gene on a specific locus on a chromosome. Now the specific locus is under fine mapping, and the disease-causing gene for psoriasis is expected to be identified very soon.

Why exactly do we need a "Super Control Genetic Database" representing the majority of Taiwanese? Dr. Y. T. Chen explained that in the course of the Human Genome Project, scientists found that among the three billion base pairs of the human genome, there is only a 0.1% gene variation (equivalent to three million base pairs) between individuals. This minor difference in genetic make-up is responsible for the different phenotypes expressed by individuals. This polymorphism of genetic make-ups is also obvious across races. For example, Taiwanese have different responses to drugs and diseases from those of other races. Therefore, if we wish to locate disease-susceptible genes for certain diseases in our population, *e.g.*, diabetes, then a local control genetic database (representing the general non-diabetic population) is needed for comparison and contrast purposes.

In the future, this "Super Control Genetic Database" will be made available to medical researchers as a control to avoid redundant collection of control samples and waste of medical resources. As all the samples collected are more or less different in their genetic make-ups, everyone involved in this database has unique contributions to the substantiality of the database. By integrating the medical information provided by participants of the project, this database will assist in the development of the nation's genomic medicine research community to solve medical problems for the nation and humankind.

Taiwan Scores High in 2003 International Physics Olympiad

The International Physics Olympiad — one of the most important events in the world of science education — was recently held in Taiwan for the first time. The 2003 Thirty-Fourth International Physics Olympiad convened in Taipei over August 2-11. The Olympiad was co-hosted by the Ministry of Education and the NSC, and organized by the National Taiwan Normal University (NTNU); Professor Lin Ming-juey of the NTNU served as the Olympiad's executive secretary. This year, Taiwan gave its strongest performance ever by earning three gold medals, one silver, and one bronze.

According to Prof. Lin, a total of 238 high school students from 54 countries participated in the Olympiad. The group of students representing Taiwan features four gold medalists and one silver medalist from the Fourth Asian Physics Olympiad held in Thailand late-April this year, an impressive display of strength by the home team.

This event is the third international science Olympiad hosted by Taiwan following the 1998 Thirty-Ninth International Mathematics Olympiad, and the 2001 Second Asian Physics Olympiad; next year's physics Olympiad will meet in South Korea. According to Minister of Education Dr. Huang Joan-tsun, Taiwan has been designated to host the 2005 International Chemistry Olympiad. Through these opportunities, Taiwan hopes to improve international academic interchange, and bring better recognition and understanding of Taiwan to bright students around the world.

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