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The midnight sky in Kam Tin, West New Territories 新界西錦田的午夜天空

Photo by Vor YIU

實驗報告 EXPERIMENT REPORT

How much has Hong Kong natural environment been lit up at night?

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Human beings have always been active in the day. But due to increasingly extensive use of electrical lighting in the last century, people are generally spending more time awake at night. However, our studies on living organisms and ecology at night has not increased correspondingly. Only a few taxa, including mammals, reptiles, amphibians, moths, longhorn beetles and fireflies have attracted attention thus far. Recently, the concept of light pollution was introduced and discussed in Hong Kong, but the focus has always been mainly on the influence of excess artificial light on our health and its impact on astronomical observation (Pun and So, 2012). Last year, concerns about the impact of a large scale property development project in Fung Lok Wai on an endemic firefly species, *Pteroptyx maipo* (Fig. 1), were extensively reported. This incident has attracted increased public interest. A study by Yiu (2012) suggested that 0.2 lux is the maximum light intensity under which *P. maipo* would display their flash signals for sexual communication in Fung Lok Wai, and increasing the light intensity to 0.3 lux to 2.0 lux by application of fluorescent lamps greatly reduced the flashing frequency of the fireflies.

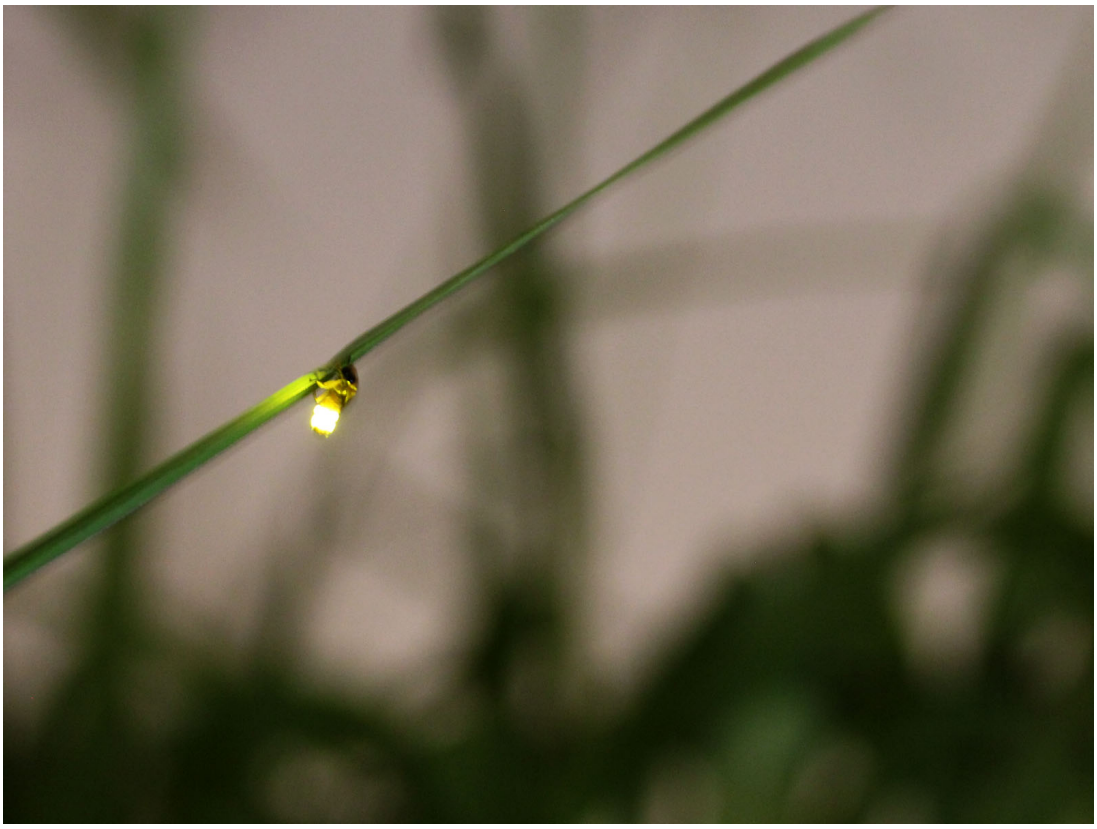

Fig. 1 Male *Pteroptyx maipo* displaying light under the lit up sky

"Ecological Consequences of Artificial Night Lighting" (2006), edited by C. Rich and T. Longcore, is a very good collection of 15 articles written by 24 authors on studies of effects of artificial night lighting on nocturnal species. The studies cover mammals, birds, reptiles, amphibians, fishes, insects in general, moths, fireflies and plants. In the last chapter, the editors summarize the findings of the collected articles in combination with some other previous findings. A brief extract follows:

1. Alterations in natural patterns of light and dark can disrupt physiological processes including entering reproductive condition, preparing to migrate or hibernate, egg laying and molt. It was suggested that changes are possibly related to the disruption of the production of hormones such as melatonin and prolactin.

2. Increased illumination may extend diurnal behaviour (such as foraging) into the night.

3. Constant artificial lighting may disorient organisms accustomed to navigation in a dark environment. Examples are hatchling sea turtles, birds, moths and many other insects and spiders.

4. Artificial night lighting may alter the reproductive behaviour of frogs. It may also disrupt the mating timing of those animals with reproductive behaviour synchronized to lunar cycles. Examples are ants, marine polychaetes, mayflies and fishes.

5. The visual communication system of fireflies could be impaired by stray light. Coyotes group howl and group-yip howl during the new moon when it is darkest could also be disrupted.

6. The balance between competing species which forage at different light levels at night could be disrupted by artificial night lighting. The balance between predator-prey relationship may also be disrupted as a result.

The overseas findings may well apply in Hong Kong considering the fact that very high local biodiversity and extremely dense human population are put together in such a small area of land. Bats and lizards foraging for insect prey around street lamps. moths and other insects attracted by lighting in public toilets and trapped inside as a result and newly emerged termites attracted to households are familiar sights to many people. Although the brightness of the environment changes everyday, even diurnal animals such as human beings, can easily adapt to it. Besides being able to see clearly under the strongest sunlight, we can see and walk safely on the road surface at 0.01 lux (personal experience). How many diurnal animals can become adapted to the nocturnal world? Such questions have never been answered. Before discussing how our local wildlife is affected by artificial lighting, we need to ask how much has our natural environment been lit up at night?

Illuminance is often measured in lux, which expresses the intensity of light incident on a surface weighted for the spectral sensitivity of human eye. The disadvantage is that it places less emphasis on wavelengths not visible by human eye but visible by other wild animals. Nevertheless, lux is still most widely used as measurement unit for lighting devices and in our city planning. From 2011-2012, the author used the "Mini-Lux" lux meter manufactured by MX-Elektronik to measure the illumination in various localities in Hong Kong (Fig.4) during his firefly survey, by holding the light sensor of the device facing in the sky vertically. All measurements were done in an open area at the time at least 45 minutes after sunset. For comparison, measurements were taken in Madagascar in October, 2012. Results are shown in Fig. 3. Measurements taken in the daytime under different weather conditions as well as measurements taken in the city at night are also included for reference (Fig. 2).

Location/condition	Illuminance (lux)
Full sunlight at noon	90,000 - 100,000
Partly sunny	40,000
Cloudy day	10,000
Overcast day	2,000 - 4,000
Under tree canopy in daytime	~1,000
Nathan Road at night	40 - 80
Tai Po Road at night	10 - 60
Public Pier at night (far from direct light source)	1.2 - 1.8

Fig. 2 Illuminance under different weather conditions in the daytime and in the city at night

Location	Moon status	Sky status	Illuminance (lux)
Mai Po	No moon	Cloudy	0.282
Mai Po	No moon	Clear	0.110
Tin Shui Wai (Rural part)	No moon	Cloudy	0.304
Tin Shui Wai (Rural part)	No moon	Clear	0.102
Lung Kwu Tan	No moon	Thin cloud	0.135
Hok Tau Reservoir	No moon	Thin cloud	0.011
Plover Cove Reservoir	No moon	Cloudy	0.057
Plover Cove Reservoir	No moon	Clear	0.022
Tai Mong Tsai	No moon	Cloudy	0.052
Wong Cheuk Yeung, Sai Kung	No moon	Foggy	0.038
Pak Heung, Yuen Long	Full moon	Clear	0.235
Tai Lam Interchange	No moon	Thin cloud	0.098
Pak Heung, Yuen Long	No moon	Clear	0.035
Ng Tung Chai	Quarter moon	Cloudy	0.128
Tai Po Kau	Quarter moon	Cloudy	0.086
Tai Po Kau	Full moon	Clear	0.148
Tai Mo Shan (North East slope)	No moon	Thin cloud	0.107
Tai Mo Shan (South West slope)	No moon	Thin cloud	0.205
Tsuen Kam Au	No moon	Foggy	0.034
Tsuen Kam Au	No moon	Clear	0.010
Tsuen Kam Au	Crescent moon	Thin cloud	0.057
Tso Kung Tam, Tsuen Wan	Full moon	Clear	0.264
Shing Mun Reservoir	No moon	Clear	0.016
Sha Lo Tung	Crescent moon	Cloudy	0.142
Victoria Peak	No moon	Clear	0.033
Deep Water Bay, Hong Kong Island	No moon	Clear	0.039
Tai Tung Shan, Lantau	No moon	Cloudy	0.015
Mananara, Madagascar	No moon	Clear	0.003
Mananara, Madagascar	No moon	Cloudy	0.002
Ranomafana (Hill top), Madagascar	No moon	Clear	0.006
Ranomafana (Near villages), Madagascar	No moon	Clear	0.009

Fig. 3 Illuminance measured at night in various localities of Hong Kong and Madagascar

The strongest natural source of light at night is the moon. During the full moon, when the sky is clear, the illuminance is between 0.148 lux (Tai Po Kau) to 0.264 lux (Tso Kung Tam). The brightness under the full moon is influenced by a number of factors: i. the distance between the moon and the earth, ii. the incident angle of moonlight, iii. clearness of the sky (tiny particles in the sky block the moonlight but reflect light emitted from the ground back to the ground). However, illuminance of artificial night lighting is much stronger than moonlight. Apart from the indoor environment which has an illuminance 380 to 2700 times of that of the full moon, illuminance on roads installed with sparse street lamps is also 38 to 540 times of that of the full moon.

The artificial night lighting not only increases illuminance in the areas directly lit. It may also increase the illuminance in other places through reflection by the particles suspended in the sky. The particles could be any solids and liquid droplets, particularly ice and water droplets in the form of clouds, rain, snow and fog. Smoke, haze, dust, ash and sand are also common light reflectors in the sky. Even if the sky looks clear, these tiny reflectors exist and reflect light comes from human settlement and affect the final illuminance incident on the ground. Therefore, under the same conditions of no moonlight and clear sky, places far away from human settlement - Tsuen Kam Au (0.010 Lux) and Shing Mun Reservoir (0.016 Lux), receive much lower illuminance than places close to human settlement - Mai Po (0.110) and Tin Shui Wai (0.102 Lux). The difference could be as high as 11 times. It should be noted that in Victoria Peak, the measurement is comparatively quite low (0.033 Lux) even though Hong Kong Island is a well developed area. This is also true in Madagascar, an underdeveloped island country close to the African continent. Under the same clear sky, Ranomafana, a famous and more developed tourist site is 3 times brighter than Mananara which is a less developed tourist site.

Under a clear sky and no moonlight, the brightest rural place in Hong Kong (Mai Po, 0.110 Lux) is almost as bright as under full moonlight in a place further from settlement (Tai Po Kau, 0.148 Lux) and is 55 times brighter than Mananara, Madagascar. Even our darkest place (Tsuen Kam Au, 0.010 Lux) is still 5 times brighter than Mananara, Madagascar. Perhaps there is no place in Hong Kong not affected by artificial night lighting.

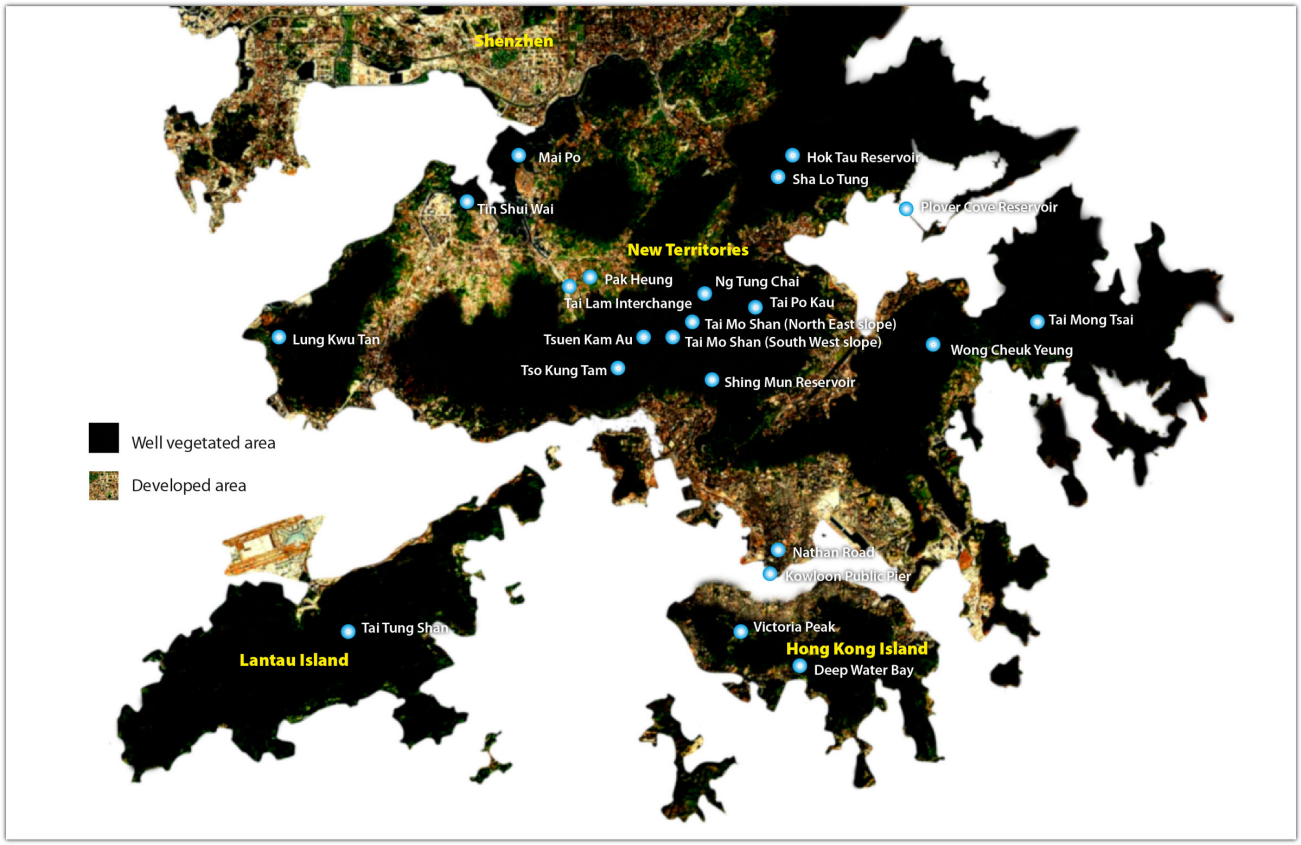

Fig. 4 Map of Hong Kong showing well vegetated areas and developed areas, and localities of illuminance measurement done in 2011-2012.

In Mananara, Madagascar, the clouds reduced the illuminance by blocking the only light source from the stars, therefore illuminance decreased from 0.003 under a clear sky to 0.002 under a cloudy sky. However, in Hong Kong, the presence of clouds or fog could greatly increase the illuminance in the same place by reflecting light from the dense settlement. As a result, clouds in Hong Kong's sky are clearly visible at night and the presence of clouds in Madagascar's sky can only be observed by disappearance of some stars (Fig. 5). When there is no moon light, the illuminance under cloudy or foggy conditions in the same place would be 2.6 times (Mai Po) to 3.4 times (Tsuen Kam Au) brighter than that under a clear sky. Comparing the illuminance under cloudy and moonless conditions in different places, the difference are great. In Tin Shui Wai (0.304 Lux), the illuminance is 20 times of that in Tai Tung Shan (0.015 Lux), and 6 times of that in Tai Mong Tsai (0.052 Lux). The great differences can be explained by the proximity to artificial night lighting.

Fig. 5 Above: Clouds are clearly visible in Hong Kong's Sky. Below: In Madagascar's sky, clouds are not visible and their presence can only be observed by "disappearance of stars".

Generally speaking, rural areas in the rapidly developing North West New Territories are the brightest. This area is also greatly influenced by the light coming from the even more rapidly developing adjacent city of Shenzhen. Rural areas in North East and East New Territories and Lantau Island are the darkest. Rural areas in Central New Territories are in between. It should be noted that the illuminance close to the peak of Tai Mo Shan is unusually high on moonless nights with thin cloud cover and 1.9 to 3.6 times of that in Tsuen Kam Au under a new moon and thin cloud although Tai Mo Shan is further away from the city lights than Tsuen Kam Au. This can possibly be explained by two reasons: 1. The very strong light emitted from the Observatory station at the peak of Tai Mo Shan. 2. As the highest point in Hong Kong, there is nothing to block the light rays emitted from other sources in the city. At lower elevations, some of the light rays are blocked by the opposite slope and spurs close to it (Fig 6). Given Hong Kong's usual climate , the sky is usually unclear due ti clouds, fog, rain, dust, etc., rather than clear. The effects of artificial night lighting on the natural environment is therefore amplied most of the time.

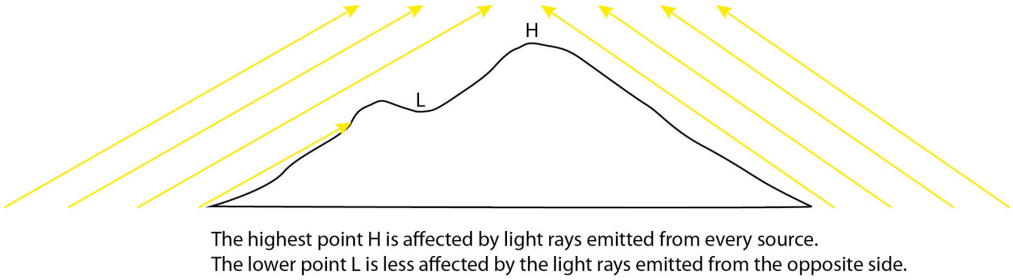

Fig. 6 Diagram showing how a location at a higher elevation is influenced differently to a location at a lower elevation

There is no doubt that our city's environment is lit up at night and much of the artificial night lighting is unnecessary or excessive. It is necessary to find out this excessive lighting can be reduced (Fig. 7). At the same time, studies on how our local nocturnal world is influenced by artificial night lighting should be conducted.

Reference

Pun C. S. J., So C. W., 2012. Night-sky brightness monitoring in Hong Kong *A city-wide light pollution assessment. Environmental Monitoring And Assessment*, v. 184 n. 4, p. 2537-2557.

Rich C.,, Longcore T. (Eds.), 2006, *Ecological Consequences of Artificial Night Lighting*, Island Press, Washington DC, 458 pp..

Yiu V., 2012. Effect of artificial light on firefly flashing activity. *Insect News (Hong Kong Entomological Society Newsletter)* **4**: 5-9.

Fig. 7 Above: Exceptionally bright light in Sha Lo Tung. Below: Sky lit up by Kowloon City.

An upcoming new computer program facilitating quick identification of Hong Kong butterflies

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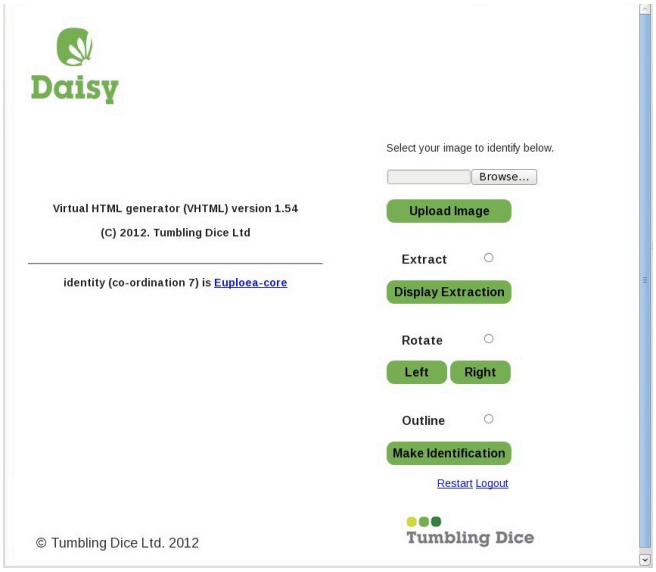
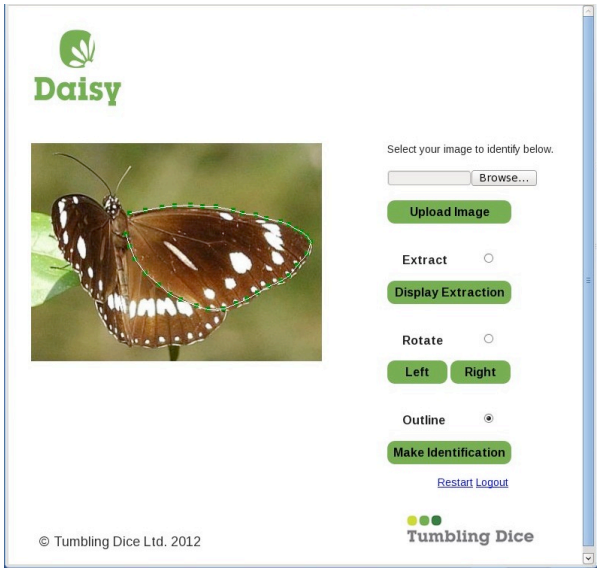
Imagine a computer program which allows one to automatically identify insects from a mere photo, making things easier for the general public and researchers alike. Far from being a remote and distant possibility, such a program might even be made available to citizens of Hong Kong in the near future.

Tumbling Dice, a technology company based in Newcastle-upon-Tyne in the United Kingdom, has developed a program known as DAISY (Digital Automated Identification System). Dr Mark O'Neill, the founder of Tumbling Dice, has been working on DAISY over the past 14 years. DAISY is a generic pattern-recognition system, and although it was developed for the purpose of identifying insects, it has proved able to identify many other things, including human faces, mobile phones, handwriting, graphics and even sounds. The system can learn as it is exposed to more examples, becoming even more accurate over time. It is fully configurable, can be operated even by non-experts and is useful for a very wide range of applications.





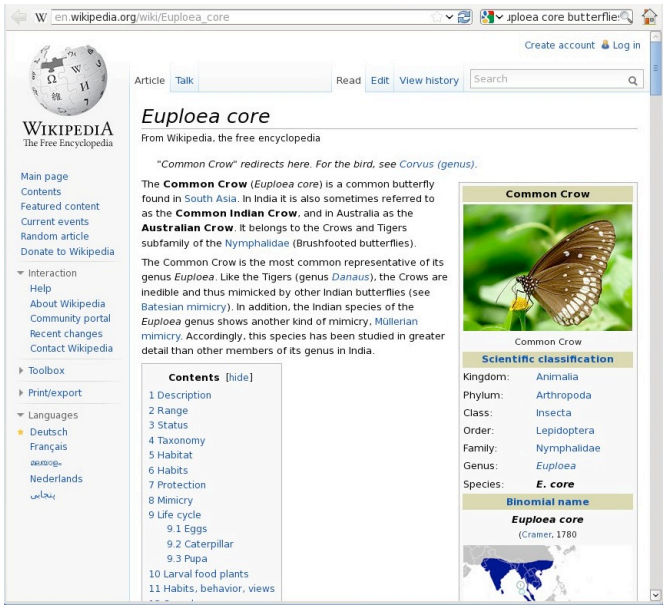


Fig. 1, 2, 3 Photos showing DAISY in action on the web-based interface most people are likely to use on PCs, smart phones and tablets.

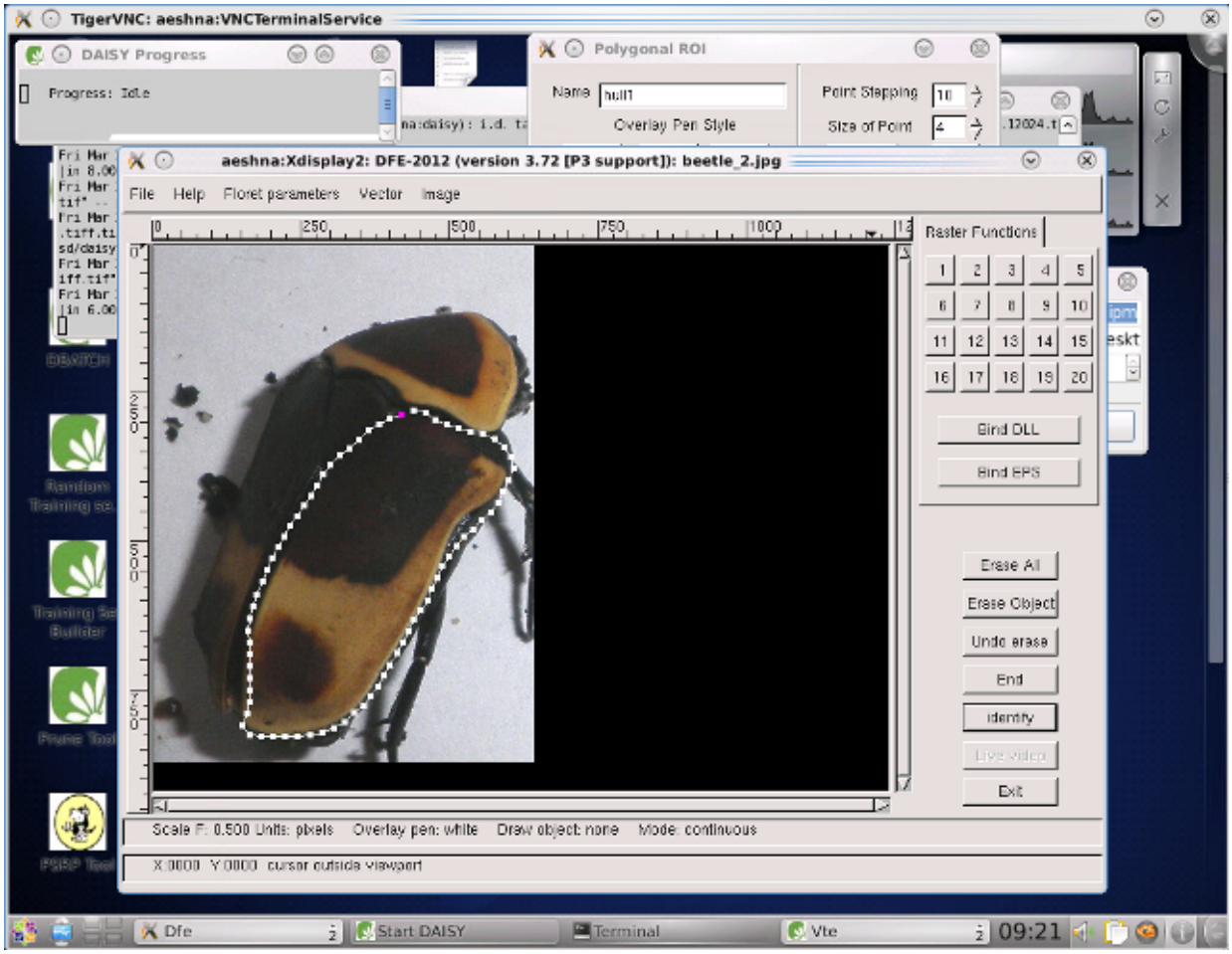


Fig. 4 DAISY on the UNIX interface for use by power users on the server itself or via a VNC connection.

In recent years, Dr O'Neill has been working with the Agriculture, Fisheries and Conservation Department (AFCD), other entomologists and members of the general public on Daisy Butterfly Identification System for the Citizens of Hong Kong, a web-based application based on DAISY which will allow people in Hong Kong to identify the 230 known species of butterflies in Hong Kong through photos on computers, smart phones or tablets. At this moment, the project is still in progress, and Tumbling Dice is still building the "training sets" which will allow the software to recognize and identify Hong Kong butterflies. How soon the program can be completed and released for use depends on how quickly the AFCD and others involved can provide Tumbling Dice with enough photo samples to develop an initial training set. After this is done, the public will be able to begin using it, and since the program can learn, it will improve further over time.

More information on DAISY can be found on the Tumbling Dice website (http://tumblingdice.co.uk/). Information on the Daisy Butterfly Identification System for the citizens of Hong Kong can be found on the following Facebook page: https://www.facebook.com/daisyhk.org

徵稿 CALL FOR ARTICLES

Contributions are invited for the 7th issue of the "INSECT NEWS", due for publication end of July 2013. We are looking for items corresponding to the following non-exclusive topics:

1. Accounts of interesting or unusual insect observations;
2. Entries for the Newsletter cover photograph;
3. Reviews of new books on insects of the bioregion (Hong Kong, Macau, tropical southern China, Indochina);
4. List of recent publications on insects of the bioregion;
5. News of insect research (academic or amateur) being conducted locally
6. Requests for information by individuals interested in particular insect groups.
7. Summaries of recent papers published by Society members in other journals;
8. Reports on various Society activities;
9. List of new Society members;
10. Reports on insect recording schemes;
11. etc.

INSECT NEWS is an online, biannual newsletter (January and July) published by the Hong Kong Entomological Society (HKES). It is open to contributions from members and non-members alike. Articles could be written in English or in Chinese accompanied by English summary. Please send your article and photos to:yiuvor@hkentsoc.org

Editors

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