An unusual observation – attraction of caterpillars to mercury vapour light in the Abu Dhabi desert (Lepidoptera: Pyralidae)

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Fig 1. Pyralid caterpillar attracted to a white sheet placed on the ground below a mercury vapour bulb in sand desert at Al Faya in Abu Dhabi emirate. The caterpillar has been putatively identified as that of the moth *Arsenaria hypercanalis*, the early stage and biology of which have hitherto been unknown to science (DG).

A great number of adult nocturnal moth species belonging to many different families are attracted to artificial light, particularly ultraviolet light. The phenomenon is so well known that light trapping has, for more than a hundred years, been one of the most productive collecting techniques employed by lepidopterists. Even diurnal species of Lepidoptera such as butterflies, if disturbed from their roosts at night, are also drawn to light. Bright lights also attract many other types of adult insects, including, but not restricted to, true flies (Diptera), beetles (Coleoptera), wasps (Hymenoptera), nerve-winged insects such as antlions and lacewings (Neuroptera), earwigs (Dermaptera), bugs (Hemiptera and Homoptera), mantids (Mantodea) and grasshoppers, katydids, crickets and mole crickets (Orthoptera).

Based on many personal observations made with mercury vapour lamps set up in desert areas in the UAE, the species attracted to light are, almost without exception, insects with functional wings. Just very occasionally, non-flying insect species such as the ground beetle *Anthia duodecimguttata* Bonelli, 1813 are attracted towards the light, as too are other types of arthropods such as spiders, camel spiders and scorpions – these terrestrial visitors usually do not remain motionless and wander around the lighted area and often may subsequently move away altogether.

The cause of attraction of insects to light, especially with regard to moths, has long been debated, but has no unique explanation (Frank, 1988). The commonest suggestion involves the concept that moths (and other insects) use a form of celestial navigation called transverse orientation in order to navigate at night, using the moon as a fixed beacon (Sottibandhu and Baker, 1979). In this process, by keeping the moon at a constant angle, moths are able to fly in a straight line, but by supplanting the moon with a close-up bright light source, they are tricked into flying in an ever-tightening spiral around the light.

However, this simply does not fit the observed flight-to-light behaviour of most insects, which generally fly straight towards the light and then either settle directly

Fig 2. Saltbush, *Tetraena qatarense*, at Al Faya showing silken tubes and feeding damage caused by a pyralid caterpillar putatively identified as that of the moth *Arsenaria hypercanalis* (MPTG).

some distance from it or else circle the light a few times at a more or less constant distance before settling. Moreover, it is well known that light traps catch many more insects on moonless nights and fewer at the time of the full moon (Bowden and Church, 1973), apparently contradicting any suggestion that the moon is essential for moth navigation.

However, the orientation/navigation of moths at night may involve not just the moon or other celestial light sources, but many other phenomena such as geomagnetism, gravity or barometric, acoustic, olfactory and terrestrial visual cues (Riley and Reynolds, 1986; Frank, 1988) and the presence of a strong source of artificial light may confuse the insects into ignoring such factors.

Another theory suggests that moths are attracted to the infra-red (IR) component of the artificial radiation because the males of at least some species have IR-sensors on their antennae and react to IR in a similar way as in their response to female pheromones (Callahan, 1977). In support of this, males of some species of insects tend to be attracted to light in greater numbers than females, but on the other hand, ultraviolet (UV) light sources radiate very little IR, but attract larger numbers of insects than hotter light sources (Frank, 1988).

Other suggestions are that it is the UV component of artificial light that attracts the moths because it mimics moonlight reflected from the petals of nocturnally blooming flowers (Stevensen, 2008). However, a majority of insects attracted to artificial light are not known to visit or feed from such flowers.

Equally diverse are the theories as to why insects, having reached the vicinity of the light source, then eventually settle down. These range from simple suggestions that the insects tire themselves out after their fluttering, to the idea that having reached the illuminated area, the insects are tricked into thinking that it is daytime and, therefore, time to settle. It is also been shown by Hsiao (1973) that moths are at first attracted towards the light, but as they approach the source, they actually then try to avoid its effects and end up flying around the lamp at a fixed distance (usually 20-30 cm) within a perceived dark area known as the Mach band. Eventually, the insects either manage to escape from the lighted area or else settle down. This fits the behaviour of some insects, especially some moths, but not of others. Indeed given the huge number of different insects of many different orders that are attracted to artificial light, it is apparent that more than one mechanism may be involved, but the end result is the same in that the insects are confused or distracted by the light into exerting abnormal behavior.

Hitherto, only the attraction of adult insects to light has been considered, but recently an instance of the attraction of immature insects to artificial light was recorded by the authors. The insects in question were small caterpillars, which appeared in numbers within an area of desert illuminated by a mercury vapour lamp. As far as can be ascertained, no other case of this type has been recorded, prompting a full description of the event here.

Fig 3. Adult pyralid moth, *Arsenaria hypercanalis*, attracted to mercury vapour light in the desert at Al Faya (DG).

The observation in question took place at night on 24 March 2009 in a sand dune area on the site of the proposed Al Faya Industrial City about 50 km east of Abu Dhabi Island, Abu Dhabi emirate (GPS co-ordinates: 24.37339 N 54.96026 E). Plant diversity in this area was very poor with an abundance of the saltbush *Tetraena qatarense* (Zygophyllaceae) and just occasional plants of *Cyperus conglomeratus* (Cyperaceae) and *Dipterygium glaucum* (Capparaceae). At this site, a 250 W mercury vapour lamp was run continuously from 19:00 until 01:00 the following morning. The lamp was positioned about 75 cm above two white king-sized bed sheets spread on the ground and these sheets were monitored at intervals for insects. Probably because of the poor makeup of the local vegetation, the diversity of insects that were collected from the sheet was low – not many more than 20 different species, including moths, grasshoppers, antlions, bugs and beetles. However, at about 20:00, several small green caterpillars were noticed on the sheets (***Fig. 1***) apparently circling the light source. Over the course of the light's operation, the number of caterpillars increased and as many as 13 individuals were counted on the sheets at about 22:00, with others present on the nearby sandy ground. The size of the caterpillars was within a range of about 5-10 mm and in appearance, they resembled micromoth larvae such as those of the Indian Grain and Greater Wax Moths – *Plodia interpunctella* (Hubbner, 1813) and *Galleria mellonella* (Linnaeus, 1758) respectively. A couple of caterpillars were collected and were subsequently shown to belong to the micromoth superfamily Pyraloidea using the key given by Solis (2006).

The source of the caterpillars was nearby saltbushes, *Tetraena qatarense*, the only vegetation present in the immediate vicinity of the mercury vapour lamp and, indeed over most of the Al Faya site. Almost every single one of these plants showed damage due to larval feeding and around the damaged areas, a web of silken tubes leading down from the branches to the soil ***(Fig. 2***). Inspection of damaged areas at night revealed many small green larvae like those attracted to the light. Protective strategies of this type are used by the caterpillars of several families of moths, including Pyralidae. The larvae remain hidden in the soil during the day and, at night, climb up the silken tubes to renew their feeding. The identity of the larvae is not conclusively known, but it is most likely to be the species *Arsenaria hypercanalis* (Amsel, 1951), three or four adult moths of which were attracted to the lamp at the same time as the caterpillars. Only single examples of other micromoths were recorded, for example *Agdistis* spp. (Pterophoridae), *Ethmia alba* (Amsel, 1949) and *E. quadrinotella quinquenotella* (Chrétien, 1915) (Ethmiidae) and *Ceutholopha isidis* Zeller, 1867 (Pyralidae). The early stages and biology of *A.*

hypercanalis are quite unknown, but a related species *A. caidalis* (Hampson, 1900) is also found in the UAE as well as N. Africa. In Tunisia, its larvae are known to fashion silken tubes on a different saltbush, *Halocnemum strobilaceum* (Chenopodiaceae), which are similar to those observed on *Tetraena*.

Although the larvae that are here recorded as being attracted to mercury vapour light can only putatively be identified as *A. hypercanalis*, there is no doubt that they originated from the infested *Tetraena* bushes on which they normally inhabit the silken tubes leading from the soil. The most likely explanation for a proportion of these larvae being attracted to the light may be disorientation brought about by the sudden illumination of the bright lamp at dusk at a time when the larvae would normally be preparing to leave the soil and ascend the silken tubes in order to resume feeding on the branches. Their behaviour in response to light is strikingly similar to that of adult moths that are attracted towards light, only then to be repelled and induced into circling the light source within the Mach band.

Could the attraction of caterpillars to light be brought about by the same or by a similar mechanism to that of adult moths and if so, does it have any bearing on adult behaviour with regard to their response to light? Clearly, as juvenile insects and without conspicuous antennae, the caterpillars in question could not be reacting to light in an analogous way to that of sexually mature moths attracted to pheromones. Moreover, caterpillars of various sizes were attracted to the light, suggesting that they were not involved in any dispersal prior to pupation and, furthermore, the probably related species *A. caidalis* does not disperse, but pupates directly within the silken tubes (Asselbergs, 2007).

Therefore, it seems unnecessary to suggest any need for the caterpillars to use a celestial point source of light for navigation; after all, in order to go about their nocturnal business, all that these particular caterpillars need to do is to follow the silken tube upwards from the soil to the feeding site amongst the branches.

However, it is not inconceivable that such behaviour might be aided either by gravitational cues or by diffuse celestial light in a fashion analogous to plant phototropism. Indeed positive heliotropism in caterpillars has been known since the pioneering work of Jaques Loeb (1918). Amongst the diverse theories proposed to account for the apparent attraction of insects to artificial light that of confusion induced by the artificial light would seem to be the one that best fits the circumstances for the caterpillars highlighted in this report. The sudden appearance at close proximity of a powerful light source may confuse the caterpillars making them unable to react to cues such as celestial light or gravity that would normally guide them to their feeding station.

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