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# University of South Florida St. Petersburg Student Research Journal, Vol. 1, Issue 1, article 5 : Geometric Probability of Mating Success for the Greater Short-nosed Fruit Bat, Cynopterus sphinx

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# Geometric Probability of Mating Success for the Greater Short-nosed Fruit Bat, *Cynopterus sphinx*

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**ABSTRACT**

In the bat *Cynopterus sphinx,* the random probability of mating success was calculated to be 4%. A combination of several adaptations dramatically increases their mating success to nearly 100%. First, the male and female hang upside down in a front-to-back mount. From behind, the male positions his penis dorsoventral toward the female's genitalia. The male maintains a tight hold on the female by biting the scruff on her neck and by holding her wings with his thumbs, allowing the pair to move forwards and backwards uninterruptedly and rhythmically. The male inserts the glans of his penis while the female bends upward, guiding his shaft to her vaginal opening.

## INTRODUCTION

Bats are the world's only mammals capable of true and sustained flight; consequently, all bats belong to the order Chiroptera, which translates to "*hand-wing*" in Greek (Davis & Schmidly, 1997). There are two suborders within Chiroptera: the Megachiroptera (or Yinpterochiroptera) suborder and the Microchiroptera (or Yangochiroptera) suborder (Teeling, Springer, Madsen, Bates, O'Brien, & Murphy, 2005). The Greater Short-nosed Fruit Bat, also known as the Short-nosed Indian Fruit Bat, is a species of "megabat" in the Pteropodidae family. It belongs to the genus *Cynopterus*, which encompasses seven distinct species of dog-faced (or short-nosed) fruit bats (Kitchener & Maharadatunkamsi, 1991). The species of the Greater Short-nosed Fruit Bat is the *Cynopterus sphinx*.

The *C. sphinx* has fine, silky fur. Coloring varies between individual *C. sphinx* bats, but typically their upper parts are brown to grey-brown with the coloring more muted for the under parts. One defining characteristic of all *C. sphinx* is that their ear and wing bones are edged in white (Figure 1). These bats also have a relatively long snout, an interesting fact considering they are a short-nosed bat species. The average adult has a wingspan of approximately 48 cm and weighs between 63.5-75 g (Bates & Harrison, 1997). There is no consistent sexual dimorphism between males and females; however, there is research to suggest that males are, on average, larger in northern regions while females are, on average, larger in the south (Storz, Balasingh, Bhat, Nathan, Doss, Prakash, & Kunz, 2001). Researchers speculate that the larger male size in the northern regions is a sexually selected trait by the northern region females (Storz, *et al*. 2001).


Figure 1. Defining white-edged ear and wing bones of the *C. sphinx*. http://www.manojcsindagi.in/gallery/main.php?g2_itemId=256

*C. sphinx* is common in Southern and South-Eastern Asia, particularly in Pakistan, Bangladesh, Bhutan, Cambodia, China, India, Indonesia, Laos, Malaysia, Myanmar, Philippines, Sri Lanka, Thailand, and Vietnam (Figure 2). *C. sphinx* bats are voracious frugivores with a preference for ripe guava, banana, dates, and lychee; they forage in mangrove forests, grasslands, tropical forests, and other areas where fruit is plentiful (Advani, 1982). *C. sphinx* bats typically roost in palm trees by constructing simple tents out of the palm fronds. They have also been known to intertwine vines and twigs to form nests; however, this is only done in areas where there are no available palm trees (Balasingh, Suthakar-Isaac, & Subbaraj, 1993).

Figure 2. Map of the *C. sphinx* geographic range.
http://www.iucnredlist.org/apps/redlist/details/6106/0

*C. sphinx* is a sociable species that roosts in same sex groups containing eight to nine individuals. The sexes remain separate until mating season when male and female groups join to form a larger roost by sharing a single palm frond tent (Balasingh, *et al.*, 1993). *C. sphinx* are polygynous with a female-biased sex ratio in breeding roosts (Advani, 1982). Mating occurs twice a year. The gestation period is 45-50 days with the first pregnancy cycle occurring between October and February/March (Sandhu, 1984). The second mating occurs immediately postpartum with second offspring born in

June/July. Males remain with females for some time after breeding; however, they eventually return to their original male-dominated groups.

The *C. sphinx* are perhaps most famous for their remarkable sexual behavior. They are the only non-primate mammal to engage in fellatio (Tan, Jones, Zhu, Ye, Hong, Zhou, Zhang, & Zhang, 2009). A small handful of primates have exhibited genital licking. For example, juvenile bonobos (*Pan paniscus*) have been observed exhibiting this behavior; however, it is usually in the context of play behavior. The *C. sphinx* engages in fellatio as a procreation behavior. Copulation transpires while hanging upside-down. The male approaches the female from behind and positions his penis dorsoventral toward the female's vagina. The male usually maintains a tight hold on the female by biting the scruff on her neck and by holding her wings with his thumbs, allowing the pair to move forwards and backwards rhythmically and without interruption. The male will insert the glans of his penis while the female bends upward and licks the shaft. The penis is not withdrawn while the female performs fellatio. It is not currently known why the *C. sphinx* engages in fellatio; however, recent observations have found that males spend significantly more time in copulation with the females who do perform fellatio than with the females who do not. Furthermore, it has been observed that females who tried to escape the male's advances were less likely to engage in fellatio.

In this paper, the random geometric probability of mating success was determined; in addition, the anatomical and behavioral adaptations that increase mating success to nearly 100% were discussed.

**Method**

The random geometric probability of mating success in *C. sphinx* was determined with three calculations: the total surface area of a female's body that is presented to the male when he is preparing to mount; the surface area of the vaginal opening; and the extra weight that the female supports after the male has mounted her. The random geometric probability of mating success was a simple division: total surface area presented to the male/vaginal surface area.

A photograph of a male/female pair of *C. sphinx* with visible genitalia and engaging in the act of mating was selected (Figure 3). Relative measurements of the male's penis and the

female's vaginal opening were made from the photograph. A model of the male's penis was added to the photograph and placed in the appropriate location based on the size ratio determined from the mating photograph (Figure 3). The penis was attached and articulated with a mini brad in order to demonstrate the area of our sample space.

Figure 3: Snapshot photograph from video of *C. sphinx* mating.

Geometric representation of the restricted range demonstrated by the articulated penis in the model. Snapshot photograph from video of *C. sphinx* mating, edited in Paint. http://www.youtube.com/watch?v=m9IXZR4cbSE

In land animals that mate front-to-back, the female carries all or a portion of the male's weight after he has mounted her. Because of the inverted dorsoventral copulation style used by the *C. sphinx*, the female does not support any of the male's weight during mating. Most often, males and females support their own weight; or, in situations where the female is smaller than the male, she will lower herself onto the male by holding onto his ankles with her feet, with the male then bearing 100% of the female's weight. Because mounting in the *C. sphinx* is essentially an all-or-nothing condition, no calculations were needed to establish the added that females support during copulation.

**Results**

The *C. sphinx* male's penis in the mating photograph (Figure 3) measured 1.20 cm in length. Using the length of the male's penis as the radius of the half circle, the total area of the

sample space was determined to be 2.26 $cm^2$ by using the formula $A = 1/2\pi r^2$, where $A$ is the area, $r$ is the radius. For simplicity, I used $\pi = 3.14$. The female's vaginal opening in the mating photograph measured .30 cm in length by .30 cm in width. The total area of the feasible space was determined to be .09 $cm^2$ by using the formula $A = lw$, where $A$ is the area, $l$ is the length, and $w$ is the width. The random geometric probability of mating success for the *C. sphinx* was .09 $cm^2$/ 2.26 $cm^2$ = .04 or 4%. Thus, the male *C. sphinx* has a 4% chance of hitting the vaginal target if the mating success by males was random.

**Discussion**

For the *C. sphinx* bat, the random geometric probability of hitting the vaginal target was only 4%; however, mating success by males is, in fact, non-random, raising the probability of hitting the vaginal target to 100%. The 96% difference in the random versus non-random mating success can be ascribed to several biological characteristics inherent in the *C. sphinx*. One of the most adaptive traits is their dorsoventral mating style, which allows the male to position his penis in front of, and between the legs of, the female, minimizing his target area. Additionally, due to the inverted nature of their mating, the penis works with gravity, which actually facilitates the aim of the male's penis downward, toward the vaginal opening. Moreover, bats have a flexible spine, which allow the female the ability to see the male's penis, an adaptation that most four-legged mammals do not have. The flexible spine and elongated tongue allows the female to use her tongue to help guide the male's penis into her vaginal opening. Finally, the possession of teeth and thumbs are also advantageous to *C. sphinx* males during mating. The male can bite the scruff of the female's neck and use his thumbs to grasp her wings, both of which stabilize the female during mating. With a collection of beneficial adaptations, the *C. sphinx* bat's mating success is high. Future comparative studies between the *C. sphinx* and other mammals with similar mating adaptations (e.g., primates) may offer further insight into the anatomical and behavioral features associated with optimal mating success.

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