The fly's flight through a behavioral ecologist eyes

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How do you describe someone who gets easily distracted? In many Latin American countries, there is a popular saying –often used by mothers and teachers– that goes '*Se distrae con el vuelo de una mosca*'. It means that even a flying fly is enough to draw someone's attention and pull them away from whatever they were doing. To be honest, I have heard it more times than I can count since I have always been the kind of person whose attention was focused on the intricate leg movement of a walking beetle, or on how bees flew from flower to flower. Little did I imagine that this so-called *distraction* would lead me to become a behavioral ecology student.

Getting distracted by a flying fly or observing animal behavior sparks a whole host of questions: Why does the fly fly the way it does? Where is the beetle heading and why? How do bees decide which flowers to visit? How do they orient themselves to return to their hives? These questions are at the heart of behavioral ecology, a field that combines the study of animal behavior, the ecological scenario where animals play their behavioral strategies, and how certain behaviors evolve over time[1]. Personally, I believe that this curiosity ties back to one of the oldest human inquiries: Why animals do what they do and –remembering Tinbergen's four questions–, how does that favor their survival?

Beyond observing animals trying to delve into their motivations, we have recognized their exceptional performance under certain circumstances and sought inspiration from them to tackle a wide variety of modern challenges. If no one had ever been *distracted* by the way flying insects fold their wings, perhaps we might never have found the inspiration for designing a specialized disaster exploration robot capable of adapting to complex environments. This hybrid ground-air searching robot can fold its wings like a bee when navigating through narrow spaces, like buildings ruins after an earthquake, which is of vital importance to rescue and save peoples lives[2]. Without studying how insects adapt their movement to complex environments, such innovations might not exist.

In fact, behavioral ecologists have been so *distracted* by insect flight to the point of sparking entire fields of research. The ability of insects to achieve such complex maneuvers has encouraged the study of the aerodynamic forces that maintain them airborne and stabilized by continuously adjusting their wing movement. These understanding has led to the development of newfangled biomechanics, such as the micro air vehicles (MAVs) like RoboBee[3], which mimic the complex biological systems of flying insects. Insect-sized flying robots can operate autonomously in multiple environments[4] and have potential uses ranging from crop pollination, search-and-rescue missions, surveillance, minimally invasive robot-assisted surgeries, to high-resolution weather, climate, and environmental monitoring.

Going even further, the study of the collective organization and communication mechanisms of social insects like ants, bees and wasps have also inspired amazing breakthroughs in algorithm design, such as swarm intelligence algorithms. For instance, the study of pheromone-based communication in ant colonies led to the development of algorithms like Ant Colony Optimization (ACO), which replicates how ants use pheromone trails to find efficient paths and is being used to optimize internet data routing and managing traffic[5]. Similarly, systems like ColCOSΦ[6] uses virtual pheromones to replicate insect chemical signaling to enable robots to work collectively. These algorithms showcase how deeply the observation of insect behavior can influence technology, offering solutions for disaster response, healthcare, and environmental monitoring. Contrariwise, they also represent a huge opportunity to facilitate social insect research, since there still are too many unresolved questions about social insects collaborative behavior.

Innovations which stem from observing animal behavior –particularly from insects– are key examples of biomimetics. Biomimicry involves emulating natural processes, structures, and systems to solve everyday human problems. The remarkable efficient communication of social insects, their resource allocation, navigation strategies and overall adaptive abilities have inspired great technological advancements. By studying these small yet complex organisms, researchers unlock sustainable and adaptive solutions that are applicable to diverse fields. Observing insect behavior not only enhances our understanding of ecosystems but also fuels breakthroughs that improve technology and quality of life.

So, from now on, if you hear someone say '*Se distrae con el vuelo de una mosca*', take a moment to reconsider that observing the fly's flight might not represent just a trivial distraction. What some see as aimless attention might actually be the kind of curiosity that leads to breakthroughs, both in understanding nature and developing innovative technology. For me, that phrase does not represent a critique anymore but a reminder that sometimes, the smallest details—like the flight of a fly—can spark the most amazing discoveries.

REFERENCES

1. Davies, N. B, Krebs, J. R. & West, S. A. *An Introduction to Behavioural Ecology*. (Wiley-Blackwell, UK, 2012).
2. Hu, J., Liang, Y. & Diao, X. A flying-insect-inspired hybrid robot for disaster exploration. in *2017 IEEE International Conference on* Robotics *and Biomimetics (ROBIO)* 270–275 (2017). doi:10.1109/ROBIO.2017.8324429.

3. RoboBees: Autonomous Flying Microrobots. *Wyss Institute* https://wyss.harvard.edu/technology/robobees-autonomous-flying-microrobots/ (2016).
4. Liu, H., Ravi, S., Kolomenskiy, D. & Tanaka, H. Biomechanics and biomimetics in insect-inspired flight systems. *Philos. Trans. R. Soc. B Biol. Sci.* **371**, 20150390 (2016).
5. Dorigo, M. & Stützle, T. Ant Colony Optimization: Overview and Recent Advances. in *Handbook of Metaheuristics* (eds. Gendreau, M. & Potvin, J.-Y.) 311–351 (Springer International Publishing, Cham, 2019). doi:10.1007/978-3-319-91086-4_10.
6. Sun, X., Liu, T., Hu, C., Fu, Q. & Yue, S. ColCOS Φ: A Multiple Pheromone Communication System for Swarm Robotics and Social Insects Research. in *2019 IEEE 4th International Conference on Advanced Robotics and Mechatronics (ICARM)* 59–66 (2019). doi:10.1109/ICARM.2019.8833989.