Fossil fly with an extremely long proboscis sheds light on the insect pollination origin

April 2 2019

A long-nosed fly from the Jurassic of Central Asia, reported by Russian paleontologists, provides new evidence that insects started serving as pollinators long before the emergence of flowering plants. Equipped with a proboscis twice the length of the body, this fly predates the first angiosperms by about 40-45 million years. This suggests that insect pollination began to evolve in association with ancient gymnosperms. The results of the study are published in *Gondwana Research*.

Archocyrtus kovalevi is only known as a single compression fossil found in the Late Jurassic rocks in Southern Kazakhstan. The fossil, estimated to be about 160 million years in age, first came into light in 1996, but its original description did not contain any photos. It is no wonder that nobody believed at first that this fly had evolved a proboscis of such proportions so early in time. Despite not having seen the specimen itself, skeptics said that the long structure next to the fly's body was not a genuine proboscis, but must be a piece of plant or other stray object. As a result, a remarkable finding fell into oblivion for more than 20 years.

To dig up the truth about the enigmatic fossil, paleontologists from Borissiak Paleontological Institute (Moscow) reexamined it using modern microscopic techniques and element distribution analysis. This allowed them to confirm the presence of a long proboscis, which has an easily discernible food canal and is identical to mouthparts of living long-proboscid flies in all other respects. Measuring 12 mm long, mouthparts of A. kovalevi is 1.8 times longer than the body. It means that this tiny fly ranks first among all the Mesozoic insects in having the longest

proboscis relative to body size.

A. kovalevi is the earliest fossil record of extant family Acroceridae, or small-headed flies. Nowadays, there are a few species of small-headed flies with a proboscis longer than body found in the Americas and South Africa. The present-day members of Acroceridae use their oversized proboscis to draw nectar from long tubular flowers, acting as pollinators in the process. The unusual thing is that A. kovalevi existed at the time when not a single flower was blooming. The first flowering plants emerged much later, in the Early Cretaceous, and at first had small, inconspicuous flowers. So what was the proboscis of A. kovalevi used for?

"There is a well-known story about Charles Darwin, who famously predicted the existence of a pollinating moth with a long proboscis after seeing the deep nectar spur of the Madagascar orchid. We have to argue the other way round and conclude from the ancient long-nosed fly that we see to a plant which it may have pollinated", said Alexander Khramov, the first author of the study and a senior researcher at Borissiak Paleontological Institute.

Luckily, researchers did not need to go too far in their guesses. Dozens of cones of the plant called Williamsoniella karataviensis have been collected from the same strata as the fly. This plant belongs to Bennettitales, an extinct group of the Mesozoic gymnosperms, many of which had showy, flower-like reproductive organs, and on this ground scientists have long suspected them to be insect pollinated. *W. karataviensis* fits into this picture perfectly. It has bisexual cones consisting of twelve petal-like bracts (modified leaves) arched over the ovules (precursors of seeds). Like modern Gnetales, a relict group of gymnosperms pollinated by insects, including flies, ovules of *W. karataviensis* could have produced sugary pollination drops.

The depth of the cones of *W. karataviensis* roughly matches the length of proboscis of A. kovalevi, so the pieces of the puzzle come together: small-headed flies first evolved an extremely long proboscis to get an access to the sugary secretions hidden deep in the cones of ancient gymnosperms. It is highly probable that they did pollination work in return for sweet reward. It follows that the foundation of pollination mutualism between plants and insects had been laid long before the first true flowers adorned the Earth. When the Mesozoic gymnosperms left the stage, Acroceridae and probably some other long-proboscid insects offered their pollinating services to newly emerged flowering plants.

More information: Alexander V. Khramov et al, A Jurassic dipteran pollinator with an extremely long proboscis, *Gondwana Research* (2019). DOI: 10.1016/j.gr.2019.02.004

Provided by AKSON Russian Science Communication Association