

# Zofia Kielan-Jaworowska

## (1925–2015)

Discoverer of early mammals.

Much of what we know about the origin and early evolution of mammals stems, directly or indirectly, from the work of Zofia Kielan-Jaworowska. Her greatest achievement was the collection of fossils amassed by several Polish–Mongolian expeditions to the Gobi Desert (1963–71), which she led. She also discovered species of crocodile, lizard, turtle, dinosaur and bird.

The Gobi specimens, which include skulls and skeletons, are unprecedented in their variety, number and completeness. Kielan-Jaworowska spent half a century describing and interpreting them while forging scientific exchange from Poland through the Iron Curtain. The fossils altered views on mammalian history, and stimulated discoveries around the world.

Kielan-Jaworowska, who died on 13 March, came of age in war-torn Eastern Europe. Born in 1925 in the town of Sokołów Podlaski in east-central Poland, she spent most of her formative and professional years in Warsaw. With higher education banned and punishable by death at the hands of the Nazi occupiers, she enrolled in clandestine classes at the University of Warsaw. She also served as a medic from age 15 in the Polish resistance until the Warsaw Uprising of 1944 and the subsequent levelling of the city by retreating Nazi forces.

In 1945, Kielan-Jaworowska joined the Zoological Museum in Warsaw as a volunteer, helping with its post-war restoration. Here she came under the influence of leading invertebrate palaeontologist Roman Kozłowski, who supervised her master's degree, awarded in 1949, and her doctoral work, completed in 1952, at the University of Warsaw. Her early research, which continued into the 1960s, concerned trilobites and sea worms, marine fossils from the Palaeozoic era (541 million to 252 million years ago). Sea worms have complex and delicate jaws, previously known from isolated fragments: using innovative techniques, she was able to prepare complete specimens.

Kielan-Jaworowska's formidable research and leadership abilities led to her appointment in 1961 as director of the pre-eminent Institute of Paleobiology in Warsaw, part of the Polish Academy of Sciences (PAN). By coincidence, as she was assuming directorship, the PAN established a cooperative agreement with Mongolia for palaeontological



expeditions. Kielan-Jaworowska, who had long been interested in vertebrates (reading as a student at the Zoological Museum library, miraculously spared from wartime damage), was aware of the Gobi Desert's dinosaur and other vertebrate fossils, thanks to legendary discoveries made in the 1920s. Fate put her in the right place at the right time.

Equipment and supplies to sustain a field party of 20 for 3 months were shipped to Ulan Bator, Mongolia's capital, before each field season. Polish–Mongolian parties made several spectacular discoveries of Late Cretaceous vertebrates (about 80 million to 75 million years old) in the Nemegt Basin, including the 'fighting dinosaurs' (a kick-boxing *Velociraptor* locked in a death pose with a plant-eating *Protoceratops*), the awesome forelimbs of *Deinocheirus* (an ostrich dinosaur) and the mammal specimens she would go on to study. Nothing stood between Kielan-Jaworowska and her work: in 1971, having suffered a ruptured eardrum during a Gobi sandstorm, she travelled back to Warsaw for surgery, and then returned immediately to resume field work.

As fossils from the expeditions came pouring in, she navigated cold-war roadblocks to establish ties with leading Western scholars, notably those in Britain, France and the United States, anticipating political glasnost (openness) by a good two decades. She built a science network from her hub in Warsaw, with spokes running to research

programmes worldwide.

For a discipline built mainly on the study of fossil teeth and jaw fragments, Kielan-Jaworowska's discoveries were a game-changer. Because of their stunning completeness, the species she painstakingly collected and described have become points of reference in the study of early mammals. Multituberculates, early rodent-like forms, are abundant and well represented in the collections. In collaboration with French and British colleagues, Kielan-Jaworowska sectioned two skulls, of *Nemegtbaatar* and *Chulsanbaatar*, providing details of cranial vasculature, innervation and the brain itself.

The Gobi specimens underscored the fact that new fossils can upend decades of entrenched wisdom. *Deltatheridium*, for example, found in the 1920s, was long thought to have been a peculiar sort of placental mammal (the group that dominates today). Her specimens showed that it is actually closely related to marsupials.

Kielan-Jaworowska set into motion a remarkable new age of exploration and discovery. Palaeontologists have continued to exploit the fossil-rich Gobi Desert and elsewhere; breathtakingly complete Jurassic and Cretaceous specimens (including hair) have been recovered from Liaoning, China.

Zofia made the most of her 89 years, continuing with research well after her retirement from the PAN. In 2004, she published *Mammals From the Age Of Dinosaurs* (co-authored by Zhe-Xi Luo and me; Columbia Univ. Press), a widely used reference book. She made substantial contributions as editor of the journal *Acta Palaeontologica Polonica*, often helping developing-world scientists to publish their research.

Zofia spurred everyone to do their best. She was a peerless role model. Apart from her intellectual prowess, she will be remembered most for her indomitable spirit. Her style was, at times, unapologetically exacting — an apprenticeship with her was akin to martial-arts training with a Buddhist monk — but she pushed the rest of us to reach for better science. We will miss her. ■

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