Beetles are arguably the most successful group of organisms. With almost 400,000 described species they comprise about 20% of all known animal species. We know over 5,500 fossil beetle occurrences from over 220 localities, beginning in the Carboniferous (Smith & Marcot 2015). One of the main reasons for the beetles' success is certainly their sturdiness; they have a strong exoskeleton with modified fore wings. These wing cases or elytra protect the hind wings and abdomen without substantially reducing the agility of the beetles. A strong exoskeleton makes fossilization more likely, but also tends to conceal details. Unlike transparent wings that reveal venation or thin, membraneous body parts showing setation patterns, often only the outlines and coarse sculpture can be seen when strong dark sclerites are fossilized.

Scarab and stag beetles (Coleoptera: Scarabaeoidea) are particularly hard-shelled beetles. They appeared in the Jurassic (Krell, 2006) and evolved into one of the largest beetle superfamilies with over 35,000 species. This is my study group, from which I choose most of my examples. While some scarabaeoids are amongst the largest extant and fossil beetles, such as goliath and rhinoceros beetles, most of them are less than one cm long. Sufficiently detailed preservation of such small beetles requires either an extremely fine-grained sediment, or embedding in natural resin.

Mesozoic amber – Two areas in the world have revealed the most insect-rich Mesozoic amber deposits: Lebanon and Myanmar. For some time Lebanese amber was the richest window into the early history of many insect families, with around 8,500 biological inclusions, mainly insects (Azar, 2012). Dany Azar discovered over 375 outcrops. With an age of around 125 Ma it still reveals the oldest three-dimensional fossils for many taxa. Lebanese amber specimen numbers have recently been greatly surpassed by a steady stream of insect inclusions recovered from the amber mines in northern Myanmar. With a date of 99 Ma, Myanmar amber is younger than the Middle Eastern amber. By end of 2016, 643 fossil species had been described from burmite, including 60 species of beetles (Guo et al., 2017), and the wave of new descriptions seems to be increasing. An opulently illustrated book of almost 700 pages (Zhang, 2017) gives an impressive overview of the diversity of the invertebrate inclusions in burmite. The Denver Museum of Nature & Science recently obtained around 60 specimens of burmite scarab beetles, mainly belonging to extinct families. One of those extinct groups is present in both Lebanese and Myanmar amber.

Baltic amber – With about 3,500 arthropod species described during the last 300 years, Eocene Baltic amber is the longest and most extensively studied source of three-dimensional insect fossils (see Gröhn, 2015). However, scarab and stag beetles are rare; only a handful have been described. Obtaining more than two dozen specimens, including historic types, would allow me to revise and expand the knowledge of this fauna substantially.

Eocene oilshales of Messel, Germany – The next best situation in paleoentomology after three-dimensional preservation in amber is two-dimensional fossilization in fine-grained sediment with color preservation. The Eocene (47 Ma) oilshales of Messel in Germany (Smith et al., 2018) are one of the rare Lagerstätten providing an abundance of such fossils, and in abundance. From the more than 19,000 fossil insects preserved in several German museum collections, I identified around 510 specimens as scarab and stag beetles, ranging from a few millimeters long dung beetles to over five cm long stags. This material will be described in a monograph.

This presentation gives an overview over the diversity and abundance of outstandingly preserved fossils of scarab and stag beetles of these Lagerstätten.
Krell 1. The first scarab beetle ever found in Lebanese amber, the future holotype of *Mathusalam crowsoni* Krell & Azar in litt., member of an extinct family of Scarabaeoidea, found by Aftim and Fadi Acra in 1968/1969, now in the Muséum National d’Histoire Naturelle, Paris, on loan to the author. Body length: 2.46 mm.

Krell 2. Several still undescribed June beetle species of the subfamily Sericinae are found in Baltic amber, here the future holotype of *Liparoserica groehni* Krell in litt., from the private collection of Carsten Gröhn in Germany is shown. Body length: ca. 7 mm.
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References


Biographic Summary
Dr. Frank-T. Krell is Senior Curator of Entomology in the Department of Zoology of the Denver Museum of Nature & Science. He received his diploma in biology (1992 with a minor in paleontology) and his doctorate (1996) from the University of Tübingen in Germany. His postdoctoral research took him to the Ivory Coast in West Africa where he led a project on scarab beetle biodiversity with the University of Würzburg, Germany. After a short period with the Zoological Research Institute and Museum Alexander Koenig in Bonn, Germany, he became a Research Entomologist with The Natural History Museum, London, UK, in 2000. Before joining DMNS in January 2007, he was the head of the beetle division in London. Dr. Krell is Editor-in-Chief of the Denver Museum of Nature & Science Annals and Commissioner and Councillor of the International Commission on Zoological Nomenclature.

Dr. Krell's specialty is taxonomy, systematics, and ecology of scarab beetles, especially dung beetles. Recording and explaining the high diversity in this insect group, as well as exploring the effects of anthropogenic habitat changes on dung beetle communities, are two main areas of his research. He is also working on fossil scarab faunas and has done fieldwork on all continents except Antarctica, with the main focus on Africa.