The Copenhagen Collection of Amber-Fossils

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Whenever a gale blows along the North Sea coasts, professional amber collectors get busy. Even before dawn, by lantern light, they search the shore for amber, so that few and then only small pieces are left for the chance-visitors of the next day. Considering the large quantities of amber which are collected every year along our coasts — and not only along the North Sea — it is amazing how little is found by "ordinary people".

The reason for the favourable amber-collecting conditions which prevail in the wake of a gale can be found in the history of Danish amber, which began within the older Tertiary, the transition period between the Eocene and the Oligocene. Usually, the age of the amber is estimated at about 50 million years, but modern methods may enable more precise age determination.

The Danish amber originated as streams of resin exuded chiefly by the fir, *Pityoxylon succiniferum,* in forests existing at that time. It came into existence in the extensive forests bordering on a sea which, during that period, included large parts of what we know as the Baltic and Northern Germany, and which, in addition, extended far into Central Russia. The resin was carried out by watercourses to tranquil lakes and sea-lagoons where, together with many other kinds of material, it settled in large quantities. To-day such deposits are found in East Preussian deposits. During the Glacial age the glaciers carried much of this material towards the west and south, and to-day a great deal of it is found deposited in Danish moraines. So it is that our sea slopes and, in places, also the sea floors are to-day comparatively rich in amber. Much of this is released during the gale, by the movements of the sea floor near the coast, and by the waves eating away clay and gravel from the sea slopes. The specific gravity of the amber is small (1.1), which means that all the amber released in this way is washed ashore together with seaweed and driftwood.

Amber is collected primarily for its use in the jewelry industry, an exploitation which is as old as man's presence in this country; indeed, amber jewelry should be considered one of our very oldest export articles. The raw amber, however, as it is when collected, needs treating, that is polishing, to obtain attraction. This polishing has revealed the presence of foreign bodies in amber, and this has greatly increased the general interest in amber jewelry.

A small part of the amber contains insects and other small animals which, in the distant past, were entrapped by the then still fluid resin. Although these insect-fossils, owing to their curiosity, mean an increase in commercial value, they are of far more importance scientifically, in that they provide possibilities for a comparison between the nature of the Baltic territory during the older Tertiary period and the nature which we have to-day outside our windows.

This fact has encouraged museologists to keep as much material as economically possible in our public collections. In the collection of the Zoological Museum, we have to-day more than 4000 pieces of amber containing remains of insects; of these about 800 pieces belong to the Mineralogical Museum of the University; for practical reasons, however, they are deposited in the Zoological Museum. The majority of this amber originated from the west coast of Jutland, and was collected during the last decennium. There are, however, especially in the material belonging to the Mineralogical Museum, some very ancient pieces which were collected even before the foundation of any of our recent museums. The collections contain about 600 pieces of East Prussian material.

The approximate distribution of these many fossils into the various insect-orders and other arthropod-classes will appear in the annexed survey. The greater part of these insects are small and large-winged, but only feeble active flyers. In addition, they are inclined to rest on tree trunks and branches. This material is dominated by Nematocera, first and foremost by Mycetophilidae (incl. Sciaridae) and Chironomidae (incl. Ceratopogonidae). This biological group also includes the Cecidomyiidae, Psychodidae, Coccidae, and Aphididae, together with a large number of flies with a far greater flight capacity, belonging to many different families.

Another fauna-element lived almost constantly on the trunks, among them a large number of spiders, mites, Copeognatha, ants, and Collembola. In addition, animals which bred in the wood of the trees, beneath the bark, or in the fungi growing on the stems, were very common, especially a variety of beetles (Elateridae, Ipidae, etc.). The few moths which are found (imagines and larvae), together with Chilopoda, Diplopoda, and Pseudoscorpionida, must doubtless also fall into this biological group.

It must seem highly astonishing that a very high percentage of the insects entrapped by the streams of resin is freshwater fauna. Besides the above mentioned Chironomidae and Psychodidae we find a large number of Trichoptera, some Plecoptera, a few Ephemeroptera, and among the beetles quite a number of Cyphonidae. Particularly strange is the presence of a caddis-fly larva and a May-fly larva. These water-insects would seem to indicate the presence of special swampy localities where amber-yielding trees were growing. However, the presence of the freshwater-insects is a quite natural phenomenon. The fact is that only where the fir trees of the past were growing close to the watercourses, especially to the fast flowing ones, had their resin a chance of being carried away to deposits (similar to the East Prussian deposits) from where, at a later stage, it might have been carried down to Danish moraines. It seems probable that there existed still more extensive forests with resin-producing trees at places where the resin had no possibility of fossilizing.

There is, however, another and negative side to the picture of the insect-bearing amber, as very important parts of the local fauna have been without possibilities to get into contact with the resin in its fluid state and, consequently, are almost never found among amber insects. First and foremost this concerns the fauna of the soil. It is also very seldom that large and particularly strong insects are found, for either were they strong enough

to free themselves from the sticky mass, or they quickly fell a prey to insect-eating birds and mammals which, in all probability, kept a constant look out for these naturally occurring insect traps. Many torn off remains of insects, and occasionally tufts of hair of mammals, bear witness to such tragedies.

It is obvious that a complete investigation of the collected material depends on a systematic and morphologic treatment by many specialists. Scientists with wide-ranging specific knowledge of the recent fauna will, in particular, benefit from the study of such material. Unfortunately, there is one great drawback to the study of these fossils: an animal can only be examined in the position in which it was when its death struggle ended. No leg can be straightened, and no copulatory organ can be prepared. However, it is striking that, even down to the last detail, most of the amber insects correspond to the insect-fauna existing about us to-day. It might, therefore, be more advantageous to have the material treated by entomologists with a great knowledge of the recent fauna, rather than by paleontologists, who must necessarily consider it a subject in itself. This is one of the strongest arguments for the transferring of all the public Danish material of this kind to the entomological department of the Zoological Museum.

There are still some characteristics worth mentioning.

As stated above, the amber insects, systematically, hardly differ from the recent forms; in many cases it may be almost impossible to perceive specific differences. However, a comparison between this fact and our knowledge of the geographical distribution of the recent species shows the apparently inexplicable phenomenon that the amber fauna includes forms (occasionally in one and the same piece of amber) which must to-day be considered typically boreal, together with forms which must be regarded as tropical or subtropical. There is no doubt that this fauna of "Central European" species lived together with, and under the same climatic conditions, as termites and other heat-requiring animals. We know with reasonable certainty that the climate then was warm and mild and that there were no cold winters as there are to-day. It must necessarily have been such as to have been able to satisfy the most requiring elements of its fauna and flora.

But from this it follows that for the past 50 million years, since the formation of amber, important elements of the fauna must have changed ecologically, but not morphologically. There is every probability that these conditions are connected with the gradual cooling of the earth, which was hastened during the Tertiary and culminated during the Glacial age.

Although, at the time when the amber was formed, the seasons were marked by little change, it is, however, probable that nature had a certain rhythm, the changes of light hardly differing from those of to-day. We know that the majority of the now-existing plants are very sensitive to light, and that they regulate their annual rhythm in accordance with the annual light-rhythm. Consequently, the latter has a definite influence on the flowering season.

Through analyses of pollen contained in the amber, one might ascertain whether a single plant species, even at that time, had its flowering

within a limited period. The length of this might possibly be read from the relative numbers of amber pieces in which the pollen arising from it is found. If so, it should be possible, through pollen analyses, to estimate the season of activity of some adult insects commonly found in the amber.

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List of material.

Insecta		
Collembola	200	pieces
Thysanura	20	„
Blattoidea	20	„
Saltatoria	4	„
Dermaptera	2	„
Isoptera	26	„
Copeognatha	45	„
Thysanoptera	15	„
Homoptera	190	„
Heteroptera	27	„
Ephemeroptera	4	„
Plecoptera	10	„
Neuroptera	6	„
Trichoptera	105	„
Lepidoptera	35	„
Diptera	1950	„
Coleoptera	310	„
Hymenoptera	530	„
Myriopoda		
Chilopoda	10	„
Diplopoda	7	„
Arachnomorpha		
Arachnida	250	„
Acarida	225	„
Opilionida	15	„
Pseudoscorpionida	7	„
Crustacea		
Oniscoidea	1	„
Mammalia (hair)	2	„