Glowing stone: Amber in Polish deposits and collections

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Amber in Poland — like salt and coal — is regarded as a typical raw material of this country, having been a feature of its cultural heritage since the earliest periods of human existence (Fig. 1). In the Neolithic (4500–1700 BC) amber workshops in the Żuławy region made use of this mineral for over 500 years. Archaeological excavations conducted there by R. Mazurowski (2006) revealed around 2500 seasonal workshops covering an area of 7000 m^2, making this one of the largest Neolithic amber-working centers in the world. In contrast, the traditions of amber prospecting and extraction and its use in folk art, dating back to at least the 17th century in the Kurpie region, in central eastern Poland, demonstrate that amber is not only typical of territories associated with the southern Baltic coast, but also with other regions in Poland.

Paleogene deposits

Paleogene deposits of amber (succinite) represent secondary deposits of sedimentary origin, which were transported over various distances before reaching the final destination where they were laid down. Hypergenesis of fossil resins was induced by iso- and polymerization, oxidization and by reactions stemming from bacterial activity. However, the crucial factor involved in turning a resin into succinite was the final stage spent in a marine environment (Fig. 2A).

Succinite does not occur in those areas where resin remained on-land, though other types of resin survive. Resin from coniferous trees dating from at least 40 million years ago was laid down during the Paleogene in an Eocene intercontinental reservoir; today, known as the Gdańsk Delta (Fig. 2B) (previously referred to as the Chłapowo-Sambian Delta), it constitutes the largest succinite deposit. The amber-bearing sediment dubbed *blue earth* in the 19th century formed a deposit in the delta of a river into which the waters of Fennoscandia drained, and which was referred to by the mythical name of Eridanos. Sambian *blue earth* can readily be distinguished from other geological formations. It is amber-bearing, sandy-argillaceous sediment with glauconite and a distinctive (typical) composition of heavy minerals, such as epidote, garnet, zirconium and tourmaline. Succinite is identified by infrared absorption spectroscopy.

Fig. 1. "Flame" variety of amber. Photo by J. Kupryjanowicz

The western (Polish) section of the delta was explored in 1983 with the help of three boreholes drilled in the village of Chłapowo (Fig. 3A) (Piwocki et al., 1985; Kosmowska-Ceranowicz & Müller, 1985; Jaworowski, 1987). The thickness of the Upper Eocene amber-bearing sediments varies from 10 m to 26.4 m. These formations occur at the depth of 67–132.5 m. Resources have been estimated at 643 820 tons, individual strata containing from 132 to 5976.79 g/m^3 of amber.

Research has shown that this part of the delta is a continuation of the eastern section located in Russia, where amber is extracted in Yantarny on the Sambian Peninsula (Sambia). In terms of lithofacies the sediments from Chłapowo are identical to those of Yantarny; however, they differ significantly in thickness. Their depositional depth is also different; from the Gdańsk region right up to Karwia the deposit is thicker than the strata on the Sambia, and lies at least twice as deep as its Sambian counterpart (90–120 m), which precludes its being extracted by open-pit mining methods (Fig. 3B).

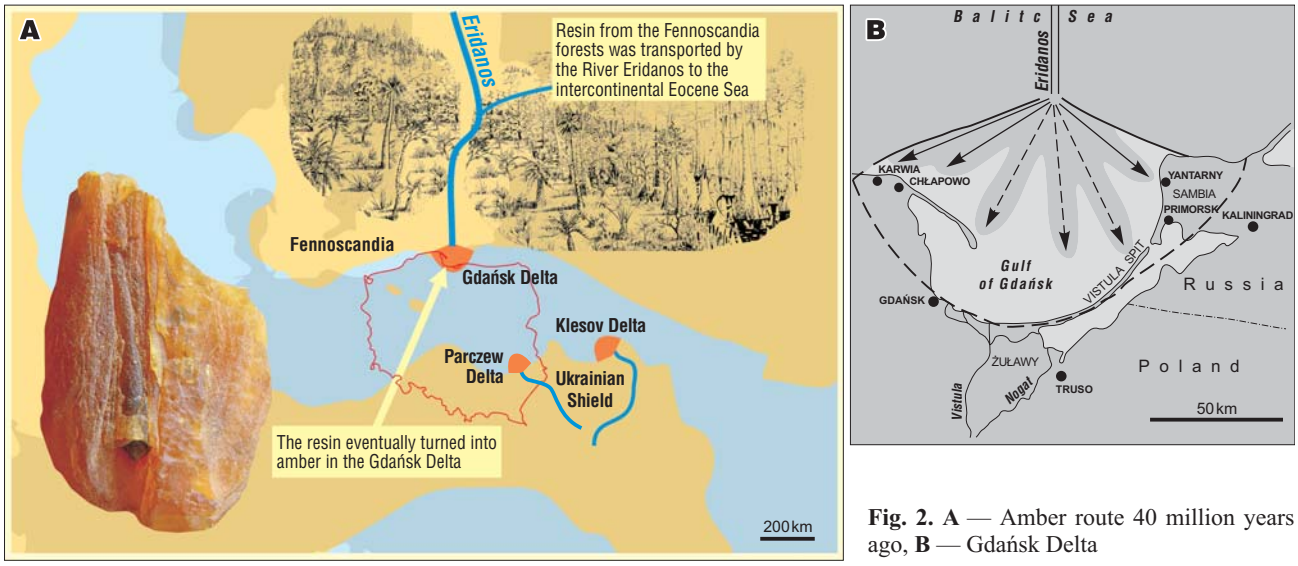

Fig. 2. A — Amber route 40 million years ago, **B** — Gdańsk Delta

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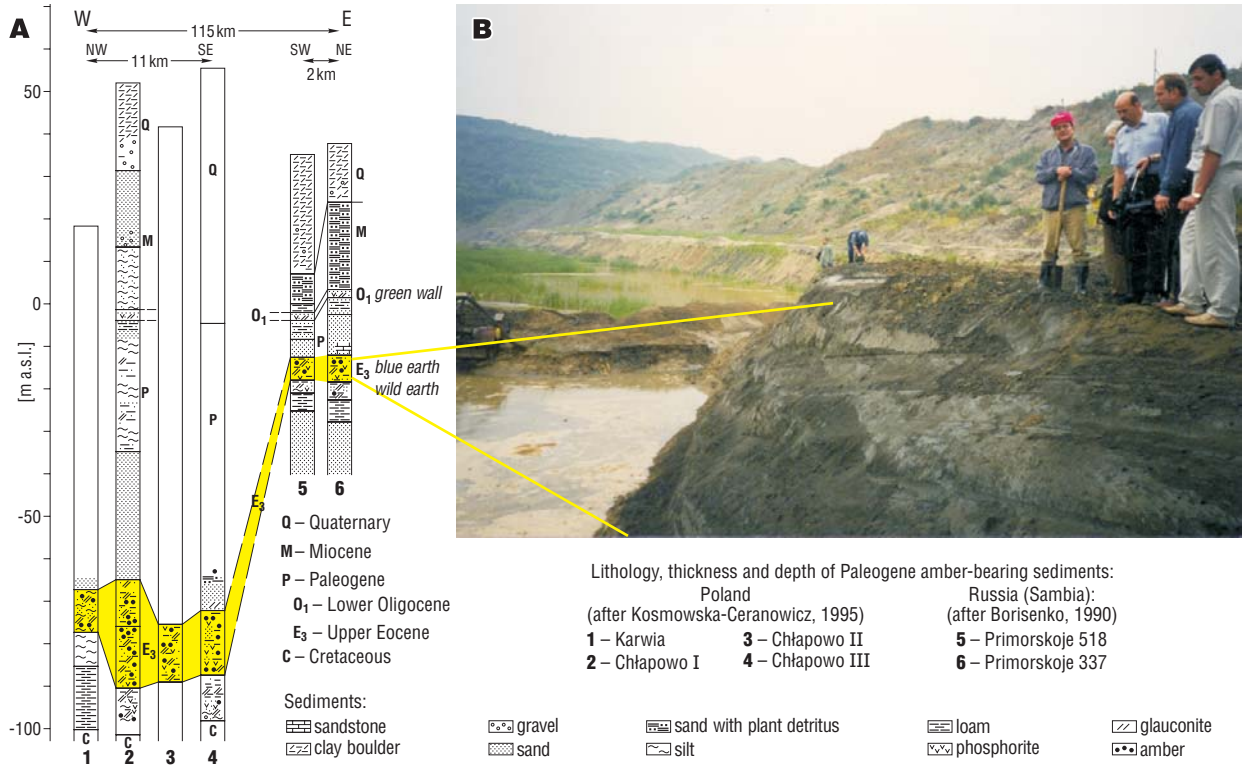

Fig. 3. A — Stratigraphy of borehole cores from the Gdańsk Delta (Kosmowska-Ceranowicz, 1995); **B** — *Blue earth* in Primorskoje amber open-pit mine. Photo by W. Gierłowski

The more intensive sedimentation in the western (Polish) section of the delta, and the greater depth of deposition than in the eastern section may point to the lability of the seabed in the Paleogene. The tectonics of this region, determined from studies of older bedrock, may have had much later an effect on the creation of the Gulf of Gdańsk. Paleogene amber-bearing sediments from the central portion of the delta (the present-day Gulf of Gdańsk) — after the formation of the Baltic Sea — were entirely removed during the Ice Age and carried south by glaciers.

Research into the age of the amber-bearing strata in the Gdańsk Delta has been carried out on numerous occasions; it is nowadays accepted that these sediments were laid down during the Late Eocene (Piwocki et al., 1985; Kosmowska-Ceranowicz et al., 1997; Kharin et al., 2004).

Amber of the succinite kind, which is just as readily workable as that from the north known as Baltic amber, was also laid down in Paleogene sediments along the southern coast of the Eocene sea (Kosmowska-Ceranowicz et al., 1990). At least two amber-bearing deltas have been identified: the Parczew Delta in Poland and the Klesov Delta in Ukraine (Figs. 2A, 4). Reserves of amber in the Parczew Delta deposit have been estimated at 6911 tons. The deposit at Górka Lubartowska (10 km north of Lubartów), in the Lublin province, lies at the depth of between 10 m and 24 m, the average thickness of the amber-bearing sediments reaching up to 7 m, which is promising in terms of its extraction potential (Kosmowska-Ceranowicz & Leciejewicz, 2006).

Just as the northern complex of amber-bearing sediments featuring epidote evidences that it was fed by Fennoscandia, so in the south the indicator complex identified contains andalusite and tourmaline and was alimented by the Ukrainian Shield, and does not, as previously believed, consist of amber transported from the north by Eocene basin currents (e.g., Katinas, 1971; Kharin et al., 2004).

Owing to the constant moisture levels in the northern Paleogene deposit, it contains fresh or only slightly weathered forms of amber (Fig. 5).

Pleistocene accumulations

The amber-bearing Gdańsk Delta was repeatedly subject to natural erosion, as a result of which a large portion of its sediments were carried beyond their original extent. The greatest damage to the deposit occurred in the Pleistocene. Successive glaciations eroded ever older strata transporting them in reverse order. Thus, the largest concentrations of amber are noted in the sediments of the youngest Baltic glaciation.

Fig. 4. Ukrainian amber, naturally polished cobbles with typical dark patina on the surface (301 g, 530 g). From the collection of the Museum of the Earth. Photo by M. Kazubski

Fig. 5. Amber nugget from sulfur mine in Machów, near Tarnobrzeg; Miocene; visible "metallic" surface (880 g). From the collection of the Museum of the Earth. Photo by B. Kosmowska-Ceranowicz

Fig. 6. A wealth of Baltic amber varieties. From the collection of the Museum of the Earth. Photo by M. Wierzbicki

Glacial, fluvioglacial and fluvial transport carried amber to parts of Latvia, Lithuania, Belarus, Poland, Germany and Jutland, as well as to the southern shores of Scandinavia and the east coast of Great Britain. Amber was carried in one of two ways.

❏ The whole chunks of *blue earth*, their structure undisturbed, were transported over significant distances in the form of floes embedded in a glacier. In Poland the presence of floes of industrial significance has been confirmed in Zielnowo near Grudziądz (Pomerania), in Możdżanowo near Ustka (Pomerania) and in a brown coal cap-rock in Kleczewo (Wielkopolska Province). Mines in Możdżanowo are mentioned in the late 18th-century chronicles, amber having been extracted using shafts of up to 22 m in depth. The deposit in Możdżanowo, estimated to contain reserves of around 20 tons, was not fully depleted and interest in it was renewed in 1957, and later in the 1970s (Olkowicz-Paprocka, 2006).

❏ Alternatively, amber was transported in dispersed form, as pebbles contained within boulder-clays and fluvioglacial gravels, or as grains of amber in Pleistocene sands.

Confirming the presence of amber in Pleistocene sands and clays using standard methods of geological prospecting is practically impossible, and the conclusions which can be gleaned from these efforts are far from satisfactory. Thus, theoretically amber can occur everywhere where Scandinavian erratics are found. Compiling a map of amber occurrences produced a picture which may be far from accurate, but which demonstrates amber's surprisingly widespread distribution. Given the low density and low hardness of amber, and the conditions in which it was transported, the climatic changes it was exposed to and the fact that it was often accompanied by coarse-grained clastic glacial sediments, it is remarkable that amber-bearing sediments are observed at such great distances from their original source. In Poland, amber has been found in at least 750 various locations other than on the beaches of the Baltic (Kosmowska-Ceranowicz, 2002).

The largest pieces of amber recorded in the literature, and early examples which survive to this day in museum collections, come from Pleistocene or Holocene sediments, providing further evidence of the wide-ranging extent of these sediments' redeposition. It was not until after World War II that collections began to include nodules from mines where amber had lain for millions of years within Paleogene deposits.

Blue earth strata provided ideal conditions for the preservation of amber, in particular because of constant moisture levels. Amber within these deposits occurs primarily in natural forms and is of very high quality, though it is not as attractive as that extracted in Poland in the form of variously rounded pebbles, which is found in younger sediments dating from the Pleistocene and Holocene. Having undergone changes induced by natural fluvial, glacial or marine transport, it appears in consecutive accumulations and is far more beautiful (Fig. 6). Clearly noticeable features include greater color saturation and, occasionally, natural clarification, or a thin cortex of weathered amber, all of which can be used to great effect in amber-working.

Amber in Holocene sediments

Holocene amber, which occurs in industrial quantities in the Baltic region, is different to that of Pleistocene one. Research in this region cannot focus solely on basic studies, but also has to take into account the need for investigations pertaining to prospecting and extraction.

Research conducted in 1972–1973 in Gdańsk (Wisłoujście and Górki Zachodnie) led to the recording of amber accumulations in sediments dating from the time when the Baltic Sea was formed during the transgression and subsequent regression of the Littorina Sea, which are covered by dunes. The richest, an 8-meter-thick stratum of post-Littoral rocks (featuring thin layers of peat) occurs at the depth of 12–14 m. The deposits comprise sands filled with plant matter which was washed out by waves during periods of storms and gales. The plants helped retain the amber within the coastal zone, preventing it from floating away (Łazowski, 2004). The amber yield amounted to 0.8–2597.8 g/m^2 in the Wisłoujście region and 2.48–247.8 g/m^2 in the region of Górki Zachodnie. Around 236 tons of amber were recorded in the coastal region, of which 75% (= 177 tons) represented reserves of Holocene accumulations in Wisłoujście.

The characteristic properties of amber, its shape and surface fashioned by its Holocene voyage are well-rounded and very well-rounded forms including partially flattened pebbles which were abraded in the wave zone. The naturally removed, weathered outer surfaces, and occasionally also the remains of barnacles and bryozoans (Fig. 7), provide indisputable evidence of the fact that in the final phase of their journey the amber nodules visited the Baltic; and when dunes began to encroach onto the ancient beach, the amber found itself in very specific conditions, which jewelers today try to recreate, employing heat treatment to produce varieties more appealing than the original ones.

Amber is extracted from Holocene strata by hydraulic means. A rotary pump propels water under pressure through a pipeline to a pump head, which is directed down towards the amber-bearing stratum. The dislodged sediment (detritus with sand and amber) is forced up to the sur-

Fig. 7. The cobble overgrown with *Balanus improvisus* and *Membranipora crustulenta* (barnacles and bryozoa) from Baltic beach. From the collection of the Museum of the Earth. Photo by J. Kupryjanowicz

face where it forms a fan-shaped deposit, on which valves are positioned and the detritus mixed with amber is collected in nets. Rinsing in a saline solution, which is usually carried out near the extraction site, separates the amber from the sediment.

Amber is an indicator mineral evidencing shore zones in the history of the Baltic Sea, particularly in its transgressive phases. The age of the deepest lying deposits (Tomczak et al., 1990) was determined by ^{14}C dating as approximately 6330 BP (the Atlantic period); higher up, at the depth of 9–9.3 m, was a younger (Sub-Boreal) stratum (3860 ± 75 BP) overlain by a third layer at the depth of 7–7.1 m (2380 ± 55 BP).

Amber collections

Amber, which has been searched after for many centuries by various civilizations, linked the Mediterranean Basin with the northern fringes of Europe. The final years of the 20th century saw the launch of the Baltic Amber Road: heritage, tourism and trade program, as part of a drive to protect the cultural heritage of Europe. The aim of the countries involved in this project is to define routes which, in allusion to the ancient trade roads that were used to take amber southwards, will be known as amber tourist routes and will lead through various locations where the most interesting amber-related centers and collections of amber can be found. Thus, numerous routes used in the past by amber merchants can today play a role in forging new links between European nations (Fig. 8).

The route corresponding to the "A1 Amber Highway" will be able to direct inquisitive visitors and geotourists on their way to the amber coast to all places of interest, starting from the south of Poland. The Vistula Spit had already been dubbed *Ripa succini* in the 16th century, 466 years ago.

The amber route outlined in Table 1 (though not including a number of constantly growing private collections)

Fig. 8. Contemporary tourist amber route. Necklace — from the Warsaw Amber Collection — made from cut and polished beads which bears a remarkable resemblance both to the Malbork necklace of the Duchess of Brieg, dating from 1610, and to the 19th-century betrothal necklaces (Brautkette) from Germany (e.g., Bückeburger, Lindhorster or Brunswick)

Table 1. Amber collections and isolated amber artifacts in Poland

Locality	Name of museum, collection, institution, other	Collection founded in	Description or name of collection	No. of specimens
Cracow	Cathedral Treasury, Wawel	16th c.	16th- and 17th-century artifacts	3
	Czartoryski Collection, National Museum	16th c.	16th–18th-century artifacts	8
	Natural History Museum, Polish Academy of Sciences	purchases made in various years	natural history and artifact collections, Jacek Serafin's Collection of inclusions (in 2001)	? 2000
Katowice	University of Silesia	2005	Prof. Jan Koteja's (1932–2004) Collection of coccids in amber	1100
Częstochowa	Pauline Monastery, Jasna Góra	from the 16th c., 19th–20th c., (Fig. 3) 2005	16th–17th-century artifacts, votive necklaces and various goods, *Totus Tuus* dress of the Jasna Góra icon	several hundred 1
Warsaw	Warsaw Amber Collections Museum of the Earth, Polish Academy of Sciences	1951	collections of: organic inclusions, natural forms, Baltic amber varieties, regional Polish and worldwide amber	29 500
Łomża	North Masovian Museum	1948	Dr. Adam Chętnik's (1885–1962) personal collection from the Kurpie province (in 1950)	700
Malbork	Castle Museum	1965	Neolithic, 16th–18th-century, contemporary, and natural history collections	1960
Elbląg	Archaeology and History Museum	1954	artifacts from Truso, Weklice and Wybicko; raw material from Truso (20 kg) and Wybicko (2 kg)	2150
Gdańsk	Gdańsk Archaeological Museum	1953	artifacts from Gdańsk and its region	2500
	Museum of Inclusions, Gdańsk University	1998	organic inclusions	1330
	Amber Museum, Gdańsk History Museum	2000, opening 2006	natural history specimens, products made before 1939, contemporary products	307 65 174

Fig. 9. A beer mug with a lid from the workshop of Georg Schreiber. The first half of the 17th c. In the Czartoryski Collection, National Museum, Cracow. Photo by T. Konart

Monastery and legendary defender of the Jasna Góra fortress during the Swedish Deluge. In the 20th century the rosary became famous for amber necklaces which have been given as votive gifts forming whole garlands around the altar of Our Lady of Jasna Góra.

In the 21st century Catholic churches became again interested in amber. As was the case at the height of amber's popularity in the 16th–18th century, when products such as crucifixes, domestic altars and field altars with figurines of the Madonna and saints were made from amber, so today there is an evident revival in the trend for using amber in religious art (Fig. 10[2]). Items produced in Gdańsk include monumental monstrances, icon dresses, chalices, missal covers and crosses adorned with amber.

Warsaw has become the focal point for research carried out on regional natural science collections of crude amber and other fossil resins from Poland and around the world, on natural forms, organic inclusions (Figs. 11, 12) (half of which come from T. Giecewicz's collection of animal inclusions gathered from a single location and numbering almost 8000 specimens), and on a collection of nearly 1000 products (Fig. 13) and imitations. It is also home to the

Fig. 11. Crustacean *Paleogammarus polonicus* Jażdżewski & Kulicka in amber. From the collection of the Museum of the Earth. Photo by J. Kupryjanowicz

Fig. 12. A termite (*Isoptera*) in Baltic amber. It lived in a climatic zone similar to that of today's Florida. From the collection of the Museum of the Earth. Photo by J. Kupryjanowicz

shows artifacts of exceptional value and historic significance and offers an opportunity to become better acquainted with various aspects of amber.

In Cracow there are priceless items linked (though possibly only by tradition) to the kings of Poland: John III Sobieski (mid 17th century), Sigismund III Vasa (early 17th century) and Stephen Bathory (Fig. 9). The contemporary natural science collection featuring important assemblages of animal and plant inclusions compiled by Jacek Serafin (a collector known in Poland and beyond) represents an important body of research material for paleoentomologists.

Geologists associate Częstochowa with the Cracow-Częstochowa Jurassic Upland Chain making up part of the Fore-Sudetic Monocline, Catholics associate it with the cult of the Virgin Mary and pilgrimages to Jasna Góra, whilst for enthusiasts of amber it calls to mind precious amber artifacts. According to tradition examples include a rosary which possibly belonged to Father Augustyn Kordecki (1603–1673), who was the Prior of the Pauline

Fig. 13. Neolithic necklaces and beads from Niedźwiedziówka, near Gdańsk. From the collection of the Museum of the Earth. Photo by K. Kwiatkowska

[2]Fig. 10 see p. 574.

most comprehensive "amber library" in Poland (Kosmowska-Ceranowicz et al., 2001). The capital cannot be bypassed on the amber tourism trail. The fossil resin collection began to be amassed in 1951 to fill the void left after 1945, when scientific institutions involved in amber research were forced to rehouse. Headquarters for future interdisciplinary research began to emerge in Warsaw after Gdańsk and Königsberg (Kaliningrad) stopped to be amber centers. The Museum of the Earth's Amber Department, which is known for its team of five scholars, the annual meetings it hosts, the access it provides to a rich store of study material and the significant accomplishments it has achieved, is regarded as the primary center for research on amber, which is conducted in cooperation with both Polish and foreign specialists.

The collections are open for public on a wide scale in the form of regularly modernized permanent displays and travelling exhibitions shown in Poland and abroad. Each successive exhibition shows the visitor newly acquired specimens of ever greater scientific and display value (Fig. 14).

In Łomża it is possible to see the historic private collection compiled by Adam Chętnik, an ethnographer of the Kurpie region. This assemblage also represents a valuable regional collection as it features crude amber which accumulated in the Kurpie outwash plain, and a collection of folk art and souvenirs made by master craftsmen form the Kurpie region.

The Castle Museum in Malbork has assembled (through purchases made at European auctions) a collection of the 16th–17th-century pieces which are among the most valuable works of art ever produced in amber, and are of notable historic significance (Fig. 15) (Grabowska, 1983; Mierzwińska & Żak, 2002). These items are also shown in foreign exhibitions. The earlier mentioned assemblage of Neolithic artifacts from Niedźwiedziówka (in the Żuławy region) has recently been deposited at the Castle Museum. Contemporary works, which were collected up until the late 1980s, are at present only sporadically added to.

The legendary town of Truso, a major settlement on the ancient amber road, located on the edge of Lake Drużno (part of the Vistula Lagoon), was one of the most important Baltic trade centers during the early medieval period (late 8th–early 9th century). Truso was involved in trade and in craft manufacture, and had its own port. Excavations at this site have been ongoing since 1982.

Fig. 14. *Amber — from liquid resin to decorative art* exhibition opened at the Museum of the Earth in 2006. Photo by R. Szczęsny

Fig. 15. From the collection of the Castle Museum in Malbork — a corner of a jewel box made by Christoph Maucher in Gdańsk. End of the 17th c. Photo by T. Konart

Fig. 16. Necklace (333 g) of imposing size and beauty of amber, honored at the amber fair Amberif 2001 in Gdańsk. Made in Helena Company. Photo by M. Kazubski

In the early 1990s a distinct revival in interest in amber took place in Gdańsk, often in cooperation with the Museum of the Earth. The International Amber Association was founded and the annual amber trade fair Amberif was launched in Gdańsk. It has been held there every year since 1994 (Fig. 16). Gdańsk has come to be regarded as the amber capital. What was the motivation which lay behind the decision to nominate Gdańsk as the Amber Capital? In 1997, as this city celebrated its millennium, amber researchers from around the world, converged on Gdańsk to attend their annual conference and share the results of their latest findings (an initiative inspired by the Gdańsk Archaeological Museum and the Museum of the Earth, of the Polish Academy of Sciences, Warsaw). This occasion marked the opening of the first permanent since 1945 amber exhibition in Gdańsk: *Amber through the ages*. In 2000 the Gdańsk History Museum established a new

Fig. 20. The Baltic — amber collectors on the beach near Mikoszewo, 2005. Photo by E. Popkiewicz

department: the Amber Museum (Figs. 17[3], 18), but earlier, in 1998, Museum of Inclusions was founded at the University of Gdańsk (Fig. 19).

The renaissance in research, the quest for new directions in decorative art, jewelry, and also in the creation of large sculptural works (including those of a religious theme) became very apparent. Developments in many of these fields continue to be made as part of the Baltic Amber Road: heritage, tourism and trade project.

The Baltic as the final destination on the amber road

In Poland the ultimate destination of the amber route, as outlined above, will be the beaches of the Baltic. Today, amber is swept up by storms onto beaches in Wolin, Darłówek, Jarosławiec, Ustka, Władysławowo, and Sobieszowo. These are mostly sections of the present-day coastline that are subject to abrasion, as in the Holocene, along the earlier lines of coastal abrasion linked to the postglacial phases of the Baltic's development.

Analysis of storm dynamics, which dictate the formation of amber accumulations, particularly during autumnal storms (from November to late February), indicates that both temperature and processes which loosen the cohesion of the seabed create conducive conditions. Lower temperatures are associated with greater salinity and an increase in water density, which facilitates the transport of amber nodules. Perhaps the amber trail could end with amber being retrieved from the sea in nets — one of the earliest methods used for its extraction.

It is difficult to judge how much raw material can be collected during a heavy storm (Fig. 20). According to estimates made by researchers into the economic impact of the amber industry in Poland, around 4 tons of amber are harvested each year from Polish beaches (Gierłowski, 2006a, b). In comparison, the sea annually casts up a mere 30 kg of amber on the coast of Scania.

Translated by Barbara Gostyńska

[3]Figs. 17–19 see p. 574

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Fig. 10. *Totus Tuus* — the rob of trust made of amber and diamonds for the Jasna Góra picture of the Virgin Mary in Częstochowa (Pauline Monastery) in 2005 (close-up in right corner); by Mariusz Drapikowski. Photo by G. Gierłowska

Fig. 17. Cabinet, Johann Georg Zernebach, Gdańsk 1724 (42 × 31 × 19 cm), amber, ivory, silver, mirror, wood. From the collection of the Amber Museum, Branch of the Gdańsk History Museum. Photo by M. Jabłoński

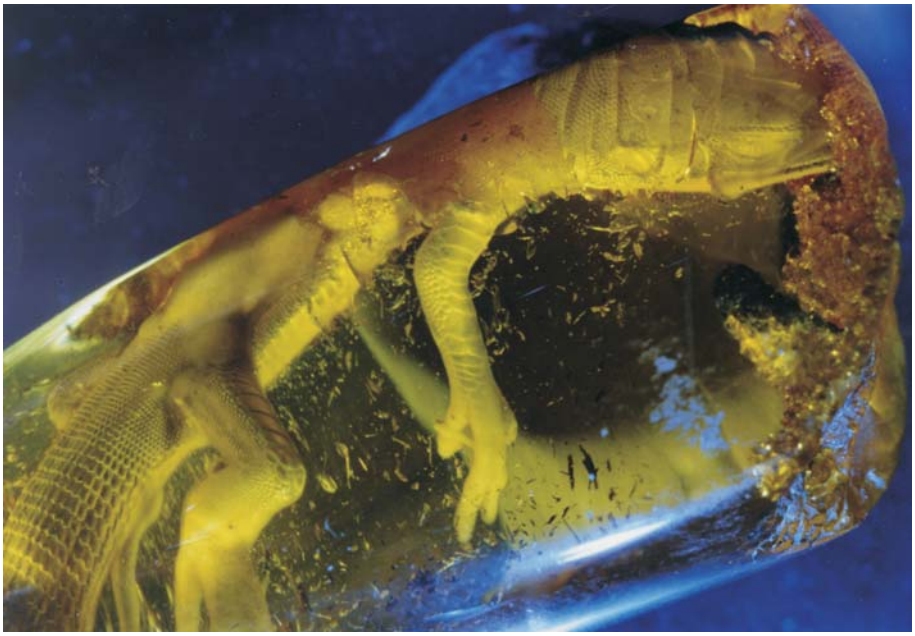

Fig. 18. A lizard of the family Lacertidae in amber. Found in 1997 in Gdańsk; named "Gierłowska's lizard" after its finder. From the collection of the Amber Museum, Branch of the Gdańsk History Museum. Photo by G. Gierłowska

Fig. 19. Diptera, *True fly*. From the collection of the Museum of Amber Inclusions, University of Gdańsk. Photo by E. Sontag