

**DETECTION OF NICOTINE AND COCAINE IN ANCIENT HUMAN
REMAINS FROM DIFFERENT LOCATIONS OUT OF AMERICA
AND AN ARCHAEOLOGICAL PERIOD SPANS A RANGE FROM
9.000 BC TO 700 AD.**

by

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Summary

Human remains obtained from artificially and naturally mummified bodies from ancient Egypt as well as skeletal finds found in excavation sites in Europe, China, Jordan and Turkey were investigated of nicotine and cocaine. The archaeological periods span a range of 9.000 BC to 700 AD.

The samples were prepared and analysed by common analytical methods (radioimmunoassay and gas chromatography / mass spectrometry). Negative and positive controls for nicotine were provided from remains obtained post mortem of traffic accidents at autopsies of smokers and non-smokers. A negative control for cocaine was procured likewise post mortem at autopsies of traffic accidents. A positive control was provided from remains obtained post mortem of addicts at autopsies.

Positive nicotine results were found in dependence of regions and periods. In samples in age 11.000 to 10.500 years found in China, Jordan and Turkey nicotine was not detected. The results suggest that nicotiana plants were known and used since the antiquity. The plants have antiputrefactive and repulsive effects on insects and bacteria. Probably therefore, they were used at the embalming procedure. The nicotiana plants were used also ante mortem as stimulant and as a „domestical remedy“ too, but not as a strong medicinal agent. The origin of the plants and nicotine could be native, however an import of both nicotiana plants and nicotine, can not be excluded.

Cocaine was demonstrated only in naturally and artificially mummified bodies from Egypt. Its use may be related to the cocaine effects as tranquilizer and/or as stimulant. It is possible that cocaine was imported or have come from unknown Old World plants.

Further investigations may clarify the precise origin of both nicotine and cocaine.

APPARENTLY, drugs were known and used since the beginning of culture history. The source of its use was the fumigation, that is to say the burning of fragrant herbs or raisins in religious rituals in honour of the Divinity and the fire. At the burning different plants substances were released. Their inhalation caused physical and psychical changes which were perceived as "rapprochement" to the Divinity. The ancient Egyptians called the incense "snti" that signified "qualified for communication with the Divinity". More of the fragrant herbs were written down in the Pyramid texts. In the course of time the use of drugs of vegetable but also of animal and mineral origin was widespread in the folk medicine. Papyrus Ebers, the oldest collection of medical prescriptions, compiled for ca 4.000 years, as well as other papyri described the plants appropriations as e.g. remedy to provoke sweating, to aid conception, to prove fertility, for improvement of the hair growth and dye, beauty and juvenility. Moreover, the papyri contained also prescriptions for use of plants for magic, such a thing for love, fortune, curses, protection from the curses and other more (17,43).

Magical plants were mentioned besides in the Sumerian culture. The first great-epic of the universal history "Gilgamesch", described the immortality plant. Gilgamesch, the sovereign of Uruk (ca 2.600 BC) found the plant, but was not able to retain and use it. The immortality was reserved only to the Divinity (50).

An ancient herbal of the Chinese, compiled probably about 1.000 years BC by a mythical emperor "Shen Nung", described more than 300 medical drugs and demonstrated profound pharmaceutical knowledge (30).

The plants written down in the pyramid texts, described in several papyri or mentioned in ancient herbals, were, as a rule, native plants. With the increase of intercourse across foreign nations, plants of distant regions were imported and used. Recently, the presence of nicotine, the main alkaloid in tobacco, and its metabolite cotinine, was demonstrated in

hair, soft tissues and bone samples obtained from artificially and naturally mummified human bodies from Egypt, dated at a period spanning approximately the Third Intermediate Period (1.070 BS) to the Ptolomaic/Roman Period (395 AD) and 600 AD to 1.100 AD respectively (5,7). The alkaloid concentrations were tested by radioimmunoassay and gas chromatography/mass spectrometry, common tests to detect chemicals in samples. In dependence of regions and periods 15% to 60% of the samples were nicotine and cotinine positive. The alkaloids were also demonstrated in human remains from Europe dated from 2.000 BC to 1.500 BC, 300 AD to 1.000 AD and in skeletal finds from southern China aged 100 to 10.000 years (8,10,12). However, in samples aged 11.000 to 10.500 years, found in China, Jordan and Turkey, neither nicotine nor cotinine were detected (6,12).

It is accepted in general that the tobacco plants were not known out of America until 1492. However, the detection of nicotine and cotinine in ancient humans demonstrated its presence in the Old World long before the time of Columbus. These surprising data revealed new aspects of cultural history. This raised the question of the reliability of the discoveries, the source of nicotine, the reasons for its use, and the possible origin of the alkaloid. Consequently, before the mentioned results were discussed, it is necessary to agree to these important points.

1.1. Nicotine

NICOTINE IS a strong basic substance. It is soluble in alcohol, chloroform, ether and petroleum, and is miscible with water (40, 42). It passes speedy all physiological membrane, to say at the inhalation of the smoke to the lung alveolar tissue, at tobacco chewing to the gastro-intestinal mucose, and at contraction of the skin transcutaneous. The anti-smoke effects of plaster or ointment

based on the nicotine transfer through the skin.

The alkaloid is metabolised preponderate in the liver, but also in part in kidney and lung (28,52,54). As above mentioned, at smoke inhalation the alkaloid is absorbed to the lung alveoli and transported to the arterial blood. Through the left heart a part is transported to the head, the brain and the upper extremities. The remnant part reached the abdominal organs and lower extremities. Thus the liver as a metabolic organ is primarily avoided. Thereby an essential part of nonmetabolized nicotine circulated in the body and is deposited in all tissues. And this is the alkaloid amount which remained in the different tissues after thousands years too. Only the nicotine transferred by blood to the interior organs and the gastro-intestinal tract is metabolised. The metabolic way is: oxidation to cotinine, nicotine-1-N-oxyde, followed by further metabolism to hydroxycotinine, nor cotinine, and ting cleavage products (2). The time of metabolism and excretion is dependent to the individual different enzymatic activity, dose and duration use. The enzymatic activity correlated with both dose and use duration of nicotine. In habitual smokers is the alkaloid to 100%, in occasional smokers to 90% metabolised. In intestine is the metabolite nicotine-1-N-oxyde reduced by intestinal bacteria to nicotine and of the same way anew absorbed (entero-hepatic circulation). Also an intestinal reabsorption of blood nicotine takes place (entero-gastral circulation) (34). During smoke 75% nicotine pass over in the collateral stream. This is the part of smoke which escapes during the smoke process. The nicotine present in this stream is the source of the alkaloid for non-smokers. In blood of such persons nicotine levels similar to these found in blood of smokers with a consumption of ca. three cigarettes per day were found. The presence of nicotine in blood, urine, saliva and sweat of non-smokers exposed to tobacco smoke under natural conditions of a typical day was demonstrated. Consequently, at the present

time a differentiation of nicotine levels found after active or passive inhalation of smoke is not possible (9,49).

In addition, it may be mentioned that a reduction of the levels of nicotine and its metabolites takes place ante and post mortem. Nevertheless the alkaloids remain detectable in relatively high values a long time after use. The influence of environmental factors on the substances deposited in the different body tissues post mortem has not yet been clarified. Ambient moisture, decomposition processes, and embalming practice may play a role. Thus, it can not be decided if the concentrations measured present the original amounts immediately after death or amounts reduced during the centuries. Consequently, the data reported may be considered not at absolute values, but just for orientation concerning high or low concentrations.

1.2. Reliability of the results: that is a possible contamination of the samples and laboratory utensils and an instrumental error

THE FOLLOWING CONSIDERATIONS speak against a contamination: the samples of one series were stored since the excavation under homogenous conditions. The conditions in the laboratory were again homogenous and the samples were simultaneous investigated. Not only in the laboratory tract but also in the entire building existed a smoke prohibition which was completely followed. Before the investigations all samples were carefully washed with distilled water and alcohol. The washing water was tested and was nicotine and cotinine negative. Also all used chemicals were both alkaloids negative. The samples extracts were applied to the gas chromatograph/mass spectrometer after its careful rinsing with chloroform, until no traces of the sought substances were detected any more. If the storage rooms, the chemicals

or the laboratory utensils were contaminated, all samples should have been positive. However, only parts of the samples were positive. Thus, e.g. only 30% of samples found at excavations in Egyptian Nubia, and 36 % to 44 % of bone samples from Europe were positive (7,10). In samples from the Turkey, Jordan and China, aged 11.000 to 10.500 years neither nicotine nor cotinine were detected (6,12) . In 33 samples from Lenthia/Linz, Austria, only one sample was nicotine positive (10). Investigations of samples obtained from autopsies of recent humans showed positive results only in samples obtained from smokers too. However, as previously mentioned at the present time a differentiation can not be followed: passive or active incorporation of nicotine. The presence of the alkaloid in blood, urine, saliva and sweat of non-smokers exposed to tobacco smoke under natural conditions was demonstrated. In addition it was also showed that the body soft tissues, bone or hair have no effect on the measurements (9,49). All this excluded an contamination of the samples and an instrumental error.

1.3. To the possible source of nicotine and the reasons of its use.

THE HIGHEST NICOTINE levels were found in samples obtained from artificially mummified bodies from Egypt (248 ng/g to 2.798 ng/g). The cotinine levels ranged from 0 to 80 ng/g and reached only 3.4% (mean value) of nicotine. In naturally mummified bodies the nicotine amounts were significantly lower (26 ng/ to 70 ng/g) ($p=0.006$). The cotinine levels ranged from 10 ng/g to 32 ng/g and the ratio cotinine in % of nicotine was 40.3% (mean value). In skeletal finds from Europe the nicotine amounts were 38 to 132 ng/g, the cotinine 6 to 48 ng/g. Thus the nicotine levels in samples obtained from artificially mummified individuals were also significantly higher as these in skeletal finds

of Europe ($p= 0.0015$). The ratio cotinine in % to nicotine was 34.4% (mean value). Investigations of bone samples obtained post mortem of traffic accidents at autopsies of smokers showed nicotine amounts from 5 to 170 ng/g, cotinine levels from 10 to 202 ng/g. Cotinine reached 596% (mean values) of the nicotine amounts. The high ratio cotinine in % to nicotine indicated the nearly complete metabolism of nicotine and the corresponding deposition of cotinine in the body. In the samples of non-smokers neither nicotine nor cotinine were found (13). The results are depicted in figure 1. The extreme high nicotine concentrations detected in the artificially mummified bodies of ancient Egypt, the lower cotinine levels and the extreme reduced ratio cotinine in % to nicotine suggest that the death occurred shortly after the use of a high dose nicotine. The metabolism to cotinine was not been complete. However, it seems more possible that nicotiana plants were used post mortem at the embalming practise. Later the nicotine was distributed by diffusion in all tissues. The small cotinine levels may be related to a post mortem oxidation of nicotine to cotinine. Following facts speaks for this hypothesis. Nicotiana plants possess antiputrefactive and repulsive effects on insects a bacteria, properties known since the antiquity. Thus, the plant might have been used for the embalming procedure. This assumption is supported by the detection of nicotine (gel-chromatography and paper electrophoresis) and remains of nicotiana plants leaves (electronmicroscopy) in the mummy of Ramses II (35, 44), too. Also coleoptera of tabac, parasites of the tobacco plants which represent a risk to the plants even today, were found in the mummy (27,51). The Egyptians celebrated burials with bouquets and garlands placed among and over the coffins and in the tomb. Possibly, these included nicotiana plants infected with the coleoptera, or perhaps the insects were attracted by the tobacco aroma during the embalming. In the first day after burial, the parasites devoured the tobacco

leaves and died afterwards. Moreover, coleoptera were found also in the tomb of Tutankhamon (1). These facts indicated that the nicotiana plants were possible, present, known and used in ancient Egypt. The question can be raised why coleoptera and traces of nicotine or nicotiana leaves were not found in other mummies? However, no one has ever investigated mummies on coleoptera, nicotine or nicotiana plants remains.

The use of different plants for the embalming was at this time widespread. Thus in the mummy of Ramses II, among others, the presence of pepper (*Piper nigrum* L.) in particularly in the nasal cavity was demonstrated, too. Pepper, an aromatic and antiseptic substance, was utilised for the embalming procedure. According to Herodot, the viscera were cleaned with palm wine and than treated with pepper, ginger and cinnamon. After that the corpses were washed with other aromatics (47). Also, in the mummy of Ramses II remains of narcise, a plant of the family compositae, that posses similarities to nicotiana plants, preservative and insecticidal effects were detected (35). The samples obtaining remains of nicotiana and narcise leaves, were embedded in resin. Consequently, both plants were placed in the body before or during embalming processes possibly to protect the body, and cannot be results of accidental contamination's.

The nicotine amounts found in the naturally mummified bodies from Egypt or in skeletal finds from Europe, were lower than these in the artificially mummified corpses. The cotinine levels were less abundant, but the ratio cotinine in % of nicotine was substantial highest: 3.4% in artificially, 40.3% in naturally mummified bodies from Egypt, and 34.4 % in skeletal finds from Europe. This indicated that in the naturally mummified bodies the metabolism of nicotine to cotinine was advanced. Consequently, the nicotine respectively nicotiana plants, were used ante mortem possible as medicinal agents at

fumigations, taken orally or by application to the skin. Against this assumption speaks the following observation. Recently, 97 bone samples from the early antique burial site Gars/Thunau, Austria, and 33 bone samples from the late antique cemetery Lenthia/Linz likewise Austria, considered as a cemetery belonging to a military hospital, obtained from different populations aged 0 to 79 years, dated 300 AD to 1.000 AD, with various pathological deformations (porous accumulations, osteophytosis, callus formations, fractures, osteoporosis, cranial vessels impressions, cribra orbitalis, appositions on the lamina interna etc), were investigated of nicotine. The alkaloid was found in 34% of the samples from Gars/Thunau however the amounts in pathological extremely altered bones were not different from these found in the remaining bone samples. The alkaloid was found preponderate in infants with and without pathological deformations. In the samples from Lenthia/Linz only one samples from an infant without pathological founds was nicotine positive. This suggests that its use can not be related to a regular use as a strong medical agent, but only as a „domestical remedy“. (10). A permanent use of nicotiana plants by regular smoking or nutrition of healthy peoples may be excluded. Only part of the samples were nicotine positive, but the nutrition within a population and settlement was at that time identical.

In order to follow the question of the reasons of nicotine use, skeletal and hair samples from naturally mummified bodies dated from 600 to 1.000 AD, found in Egyptian Sayla, were investigated of nicotine, too. The age of the individuals ranged from 0 up to 59 years. Positive results were found in 115 from 134 bone and in 27 from 34 hair samples. The bone nicotine concentrations increased with the age of the individuals from 125 ng/g, reached the highest amounts in the group of 7 to 13 years (251 ng/g) and then decreased continuously. The nicotine levels found in the hair of the group 1 to 6 year old were

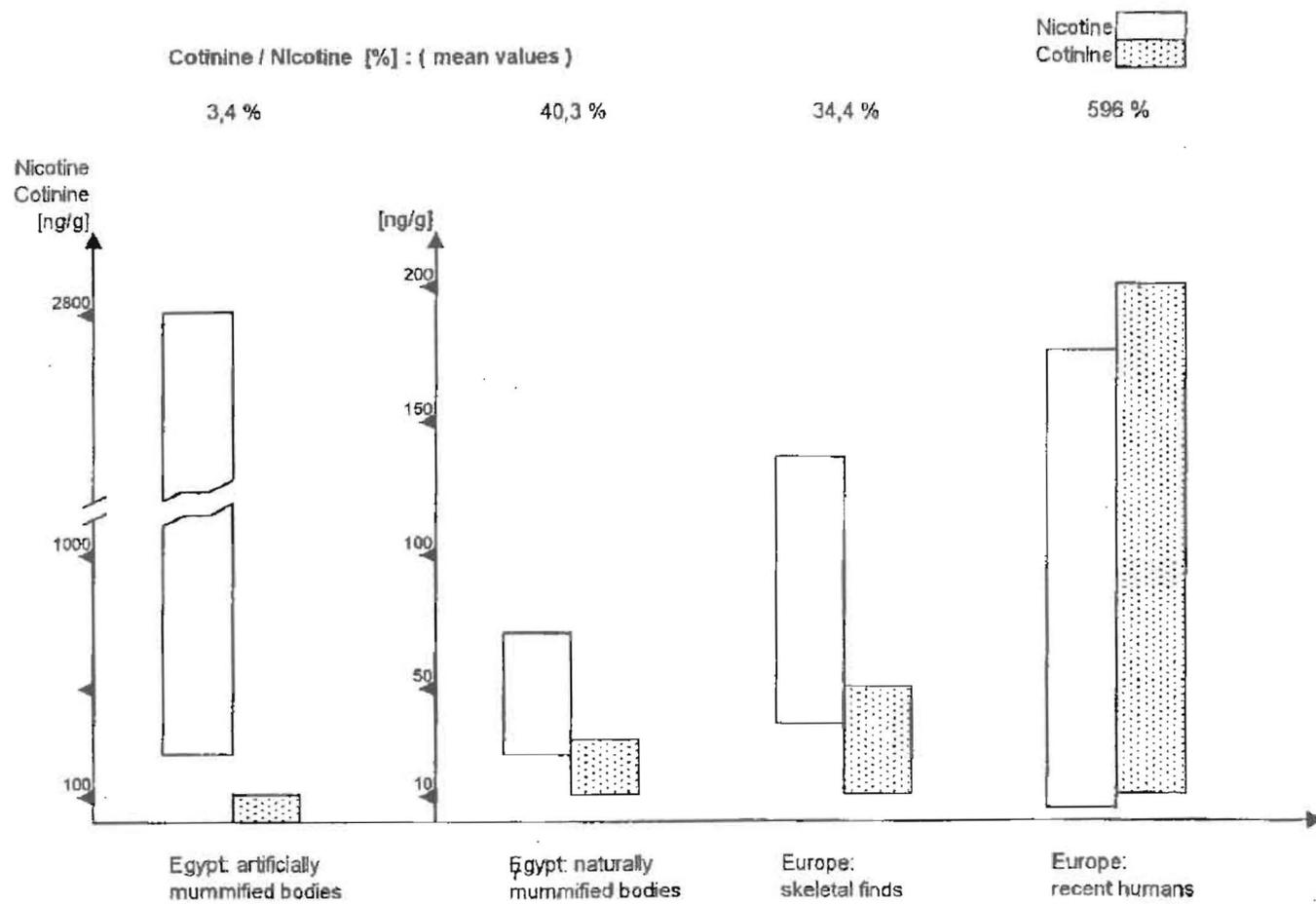


Figure 1: Nicotine and cotinine concentrations in artificially and naturally mummified bodies from ancient Egypt, in skeletal finds from Europe, in recent humans likewise from Europe, and the ratio cotinine in % of nicotine in the corresponding groups.

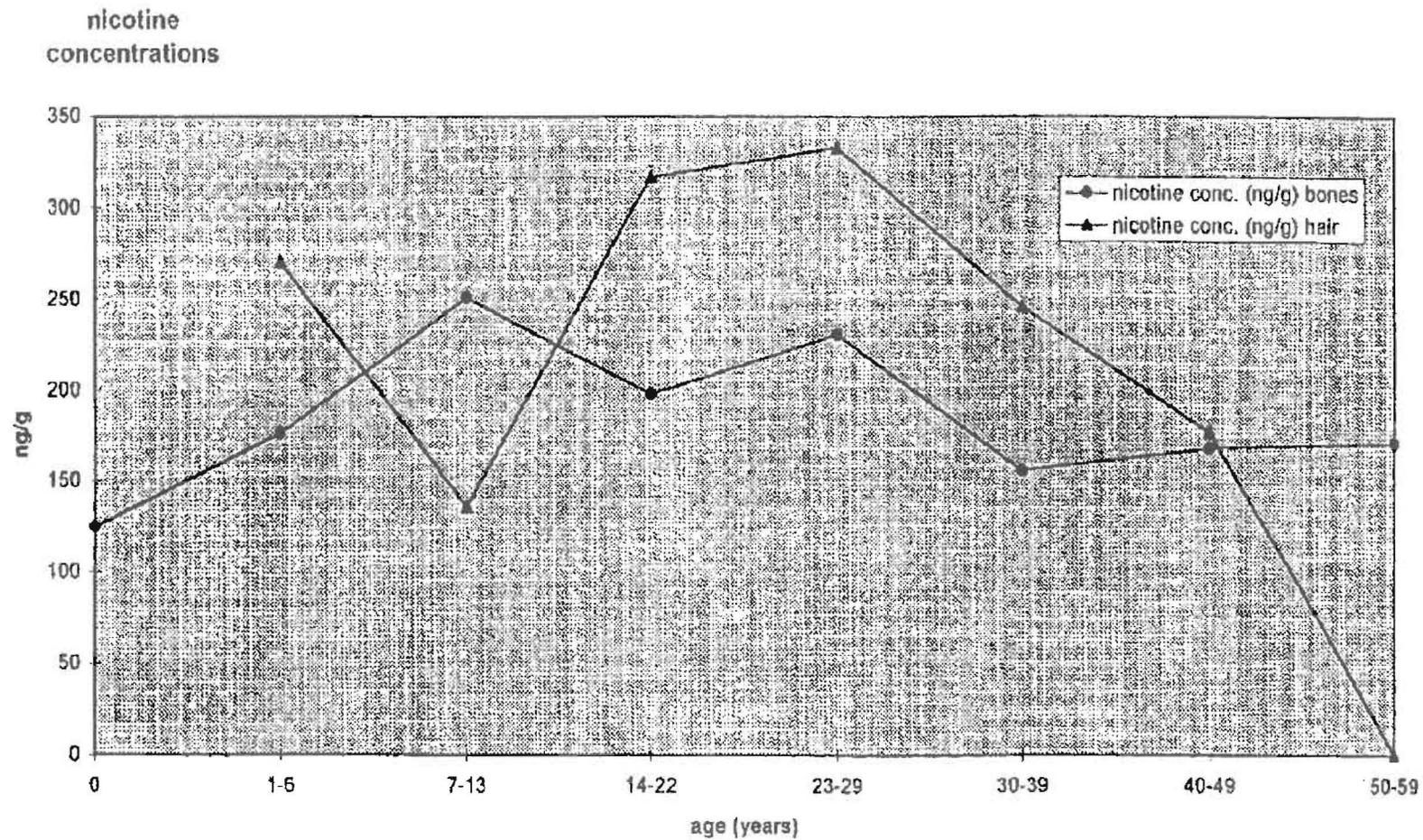


Figure 2. Correlation between the nicotine concentrations (ng/g, mean value) measured in the bones and hair samples and the age of the individuals (0 up to 59 years).

higher than these found in the group 7 to 13 year old children (271 ng/g and 136 ng/g respectively). Then the concentrations increased continuously up to 332 ng/g and at the age of 40 years decreased up to 177 ng/g (11). The results are depicted in the figure 2. The presence of nicotine found in the group of early childhood can be related on the one hand to its use as „domestical remedy“. On the other hand, the nicotine can be considered as motherly nicotine. The human placenta is permeable for the alkaloid and is also present in milk of smoking mothers. The fact that the nicotine concentrations in hair of 7 to 13 years old children were 50% lower than these found in the hairs of 1 to 6 years children supports this hypothesis. It can be assumed that at the age of 6 years the children were not longer breast-feed. Consequently, the transfer of the alkaloid with the mother's milk was interrupted. The increased concentrations of nicotine in hair after the age of 13 years, as well as the relatively constant levels found in bone of all individuals aged 7 to 29 years, can be related to the beginning of the working process and the use of nicotine as reinforcement. On the contrary, the decrease of the alkaloid amounts after the age of 30 years, may be considered as result of a reduced or not more present working process. In relation at the time, the age of 30 years was a high age.

The stimulating effects of nicotine were known already in the antiquity. These effects are mediated by the central nicotine-synapses into mesencephalic reticular formation with acetylcholine as transmitter. Release of acetylcholine can be provoked by neuropharmacological or electrical stimulation, but also by nicotine smoke or injection. The nicotine affects the behavioural functions, which are controlled by the cholinergic system. Nicotine leads to increased cognitive performance - this is the mowing power for smoking (55).

As a rule the nicotine concentrations found in hair were higher than these in the bone. This

may be related to the physiology of the hair. Drugs transported from blood into the hair matrix are distributed in the hair shaft, which is a tissue with a reduced metabolism. Consequently, all the substances deposited in the shaft remained for considerable periods present, if the hair was not cut. Investigations of hair and bone samples from recent humans showed likewise higher nicotine levels in the hair than in the bone (3,4).

1.4. To the possible origin of nicotine

NICOTINE IS the primary alkaloid of the tobacco plants. The plants belong to the nightshade solanum family. According to Theophrast plants of this family were known already in the antiquity (53). Berries of nightshade withania somnifera were found in the garlands of Tutankhamun's mummy as well as in the sacred necropolis Saqqara (31,33). More than 80 kinds of nicotine-containing plants belong to the family solanum. Nicotiana is the genus with the highest nicotine concentration.

The plants prosper in warm climate, in tropics and subtropics. Nicotine as secondary alkaloid is present also in withania somnifera, nightshade family, but also in plants of other families as e.g. zinnia elegans, family compositeae, nettle, family urticaceae, eclipta alba, family compositeae, erythrosylum coca, family erythroxylaceae, in the cherry, family rosaceae and others (29). In the time of the Napoleonic wars the tobacco price was extremely high. Therefore in England and France it was attempted to produce cigarettes from cherry leaves (22). However, this was not a profitable enterprise because the nicotine concentrations in the tobacco plants reached up to 8%, in the cherry leaves maximal up to 1%. More common food plants as e.g. aubergines, potatoes, tomatoes etc. obtained nicotine. In body fluid of recent humans, non-smokers, the alkaloid was demonstrated, however only in very small levels (24). In sight of the

decreasing nicotine concentrations ante and post mortem and the relatively high concentrations found in prehistorical bodies, it seems likely that only plants with a high nicotine concentration were used. Such plants are alone the nicotiana plants.

In the first catalogue of the Egyptian flora, tobacco as an agricultural plant, but also wild forms, widespread from the coast of the Red sea up to desert of Libya was described (26). If the tobacco plant was imported to Egypt in the sixteenth century, the question remains of whether it is possible that a plant in approximately 200 years rapidly developed new wild forms or whether the nicotiana plant, at least in wild forms, was already present in ancient Egypt. The evidence of coleoptera in the tomb of Tutankhamon and the mummy of Ramses II and the remains of nicotiana plants and nicotine present in the mummy, speaks for this assumption.

In the tomb of ancient Egyptians bouquets, garlands, jewels, food, and several utility articles were found. More of these articles were depicted on the coffin and tomb walls. Neither remains nor paintings of nicotiana plants were present. However, that is not strong evidence that the plants were unknown. Firstly, the plants were depicted sometimes such stylistically, that some plants remained unidentified up to today.

Secondly, not all plants were a frequent motive. Thus e.g. the willow tree. In many regions the willow tree was considered as sacred. Objects of willow trees were produced and used already 4.000 BC. However, only very few paintings of the tree exist. Thirdly, if nicotiana plants were used as medicine, they were not included in the tomb. And fourthly, more Egyptian names of ingredients remain still unidentified.

Benzoni 1565, described in its „Historia de Mondo nuovo“ the nicotiana plant as a plant imported in America by the Spaniard (16). Chardin 1711, mentioned in his travelogue a book called „De la Parthidi“. In this book

was, according to Chardin, reported that at the reconstruction of the city Sultania, an urn with pipes and fine cutted tobacco were found and the pipe smoke in Persia was known already 1200 AD (19). In excavation sites in the region Abu-Rausch, near the Gizen Pyramids, clay pipes, similar to these used today were found (45). According to the „Dictionnaire universale de Commerce“ 1723, tobacco imported from Egypt, was known and used in Persia long before Columbus (23).

Merxmüller and Butler discovered 1975 in Southwest Africa, in the shade of granite rocks a so far unknown tobacco plant. Morphological and karyological analysis demonstrated a relic endemite of great age. The authors called the plant „Nicotiana Africana“ (38). It is possible that this plant was imported and used in ancient Egypt. Trade relations by the Nile, its canals, the African coast as well as by caravan routes were known since ca 2.900 BC.

Thus, e.g. queen Hatshepsut imported incense trees from Punt, North and Middle Arabia. The Bible describes the import of aroma from Gilgead to Egypt. The ancient Egyptians managed to circumnavigate not only the African coast, but possibly crossed the Mediterranean too. Import of conifer from the Greek archipelago, birch-tree from Syria, cinnamon from Ceylon, China and Burma, indigo from India etc. is proved. At excavation sites in Egypt diverse products of Mycene, Crete, Cyprus, Rhodos and other Aegean Sea islands origin and vice versa were found (25). All these facts demonstrate the existence of active trade relations in the antiquity.

As mentioned above, nicotine was found likewise in skeletal finds of ancient China. According Bontius 1648, and later Loureiro 1794, in China was a native nicotiana plant present, which did not belong to the American nicotiana plant. The plant entitled nicotiana fructicosa has two Chinese names

„ca-thüoc-än“ and „Yen-ye“. The nicotiana tabacum the American kind of nicotiana, was imported in Canton through the first Dutch agency establishment 1567 and was called „Yen“ it is to say only „smoke“ (18,36). Mayen 1836, mentioned the tobacco smoke as an ancient Chinese custom (39). Today, the botanists consider the plant as a kind of the American nicotiana tabacum. It is also argued that if the plant is an ancient Chinese plant, Marco Polo, the „Globe Trotter“, would have described the plant in his travelogue. On the one hand, according to Becker, the plant was mentioned in one of the first translations of the travelogue. Later, based on a translation mistake, the plant was described as a dye-stuff (15). On the other hand Marco Polo has not described the tea-plant and the custom of tea-drinking also. However, the tea-plant was known and the tea drinking was a national Chinese custom (48). It seems possible that Marco Polo considered both tobacco- and tea-use as trivial customs and have not described them. It can be also hypothesised that possibly the nicotiana plants used in Egypt, were of Asiatic origin. At the time the Bering Strait, a bridge between the continents, was a way to migration from Asia to America. Recent investigations of a mummy found in Florida, aged 7.000 years, demonstrated identical genotype with these of Asiatic race, but not with these of Native Americans (41). Consequently, it can be supposed that also the nicotiana plants were of Asiatic origin. The favourable climatic conditions in America make a widespread of this kind possible. However, it seems more conceivable that the nicotiana plants were present since thousands years in all continents. Following facts support this deduction. As described above, nicotine and its metabolite cotinine were detected only in samples dated at 8.000 years BC. In the samples of age 11.000 to 10.500 years both alkaloids were not found. This was in accordance with the evolution of the global temperature. Its increase at the end of the last glacial epoch, approximately 7.000 BC, was

instrumental for the beginning of vegetational development, agriculture and stationariness. With the development of thousands of plants, different kinds of nicotiana plants come into being too. These plants, in dependence of the corresponding climatic conditions, were widespread, known and used since the antiquity.

2. Cocaine

ANOTHER PLANT used primarily in religious rituals is the coca plant *Erythroxylon coca*, a plant with a divine status, related in the past and present to ceremonial sacrifice in the Anden, but also known as reinforce, medicinal agent and anaesthetic used since centuries (20, 21, 37, 46). The anaesthetic and stimulating effects are related to the main alkaloid of the plant, the cocaine. Chewing coca leaves with addition of an alkali, e.g. lime, leads to a release of the alkaloid, and thus to a display of its effects. Coca-rich saliva was used for skull trepanation's as a local anaesthetic (32). Coca-plant is an Andean, in general a South-American plant unknown out of America until 1492.

Recently, cocaine was detected in samples of artificially mummified bodies of Egypt, from the Munich Museum, dated from 1070 BC to 395 AD. The concentrations ranged from 24 ng/g to 441 ng/g. The measurement was performed by radioimmunoassay and confirmed by gas chromatography / mass spectrometry (5). Cocaine was found too in skeletal samples from 71 individuals without signs of artificially embalming procedure, from Egyptian Nubia, dated 600 AD to 1100 AD. The age of the individuals ranged from 0 to 59 years. In 34 bodies hair remnants also were present and analysed of cocaine. The alkaloid was found in 56 individuals. The highest levels were found in the group of 1 to 6 years old children (82 ng/g). Up to the age of 22 years the concentrations decreased up to 52 ng/g and increased again up to 67 ng/g. Then at the age of 30 years the cocaine

amounts decreased steadily. The highest levels found in the children aged 1 to 6 years suggests that the alkaloid was used as tranquilizer or may be of maternal origin, too. It is possible, that it was used by the mother as reinforce and transferred across the placenta or through the mother's milk to the infants. The decrease of the cocaine amounts may be related to the end of breast-feed, and the new increase indicated its use as reinforce at the beginning of working process (14).

As mentioned for nicotine, it can not be determined if the cocaine amount measured in bone and hair represents the original values immediately after death or have been reduced during the centuries. The concentrations may be not considered as absolute values, but as a relative estimation of high or low concentrations, too.

In general, it is accepted that the coca plant was a South American import and was used in Africa, Asia and Europe firstly after

Columbus. However, it can not be ruled out that the coca-plant was possibly imported to Africa before 1492. Although trade relations between the New World and Africa are not known, the existence of links between the continents can not be rejected. The Norwegian anthropologist Thor Heyerdahl crossed the Atlantic in an Egyptian reed boat. Possibly, ancient people navigated South Americas rivers to the Atlantic, crossed the ocean and reached the African continent. But it can not be excluded that the source of cocaine could be an unknown Old Worlds plant.

The previous described results indicated the presence of cocaine and supported the hypothesis that the plant was known and used in ancient Egypt. The question of its origin may be clarified by further investigations.

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Zusammenfassung

Haar-, Gewebe- und Knochenreste von prähistorischen Mumien, aus Ägypten, Ägyptisch-Nubien (Sayala), Europa, China, Jordanien und der Türkei wurden auf Nicotin und Cocain untersucht. Das Material stammte aus der Zeit zwischen 9000 v.Chr. und 700 n.Chr.

Die Messungen wurden mittels Radioimmunoassay sowie Gaschromatographie / Massenspektrometrie durchgeführt. Für negative und positive Nicotin-Kontrollen wurden bei Autopsien von Verkehrsunfällen Proben von Rauchern und Nichtrauchern entnommen. Proben für negative Cocainkontrollen wurden ebenfalls von rezenten Menschen bei Autopsien von Verkehrsunfällen, für positive Cocainkontrollen bei Autopsien von Drogentoten gewonnen.

Je nach Region und Epoche wurde Nicotin gefunden. In Proben mit einem Alter von über 10.000 Jahren konnte Nicotin nicht nachgewiesen werden. Die Ergebnisse deuten darauf hin, daß Nicotianapflanzen in vorkolumbianischen Zeiten außerhalb Amerikas bekannt waren. Die bakteriostatischen und antiparasitären Eigenschaften der Pflanzen waren seit dem Altertum bekannt. Aufgrund dieser Eigenschaften wurden einerseits die Nicotianapflanzen bei Einbalsamierungen verwendet. Andererseits fanden die Pflanzen möglicherweise auch als Stimulans sowie bei Erkrankungen als "Hausmittel" Verwendung.

Cocain ließ sich nur in Proben von ägyptischen Mumien nachweisen. In Altägypten wurden Coca-Blätter wahrscheinlich bei Kindern als Sedativum und bei Erwachsenen als Stimulans benützt.

Beide Pflanzen, Nicotiana und Coca, sind möglicherweise einheimisch. Auch ein Import wäre jedoch denkbar. Der Ursprung des Cocains könnte auch eine z.Z. unbekannte Pflanze der Alten Welt sein. Weitere Untersuchungen sollen diese Fragen klären helfen.

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