

INVESTIGATION ABOUT LONG DISTANCE DRIFTS OF DOMESTICATED PLANTS -

DRIFT- AND GERMINATION EXPERIMENTS DELIVER NEW KNOWLEDGE ABOUT THE TRANSOCEANIC SPREAD OF CROP PLANTS

by

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Summary

When the first Europeans came to America they observed that the indigenous people already cultivated many crop plants. Instead of their first suspicion they rapidly learnt to use all these American agriculture products for their own nourishment. The European invaders exported the new plants into their home lands where these species were added to the existing crop plants very successfully. Today, more than 60 % of all these plants originally came from the New World, e.g. maize, potato, maniok, vanilla, cacao, tomatoes, chili, pineapple, avocado, sun flower etc.. The American (tetraploid) cotton replaced the original (diploid) cotton and opened the way free for its world wide economical use.

Finally, the American natives were also responsible for the domestication of the much desired stimulantia, like tobacco and coca. Before the spectacular discoveries of traces from nicotine and cocaine in Egyptian mummies by SVETLANA BALABANOVA, everybody believed that these stimulantia appeared in the Old World only after the discovery of the New World by COLUMBUS. These suggestions were supported by the mainstream opinion that prehistoric navigation was not able to realize a back and fourth voyage and to connect the Mediterranean world with the lands beyond the Strait of Gibraltar. But now, after the ABORA II Expedition, indications have become stronger that an advanced navigation has existed long before the antique civilizations. The team around the two biologists Mrs. CORNELIA LORENZ and Mr. DOMINIQUE GÖRLITZ made entirely new drifting experiments with cultivated plants. This study was supported and carried out in cooperation with the renowned Institute for Plant Genetics and Crop Plant Research Gatersleben (IPK Gatersleben) under assistance by Dr. ANDREAS BÖRNER – responsible for the maintenance of the gene bank collection in Gatersleben.

Seeds and fruits of six species were selected to investigate their salt-water resistance and ability for long distance drifts. Two test examples were towed 1165 nautical miles through the Eastern Mediterranean Sea behind ABORA II. An other fraction of the same species was kept in the seed store in the IPK Gatersleben. After the voyage the test seeds (plants) were cultivated in the IPK Gatersleben to investigate their germination rate. These data support the hypothesis that a transatlantic exchange of seeds and cultivated plants by oceanic drifting

is very unlikely, due to their botanical properties. The introduction of several cultivated species into the American agriculture must then have been the result of transoceanic voyages by prehistoric cultures across the Atlantic as well as the Pacific Ocean. This article discusses this important question, based on completely new experiences in the field of experimental research and plant genetics.

The beginning of agriculture in the Tehuacán Valley

ALREADY 5000 years BC. the people of the Tehuacán valley in Central-America started the first attempts in cultivating plants. Step by step they learnt to domesticate the first crop plants which were easy to breed due to their favourable biological characteristics. One of the first plants were the bottle gourds, other cucurbits, tornillo, amaranth, chili and perhaps avocados. The early fields did not need a lot of care and they did not contribute very much to the nourishment of man. These people were hunters and collectors, completing their menus during certain periods only by plants. Around 3400 BC. when the population increased, the hunters settled down and changed their way of life. Now, on their fields, tiny maize fruits and a lot of other new crop plants appeared. The domestication of maize was probably the most important step for the development of the American agriculture. "This agriculture should be the result of a climatical change in the late Pleistocene... and the early Holocene. On base of the changing vegetable conditions the supply of important food plants was less calculable than before"(1). This was the pressure to invest more time and care in the breeding of plants, which more and more constituted the nourishment of the natives.

During the following centuries the agriculture spread out from its two centers in the Tehuacán and Oaxaca valley. How the maize came to South America, is as controversial as its domestication in Central America. The literature is very extensive and sometimes

contradictory. According to the mainstream, maize was developed by natural mutation and hybridization of his nearest wild relative – the teosinte (*Zea mexicana*) (2). Under natural circumstances there occur often hybrid plants between maize and teosinte. Both forms have the same number of chromosomes and have the same anatomical features. Moreover, they have the same spreading area in Meso-America and in many parts of Mexico. The teosinte is called > madre de maiz < - mother of the maize. In opposition to this theory other botanists believe that both, maize as well as the teosinte, arose by hybridization of an unknown ancestor of maize and the genus *Tripsacum*, a related wild grass (3).

In each case the maize is the result of a chain of occurrences in which man intuitively intervened. Thus the evolution of maize is a favorable example for the main principle of evolution: coincidence and necessity, the development of new qualities by combination of existing species as well as the influence of several different species including ourselves as human beings.

HOWEVER, the development and spread of crop plants was never a one-way street. It is very interesting to see, that the victory of maize did only occur in combination with the development of other crop plants and the successful transfer of their breeding methods. So, it seems rather unlikely that the increase of the thumb-sized fruits of the teosinte to the typical size of the ears of maize was totally independent from the hybridization of cotton at the end of the 4th millenium BC.. What was the reason for such breeding attempts? Did

they occur just accidentally, or based on cultural interaction by other agricultural centers?

THESE QUESTIONS lead us to one of the most interesting problems in the field of cultural diffusion. It has been discussed, since the beginning of botanical research, whether the origin of American agriculture was completely independent or if the idea has in some way been imported from the Old World? The majority of scholars maintain that the agriculture of the New World would have mainly been invented in isolation from Old World influences. This may have been the case for most of the American crop plants. However, there are two exceptions - the bottle gourd and the cotton, which were very important for the development of the agriculture in the New World.

Bottle gourd and Cotton – imported or indigenous?

The bottle gourd *Lagenaria siceraria* is a member of the family *Curbitaceae*. In contrast to the most pumpkins, bottle gourds are mainly used as containers for food and water, as scoops, bowls or even as music-instruments (4).

Six different species belong to the genus *Lagenaria*. It is monophyletic, and the region of its origin is thought to be in Africa. Today the species *Lagenaria siceraria* is cultivated throughout the entire area of the tropics. Therefore, the question of the primary area of spread is disputed, but most botanists believe that it is Africa (5). This species has two different subspecies (geographical races). One can distinguish them by the characteristics of leaves and seeds. The first type *Lagenaria s. subsp. siceraria* is mostly located in Africa and America. The second type *Lagenaria s. subsp. asiatica* exists mainly in Asia and Polynesia.

The bottle gourd belongs to one of the oldest crop plants in America. Many botanists make

it responsible for the development of the American agriculture, as in the pre-ceramical period it was the only possibility to carry water and irrigate the dry fields, like as is known from Oaxaca. Moreover, the bottle gourd was the only container to store food, water and corn. It occurs very early in excavations but there are no wild ancestors in the New World.

Because of the fact, that the occurrence of all five related *Lagenaria* species is limited to Africa, the majority of the botanists propose Africa as the primary region of origin (6). Therefore it is assumed, that the ancestors of the domesticated bottle gourd were originally dispersed in Africa too. There, it possibly could have been domesticated long before 6000 BC. and then spread by African explorers to America (7). Other scholars reject this theory, because they reject the principle to infer the primary centre of origin only on the existence of wild ancestors.

THE OTHER exception which contradicts the autochthonous origin of the American agriculture are the different species of the American cotton. The origin of cotton is also very controversial but its introduction into the New World was much more difficult than the bottle gourd. When the Spaniards conquered the American continent, they met splendid temples, colossal buildings and the representatives of a highly developed culture. The inhabitants of prospering cities in the narrow belt between Mexico and the area of the Andes in Peru and Bolivia wore magnificent gowns made of coloured (polychrome) cotton clothes, which were woven on looms that were of exactly the same kind as the ones used by cotton cultivators of the Old World. For centuries, people believed in an interesting parallel of domestication: the indigenous Americans were said to have made the step towards cultivation of cotton and its use independently. Even though some botanists complained that the first finds in Mexico, in Teotihuacan-Valley, from about 3500 BC. appeared at a rather late period of

time; this critical voices were either hushed up or suspended by the fact, that even this period is marking the beginning of the American agriculture. The lack of archaeologically ascertained preliminary stages of looms, from the easy, horizontal to the vertical one, as well as of artefacts from deeper, older layers did not seem to interest anybody or it was simply ignored due to the lack of interest.

By this way the thesis of an indigenous cotton domestication on American soil has been established among botanists until 1947, where three young American phytotomy genetics, HOUTCHINSON, J.B., SNOW, R.A., STEPHENS, S.G., studied the problem. What science had thought impossible, the genetic material for the cultivation of spinnable seed hair in America, came, against all assumptions, from the Old World. How is it possible, that cotton species of the genus *Gossypium* do grow in the American hemisphere?

THE WORK OF the phototomy genetics was, strictly speaking, very simple. With the help of microscopes they compared sets of chromosomes of the families from the New with those from the Old World, thereby finding that American non-spinnable species distinguish from their relations in the number of chromosomes (carrier of the genes). All wild species in America are not spinnable, contain 13 small chromosomes and are diploid. Apart from their species there are three cultivated families which are spinnable and tetraploid. They contain 13 small and 13 big chromosomes and appeared in America before the beginning of the first advanced population. This striking difference in the set of chromosomes immediately points to the Old World, where all cultivated or wild species contain 13 big chromosomes. Only their seed hair is long enough to be processed to spinnable fibres (8). The fact that spinnable tetraploid cotton species appeared in America only about 3 500 BC., although their relatives had been growing on the continent for million of years, leaves only

little room for further explanations: The genetic material of the 13 big chromosomes seems, in some way, to have fallen into the hands of the early farmers in order to be crossbred with indigenous, non-spinnable cotton plants. The hybridization can obviously be proven by archaeological material that has been found. All in all several American hybrids were bred, all of them appeared for the first time about 3 500 BC.

FROM WHERE did the pre-Colombian farmers get the seed material for the cross-breeding? Was a handful of seed samples drifting across the Atlantic Ocean sufficient to motivate farmers to start experiments of cross-breeding with the wild plant that had been useless until then?

Ethnographic studies of native tribes in Africa cannot prove the first use of African cotton, but demonstrates doubtlessly, that Africans have used these plants for their daily life since time immemorial and are still using them today. West-African tribes use the fibres of the stem of all today cultivated species, *Gossypium herbaceum*, for many different purposes in farming. Apart from the use as textiles, African fishermen use, as already mentioned, cotton nets together with bottle gourds for fishing. The expert of ethnobotany, CHARLES B. HEISER, has surprisingly proved that also on the coast of Brazil, fishermen use the same method of fishing. The combination of several useful plants for one purpose in a common feature, strongly points to cultural contacts. (Figure 1)

But if these plants had to be introduced to Brazil from other countries, because they did not exist in Brazil, one can no longer maintain the dogma of the independent development of the American agriculture.

The phytogeographer CARL O. SAUER points to the fact, that the bottle gourd and the cotton appeared in the New World so early, that they might have possibly stimulated the development of the American



Fig. 1: The transmission of the immaterial methods for breeding and usage is much more important than the genes and plants themselves. But that could only happen by the ancient navigation which was powerful enough to cross the Atlantic Sea before the development of the advanced civilisations.

agriculture. An Atlantic Ocean crossing without an active participation of humans might have meant, according to his opinion, that a „waiting farmer“ on the coast of Brazil received the bottle gourd and the cotton and immediately recognised its cultural value (9). The number of references of a transmission of biological plant material to the early American farming cultures can no longer be doubted. The question, which is still not answered, is the way by which the germplasm were introduced to the Old World.

Two American plants in the Old World before COLUMBUS?

MAYBE, it was the most important discovery of ethnobotany at the end of the last century, when the mummy of Ramses IInd

was transferred to Paris at September, 26th 1976. With this event a big investigation and restoration campaign started which should have shed completely new light on the transatlantic connections before COLUMBUS. A group of scientists under the leadership of Dr. MICHELE LESCOT from the Musée de l'Histoire Paris investigated the source of the damage of the famous human body. It was supposed that the damages came from beetles, but unexpectedly they found remains of leaves of the tobacco plant. Tobacco belongs to the *Solanaceae* plant family and is actually originated in America. The tobacco remains which were found in the inner side of the mummy of Ramses surprised botanists as well as egyptologist because tobacco was allegedly unknown in the ancient world. The discoverer believed that the filling with tobacco leaves was

intended to preserve the body tissue with phytotoxin to protect it against insects, bacteria and fungi (10). The researchers published their results but they were attacked by the majority of colleagues. The critical arguments culminated in the suspicion of contamination during the excavation of the mummy, with an unknown native tobacco species in Africa although tobacco was only proved in the pre-Columbian America. (Figure 2) But this problem of origin was denied by almost all scientists and it took more than 16 years before the nicotine 'story' was resumed.

SVETLANA BALABANOVA a toxicologist at the forensic institute of the university of Ulm conducted a series of unique experiments on examples of Egyptian mummy remains at the museum of Monaco. Dr. Svetlana Balabanova investigated samples from different parts of the mummified remains. Her results were exciting and unexpected. She found that all mummies contained a big amount of drugs. Apart from a high concentration of hashish (genus *canabis*), which was not surprising because *canabis* was quite commonly used in Pharaonic Egypt, the team around Dr. Balabanova discovered high deposits of nicotine and even cocaine. Both alkaloids are typical stimulants in drug plants of the New World. Their existence in Egyptian mummies was a real enigma for all scientists. It was quite impossible to explain from where the tobacco came into the Egyptian mummies. However, cocaine is an exclusive product from the shrub *Erythroxylon coca*. It was the typical drug of the Andian Indians in Bolivia and Peru. There, the natives chew coca leaves to protect them against hunger and exhaustion. Botanical research shows that this plant is endemic only in South America, and this genus has with just one exception no other relatives in the Old World. Its introduction into the Old World took place just in the end of the 19th century (11). Of course Dr. BALABANOVA and her team had doubts about their own results.

Therefore, they sent all examples to other laboratories where the results were confirmed. Since the first tests Dr. Balabanova and her colleagues have done about 3000 similar tests of mummified bodies with an age between 800 to 7000 years. The examples came from Egypt, Nubian (Sayala), China, Turkey and even Europe. All samples were analysed by common analytic methods (radioimmunoassay, gas chromatography and mass spectrometry) (12). Nicotine and cocaine could be proven in a big number of the test objects. After long and controversial discussions one can say that methods and results are incontestable (13).

The discovery of these two American drug plants in non-American mummies leads us to necessity for further discussions about the transoceanic voyages and cultural interactions before Columbus. Even if we have no direct evidence for the influence of the development of the American agriculture by an Old World farmer, the existence of cultivated plants from both sides of the Atlantic Ocean cannot be denied anymore. We have to consider that the spread of domesticated plants and animals into new habitats is a very difficult process which is mainly dependent on the support of man who has bred these species out of the nature. Usually, crop plants lost a large number of genes of the gene pool during domestication because man was only selecting some features of genomes of the original species. This leads to a decrease of the genetical variability and thus to a loss of the natural power of resistance. For this reason the introduction of new crop plants into foreign habitats is very unlikely without the aid of man. Even if the origin of tobacco is still controversial one did never find any native coca-plant in the Mediterranean world or Africa. However, the fact, that Mediterraneans have used pieces or products of both New World species is a very strong indication for cultural interactions between both hemispheres. This use cannot be explained just by the drifting of plants.

Cultivated Plants from the Old and New World

from Africa



Cotton with flowers of the species *Gossypium barbadense*.



Fruits of *Lagenaria siceraria* subsp. *siceraria*. The shield berries are very variable in size and shape.

from America



The coca-plant and their leaves. The plant is originated in the Andes and spread until Mexico.



The flowers of *Nicotiana tabacum*. The Indians used the leaves for smoking.

Fig. 2: Presentation of the four most interesting domesticated plants which are in suspicion to be spread by the aid of man across the Atlantic Ocean. From left to right: Up) cotton-plant and bottle gourd fruits and down) coca as well as the tobacco-plant.

across the Atlantic Ocean, particularly when we are speaking about the use of at least four different domesticated species from several regions.

Interdisciplinary Research delivers further Arguments

THE BIOLOGY can enumerate a lot of examples that species have conquered distant new habitats by land or by sea. Such processes are mostly caused by changing of the living conditions or an overpopulation in original biotopes. The move to remote habitats could have happened by active or passive processes. Active moves are the flight of birds or terrestrial roaming of big mammals. Passive moves are related to zoological or climatic effects. So, animals are often important vehicles for a passive spread of plants or little animals. In case of the transatlantic spread of domesticated plants only birds or big marine animals are able to carry seeds or fruits over several thousands of miles to the other side of the Atlantic. According to our knowledge there are just some known kind of birds, who are regularly crossing the Atlantic: one of them is the sea swallow (*Sterna paradisaea*). However, the sea swallow is an arctic bird who has no habitat in the tropical Africa or America where bottle gourd, cotton, coca or tobacco is growing. Their flight route is also not touching the living habitats of these plants. They are starting their journey in North Canada, via Greenland to Ireland and they follow the Western coast of Europe and Africa before they cross the Atlantic either following the North-Equatorial current to Brazil or across the South Atlantic passing Antarctica back to America. This bird migration is probably the longest which is regularly covered by birds and is estimated to cover 35.000 to 40.000 km (14). Even if such a sea swallow should have occasionally brought a seed of coca or tobacco from the New World to Europe, how would an Egyptian mummy expert get such a seed into his hands? From where from should he get

the knowledge about its purpose or the necessity to breed it? (Figure 3)

An other possibility for the common habitat of tobacco, gourds or cotton is the global changing of the earth surface by the continental drift. It is an important fact that this drift has split a single population into two different ones. However, we know that the modern plants (angiosperms) did arise quite late during the end of the Cretaceous period. Highly developed plant families like the *cucurbitaceae* (bottle gourd) or *solanaceae* (tobacco) arose much later during the Tertiary. In that era Africa and America were already separated for millions of years. Seeds and fruits of those plant families had to drift thousands of miles across the ocean in order to reach the new continent without the help of man or birds. Therefore, the lack of any ancestors in early excavation layers shows that these species arrived very late at their new homelands. The archaeology shows that the bottle gourd appeared about 5000 BC. and the cotton about 3500 BC. in the New World. On the other hand, nicotine and cocaine probably came to the Old World a few thousand years earlier. That means these four species had millions of years of time to drift across the Atlantic, but they did not. They appeared exactly in the same period when the first sailing attempts took place in the Mediterranean and Chinese World. (Figure 4)

NEVERTHELESS, it could have happened that the species started their drift very late. The Old World species like cotton and gourd could have fallen into the river Niger, then drift with the help of North-Atlantic currents to America. The oceanographic conditions are not unfavourable in this area. The unique condition for such a long voyage is a sufficient salt water resistance. Therefore, it is fundamentally important to have a good knowledge about this capability. Such a drift across the Atlantic Ocean would need at least four to five months. However, botanists have no experiences about the drifting capability



Fig. 3: The sea swallow (*Sterna paradisaea*) has the longest bird migration in the world which is regularly covered by birds. The sea swallow crosses two times the Atlantic during its migration and covers an unbelievable distance of about 35.000 to 40.000 km per year.

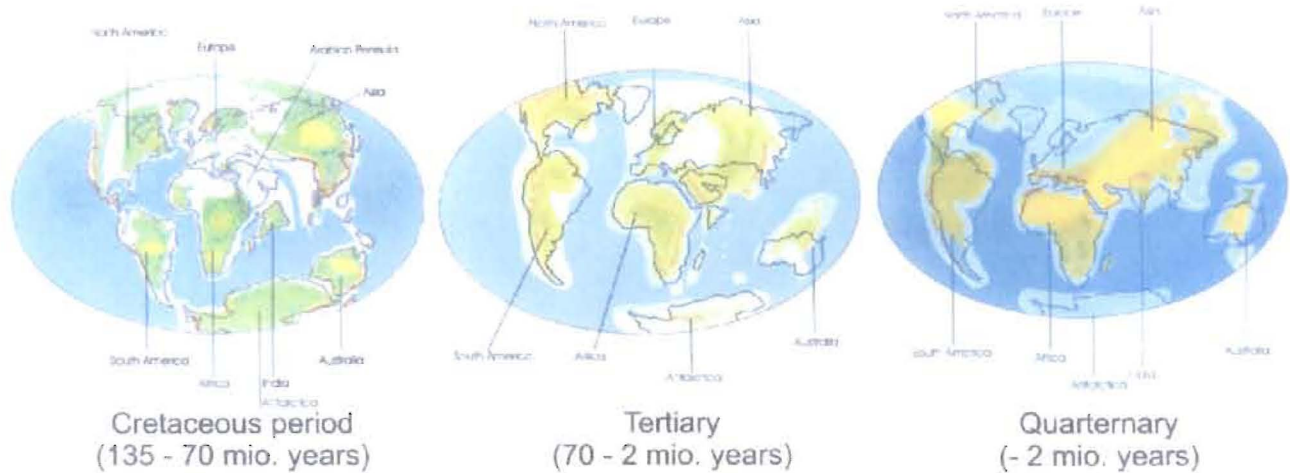


Fig. 4: The continental drift is an other important fact which can divide an primary population into two parts and thus in two different species. However, most of the modern plant families arose during the tertiary. In that time Africa and America were already quite remote from each other. (according to "Das Visuelle Lexikon", Gerstenberg Verlag, Hildesheim 1996)

of domesticated plants. Even the coconut, optimally adapted for a spread by the sea, cannot drift for several weeks in the ocean without losing its germinating capability. This has been shown already in 1941, in an experiment of the Hawaii islands, where the coconuts, after 4 - 6 weeks had lost their germination capability, because bacteria entered through their germinating pores, so that the young sprouts died (15).

Unfortunately, we cannot apply such results for all plant species. This would be mere speculation. For this reason the ABORA team started tests to investigate the salt water resistance already in 1999. Co-operating with IPK Gatersleben and on board of the reed boat ABORA I they tested the drift capability of selected cultivated plants under realistic maritime conditions.

First knowledge of the drift capability by open sea experiments

AS YET EXPERIMENTAL investigations have been based only on simulated experiments using sea-water. These experiments were made over several months and mainly delivered positive results with regard to the salt-water resistance. For the two important African species bottle gourd and cotton one found out that *Lagenaria siceraria* could resist 273 days and *Gossypium herbaceum* could survive even 9 month of immersion (16, 17). Most results of our study are in conflict with the today's majority opinion regarding these findings, especially with respect to the geographical and botanical origin of these early imported American cultivated plants.(18) (Figure 5)

THE DRIFT investigations took place with five species by towing them behind the reed boat ABORA I namely: several local kinds of barley of the genus *Hordeum*, pumpkin, yam root, the African diploid cotton *Gossypium herbaceum* as well as the bottle gourd *Lagenaria siceraria*.

The samples remained in the sea water for 26 days in the sea water. The results of this first experiments are very remarkable, because most of the species died after a few days of immersion.(19) Probably the most important result was the dying of all cotton seeds, although all botanists believed, after simulated experiments in salt water basins, that the seeds could survive more than nine months in sea water. Our test result contradicts the widespread hypothesis, that African seeds could be spread out by a transoceanic drift out of Africa, possibly already at the beginning of the Pleistocene (20). If these species cannot survive a drift period of about one month, how could they reach the coast of America without losing their germination capability after 5 month of immersion?

The same results we have got with other species, except the bottle gourd. From our three bottle gourd samples, one survived with a high rate of 67 % of all seed specimens. This was a first indication that the bottle gourd has a drift capability at least for one month.

Unfortunately, for all specimens we had to reduce the number of the representative species. Moreover, we tested not all geographical variants. The uncertainty factor of uncertainty can be seen in the limited duration of our drift experiments with only 26 days. This time span is not more than 1/5 of the time of a simple drift across the Atlantic. Therefore, the drift data for the bottle gourd are not a direct proof for its ocean drift capability. There are first indications, that the shield berries of the bottle gourd have a higher resistance than other domesticated plants.

For this reason it was absolutely necessary to continue and improve these experiments by further maritime expeditions. Only three years later we organised the next reed boat expedition ABORA II where we also carried out drifting experiments in order to increase



Fig.5: The specimens were towed behind the reed boat ABORA II. We investigated the seeds in two test variations in the Mediterranean Sea: 26 and 63 days. After the Immersions all seeds were dried and later germinated at the IPK Gatersleben.

our knowledge about the drift capability. It was an unique chance to learn from our first experiences and to improve our methods as well as the spectrum of species. In contrast to ABORA I we investigated 77 representatives of cultivated and wild barley, 8 cotton samples as well as 18 samples of the bottle gourd which contained many representatives of both subspecies of *Lagenaria siceraria* *subsp. siceraria* and *subsp. asiatica*. For the first time we also tested 15 samples of tobacco (*Nicotina tabacum*) and 12 of hemp (*Canabis sativa*). Unfortunately, due to customs regulations, it was impossible to also investigate specimens of the coca-plant.

THE VOYAGE of ABORA II was a big success. The reed boat was able to tack even 75 degrees against the wind. Apart from the expedition results, the plant specimens were towed behind the hull until 63 days. The duration of immersion was increased of two months and thus much more realistic than with ABORA I. All tests were again prepared and analysed by the IPK Gatersleben.

Objective Part of the Survey

THE ANALYSIS of the previously discussed references showed, that man already exported cultivated plants from the first agricultural centres of the *Near East* and *Africa* at a point in time much earlier than assumed until today. The spreading of the first domesticated plants occurred by land as well as by sea. The fact that during the Neolithic even the most remote areas of the West-African and the European continent were reached, is today generally accepted by the majority of the ethnobotanists and zoographers. The question if a spreading of species bred by man reached the pre-Columbian people in America is the subject of this survey. For this study different cultivated plants were chosen, which on the one hand are in the centre of attention of ethnobotanic research and on the other hand

also appeared to be interesting objects of research.

Within the tests the following questions are to be scrutinized experimentally:

1. How do these cultivated plants behave under the conditions of an ocean drift?
2. How many days do they keep their ability to sprout after being exposed to the water?
3. Which differences do we observe in the new results according the first drift analysis from 1999?
4. Are there any differences in ability to germinate between the subspecies with respect to the different geographical occurrence within one species?
5. Of what importance are the tests of drifting and germinating for the ethnobotanical research?

Experimental part

Plant material

In total 130 accessions originated from the genebank collection of IPK Gatersleben and belonging to the genera *Hordeum* (77 accessions), *Lagenaria* (18 accessions), *Gossypium* (8 accessions), *Nicotiana* (15 accessions) and *Canabis* (12 accessions) were investigated. The genebank holding numbers, species and geographical origins of the material studied is given in table 1. Seed samples were divided into three equal parts, one of which was stored in the seed store of the IPK. The other two samples were used for the drift experiments lastin 26 and 63 days, respectively. In addition two shield berries harvested in 2001 were included (accessions LAG 76 and LAG 83). The berries were removed from the sea water after 26 (LAG 76) and 63 (LAG 83) days.

TABLE 1: Accession number, species and geographical origins of the material selected for the investigation. They are only listed bottle gourd, cotton and tobacco:

Table 1

Lagenaria

LAG 33	<i>Lagenaria siceraria</i> subsp. <i>asiatica</i>	unknown
LAG 37	<i>Lagenaria siceraria</i> subsp. <i>siceraria</i>	Libya
LAG 38	<i>Lagenaria siceraria</i> subsp. <i>siceraria</i>	Libya
LAG 41	<i>Lagenaria siceraria</i> subsp. <i>asiatica</i>	Italy
LAG 44	<i>Lagenaria siceraria</i> subsp. <i>asiatica</i>	Italy
LAG 45	<i>Lagenaria siceraria</i> subsp. <i>asiatica</i>	Italy
LAG 48	<i>Lagenaria siceraria</i> subsp. <i>asiatica</i>	Georgia
LAG 49	<i>Lagenaria siceraria</i> subsp. <i>siceraria</i>	Georgia
LAG 53	<i>Lagenaria siceraria</i> subsp. <i>asiatica</i>	Libya
LAG 54	<i>Lagenaria siceraria</i> subsp. <i>asiatica</i>	Libya
LAG 55	<i>Lagenaria siceraria</i> subsp. <i>asiatica</i>	Irak
LAG 56	<i>Lagenaria siceraria</i> subsp. <i>asiatica</i>	Irak
LAG 71	<i>Lagenaria siceraria</i> subsp. <i>asiatica</i>	Tunesia
LAG 75	<i>Lagenaria siceraria</i> subsp. <i>asiatica</i>	Italy
LAG 76	<i>Lagenaria siceraria</i> subsp. <i>siceraria</i>	Niger
LAG 77	<i>Lagenaria siceraria</i> subsp. <i>siceraria</i>	Albania
LAG 78	<i>Lagenaria siceraria</i> subsp. <i>siceraria</i>	Cuba
LAG 80	<i>Lagenaria siceraria</i> subsp. <i>asiatica</i>	Austria
LAG 76 (berry)	<i>Lagenaria siceraria</i> subsp. <i>siceraria</i>	Niger
LAG 83 (berry)	<i>Lagenaria siceraria</i> subsp. <i>siceraria</i>	Italy

Gossypium

GOS 1	<i>Gossypium herbaceum</i>	unknown
GOS 14	<i>Gossypium herbaceum</i>	Morocco
GOS 16	<i>Gossypium arboreum</i>	Korea
GOS 17	<i>Gossypium hirsutum</i>	Italy
GOS 18	<i>Gossypium arboreum</i>	Korea
GOS 19	<i>Gossypium arboreum</i>	Korea
GOS 21	<i>Gossypium hirsutum</i>	Tunesia
GOS 23	<i>Gossypium sp.</i>	Gambia

Nicotiana

NIC 201	<i>Nicotiana tabacum</i>	unknown
NIC 245	<i>Nicotiana tabacum</i>	unknown
NIC 286	<i>Nicotiana tabacum</i>	unknown
NIC 307	<i>Nicotiana tabacum</i>	Romania
NIC 309	<i>Nicotiana tabacum</i>	unknown
NIC 312	<i>Nicotiana tabacum</i>	unknown
NIC 317	<i>Nicotiana tabacum</i>	unknown
NIC 321	<i>Nicotiana tabacum</i>	Hungary
NIC 379	<i>Nicotiana tabacum</i>	USA
NIC 396	<i>Nicotiana tabacum</i>	Peru
NIC 397	<i>Nicotiana tabacum</i>	unknown
NIC 526	<i>Nicotiana tabacum</i>	Cuba
NIC 527	<i>Nicotiana tabacum</i>	Peru
NIC 530	<i>Nicotiana tabacum</i>	Cuba
NIC 531	<i>Nicotiana tabacum</i>	Cuba

Germination test

FROM EACH accession three seed samples were investigated. Beside the control sample kept at the seed store in Gatersleben two treatments (26 days drift and 63 days drift) were investigated. The germination tests were conducted according to the ISTA rules (21) in paper rolls (*H. vulgare*) or on filter paper (*Hordeum* wild species, *Lagenaria*, *Gossypium*, *Nicotiana* and *Canabis*) on a Jacobsen apparatus. The amount of seeds tested per sample (control, 26 days, 63 days) was varying for the species analysed. From *Hordeum* between 50 and 30 seeds were analysed. Fifty seeds were also available from *Nicotiana* and *Canabis* whereas from *Gossypium* and *Lagenaria* 20 and 10 seeds, respectively were germinated. (Figure 6)

Results

No germination both after 26 days and 63 days drift was obtained for cultivated barley (*Hordeum vulgare*), *Gossypium* and *Canabis* whereas for *Lagenaria* and *Nicotiana* accessions with a reduced germinability were detected (Figure 6). Surprisingly the ability to germinate for the latter was lower in the 26 days experiment compared to the 63 days study. From all the wild barleys tested only one seedling was obtained in the 63 days experiment from the accession GRA 801 belonging to the species *Hordeum marinum*. Analysing the seeds of the berries no germination was obtained for LAG 76 (26 days drift) whereas the germinability of LAG 83 (63 days drift) was 56%.

ABORA II solved the cotton enigma

Three years after the first open sea drift study with ABORA I this second survey delivered further evidences that a man-independent spread of cultivated plants across the Atlantic did probably never occur.

IN ORDER TO disprove the completely autochthonous development of the American

agriculture, two African crop plants - the bottle gourd and the diploid cotton - are in the centre of consideration. Both plants appear very late in America, and they have no ancestors there. Nevertheless, the majority of botanists believe that these two species came without the aid of man into the New World. We find this position among mainstream scientists in many publications, e.g. in the German URANIA-PLANT-ENZYKLOPEDIA: "There can be no doubt that the cultivation of *Gossypium* species took place absolutely independent in Asia and America... Since *Gossypium* seeds in water retain their germinating capability for up to 9 months, a transoceanic drift from Africa, possibly already at the beginning of the Pleistocene, is probable" (22).

AND IT IS EXACTLY the refutation of this assertion, in which we see the value of our experimental investigation, because all cotton seeds of the genus *Gossypium* did not survive the 26 and 63 days drift behind ABORA II. The test specimens, which had been stored in the IPK Gatersleben cold chamber, show a high germinating capability of 92.5 percent, which means that the basic seed material must have been of high quality. These results perfectly confirm the data from the first study. Now, in this survey we also involved species from the Old and New World of the genus *Gossypium*. All seeds (several hundreds) died hundred per cent. With this in mind, there remains no room for any interpretation that the genetic nature to produce long spinnable seed hairs could have never originated by seeds drifting across the ocean. Either they were spread by man, or they arose independently by natural hybridisation of two diploid species from America (allopolyploidisation). An impressive molecular-biological study proves that New World tetraploid *Gossypium*-cotton (AD-genome $4n=52$) originated through hybridisation of ancestral diploid species "that presently have allopatric ranges in Africa-Asia (A-genome $2n=26$) and the American tropic and subtropic cotton (D-

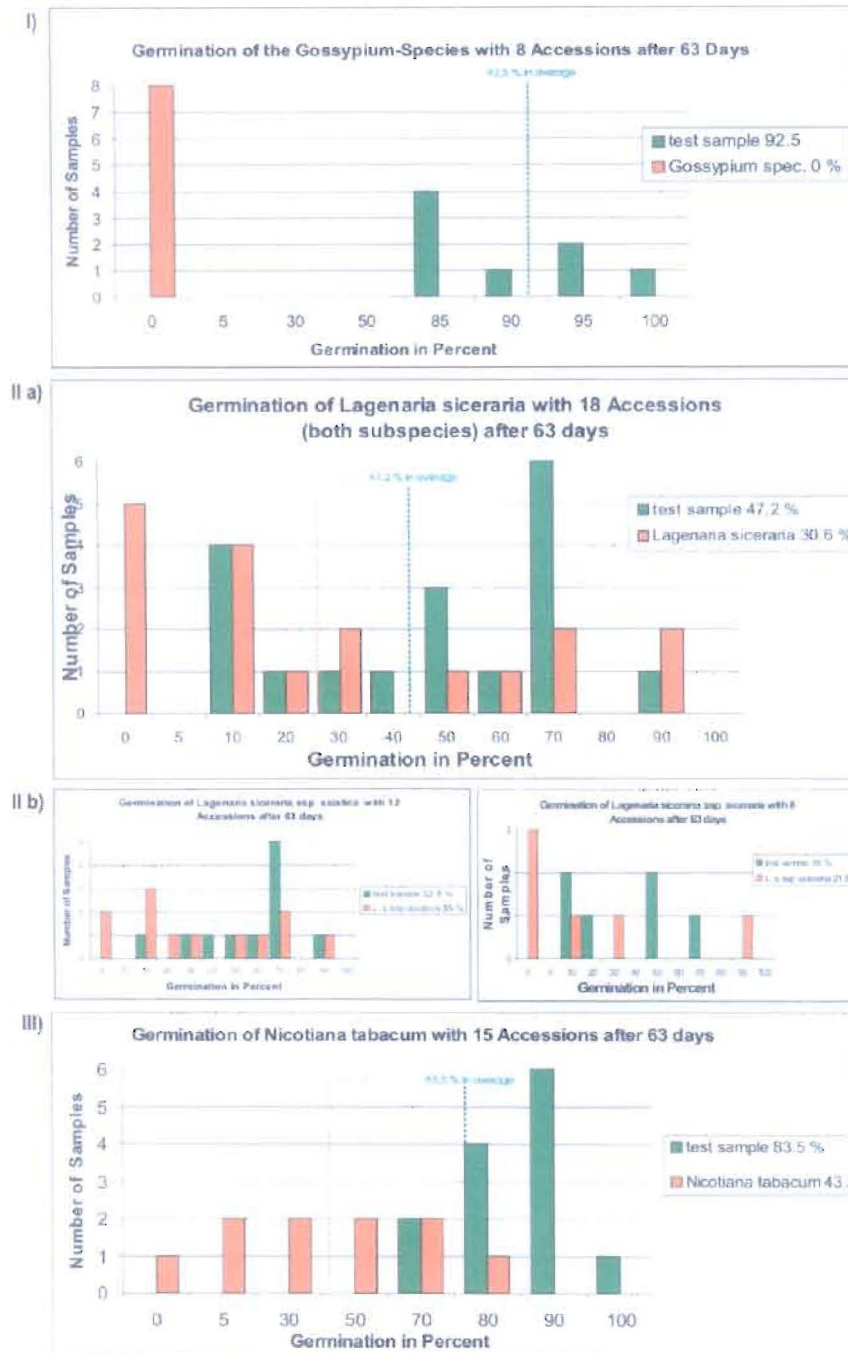


Fig.6: Presentation of the germination rate according to the number of the samples in percentage after 63 days. The comparison of the green (test samples in the IPK) and red columns (drift samples) shows a distinct shift to the left side indicating a decrease of the germination rate: I) All cotton representatives and their dying; II a) All representatives of the bottle gourd; II b) two separated presentations of both subsp. siceraria as well as asiatica; III) data of the tobacco-plant.

genome $2n=26$)." The investigation was made by WENDEL, SCHNABEL and SEELANAN at the Iowa State University in 1994. They used sequence data from the ribosomal DNA for their phylogentic analysis and compared them with sequences of the African species with the A-genome and the American ones with the D-genome..."(23) The main result is pointed out by the authors: "Following transoceanic dispersal of an A-genome species to the New World, hybridisation between the immigrant A-genome species and a D-genome species led to the evolution of the New World allopolyploids with AD-genome." About the age of that division they come to the conclusion "that the divergence of chloroplast DNA sequence data suggests that the A-genome and D-genome groups diverged from a common ancestor 6-11 millions years ago."(24) However, this does not ultimately mean that the divergence has taken place so late, or just 11 millions years ago. According to our knowledge the division of both populations has taken place in the early tertiary, when both continents were still closer to each other. (Figure 7)

Finally, the combination of knowledge of the molecular-biologic research and our drift experiments are proving that the A-genome doubtlessly came from Africa, however, not by a transoceanic seed drifting. Archaeology shows that first indications for the appearance of tetraploid *Gossypium* cotton occurred somewhere in the 4th millenium BC. Maybe this data is too young and we have to postpone it some thousand years back into the past. Nevertheless there is absolutely no evidence of tetraploid cotton before. According to our empirical investigations we have to maintain that the introduction of the A-genome of *Gossypium* was related to the activity of early man.

THE NUMBER of references of a transmission of biological plant material in the early American farming cultures can no longer be doubted. The question, which is

still not answered, is the way on which the genes were introduced to the Old World. It is utterly surprising, that the Americans themselves, in their myths of origin, ascribe the introduction of cotton to strangers. One of the many legends about the visit of the culture carriers from overseas was written down by Spanish chronists: "Long time ago, when our ancestors were simple corn farmers, white, bearded men came across the sea of the rising sun. They wore long gowns, belts and leather sandals. These men taught the people all sciences, morality and the recording of wise laws. They created an empire, where the corn cobs reach the size of man and the cotton grows already coloured"(25). Moreover, we have to add that tetraploid cotton seed hairs often change their colour from white to light red-brown during breeding. The reference, that the cultivation and harvest of large corn plants as well as of coloured spinnable cotton can be traced back to the presence of non-American bearded strangers, is an important mythological evidence, verifying the genetic researches and drift experiments as an interdisciplinary fact. Maybe even the hybridisation of the modern corn by the teosinte and an unknown maize ancestor was just possible by this important encounter. The hybridisation of tetraploid cotton is also a result of this event because well experienced farmers came from overseas. In the early phase of the developing cultures of the Indians, transatlantic seafarers must have introduced new plant material as well as new methods into the young farming culture of America.

Not all questions are answered– the bottle gourd controversy is not yet terminated

IT WAS ALREADY pointed out that not all seeds of *Lagenaria* died after 63 days of drifting. They kept a germination capacity of 30.6 % as an average. In opposite to ABORA I one of the two shield berries was broken during immersion (and, as a consequence, the seeds died). Seeds of LAG 83 did germinate. Although the quality of the basic material

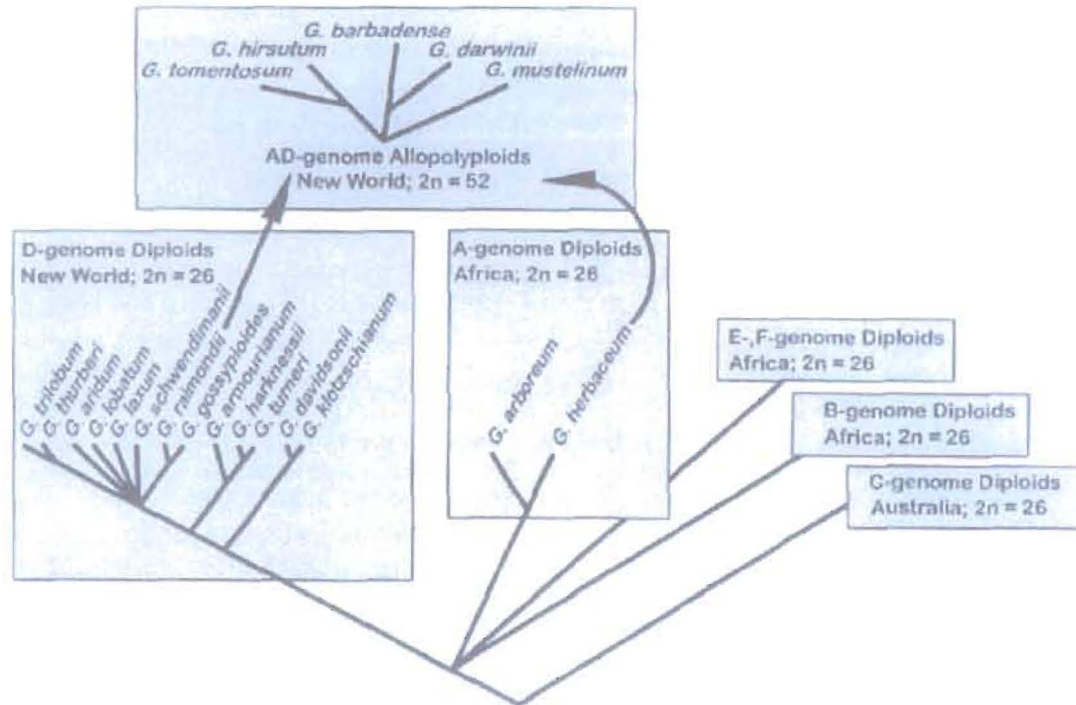


Fig. 7: The picture shows the evolution of the tetraploid cotton species in America: Following transoceanic dispersal of an A-genome species to the New World, hybridisation between the immigrant A-genome species and a D-genome species led to the evolution of the New World allopolyploids with AD-genome. The AD-genome descend from the African cotton *Gossypium herbaceum* and American origin species *Gossypium raimondii*. (according to Molecular Phylogenetics and Evolution Vol. 4, p. 300, 1995)

was mediocre, the ability to germinate decreased by the more relevant test with *Lagenaria s. ssp siatica* from 52.5 to 35 %. In combination with the subspecies *siceraria* the decreasing was even higher. This loss is a certain indication that the seeds lose their salt water resistance. The start of this process is unknown. However, on the basis of the experiences of the IPK Gatersleben one can say that the decreasing of the germination capacity is not a linear process. By its start the decreasing takes place abruptly and dramatically. So, it is not just speculation to maintain that all accessions would not survive a complete drift across the Atlantic,

which would mean at least twice the 63 days. Nevertheless, we must state that after two months *Lagenaria siceraria* preserved a certain germination capability. However, between 10.000 until 4.000 BC. the estimated time of arriving of the seeds and the distance for drifting was more or less the same as today. Therefore, a transportation without man is quite unlike, particularly in consideration of the common applications of the fruits on this side and on the other side of the Atlantic.

THE QUESTION whether microorganisms can damage the bottle gourds has to be

answered by real drift-experiments like the ones we have done to reflect the real conditions in the eco-system of the sea. The influence of seed material by marine animals could even not be taken into consideration during that drift study because all seeds or fruits were protected in little nets or linen bags beside of the hull of ABORA II. At this place it is reasonable to quote THOR HEYERDAHL, the expert for early navigation, on the topic of oceandrift and the problem of the bottle gourd:

"As everybody, who has already drifted over the oceans, knows, eatable things like bottle gourds fall a victim to sharks or other organism like the shipworm. During the four months needed by an African bottle gourd to drift across the Atlantic, it would come into the situation to be swallowed by a hungry shark or to be bored into by shipworms and lose the ability to germinate for more than thousand times." (HEYERDAHL, Wege übers Meer, S. 223)

For maritime experts like THOR HEYERDAHL it sounds paradox when somebody claimed, that of two African culture-elements – the terrestrial bottle gourd and the maritime boat – the bottle gourd is able to drift with success to the Americas but not the boat.

AND THERE IS a second strong argument against a lonely drift: The big differences in the results between the 26 and 63 days experiments. They deliver further indications that a simple drift across the Atlantic is not enough for a successful introduction just by drifting. During the drying or storage of the 26 days specimens in the hot sun at the island Cyprus anything must have happened. The biologist and sailor from ABORA II, CORNELIA LORENZ, who prepared the specimens for storage, suggests that the unfavourable hot conditions on the wharf in the port of the city of Larnaca could be the reason for the loss of the germination capacity. The 26 days samples had hung for

37 days in the clammy basket cabin of the reed boat ABORA II before they were sent to Germany for germination experiments. The negative influence of the hot sun and also the dampy storage conditions could have damaged the seeds after the 26 days of drift. This observation is very important. It shows the importance of a careful handling and breeding of the sensitive and swelled seeds after a long time of immersion. In the IPK harvested seeds are dried in several careful stages in the laboratory before they were stored or sowed again in the next year. It is very unlikely that seeds arriving from a four or five months drifting across the Atlantic sprout out by themselves somewhere on unfavourable shores. Hot and salty conditions will further damage the dispersal organs. At this point we have to repeat our statement again: We are speaking about domesticated plants that lost a lot of their natural resistance during their domestication. Even wild species will have these problems after a long time of swelling. Based on these experiences we can suppose that the bottle gourd will probably not multiply on the other side of the Atlantic under such circumstances and conditions.

Tobacco on both sides of the Atlantik Ocean

Both crops, the bottle gourd and cotton have already for a long time been suspected of having been introduced by transoceanic voyages. But the scientific discussion has been very controversial due to the lack of knowledge and scientific data about the botany of these plants. Since the discovery of the American cotton being hybridized through an unknown Old World ancestor, hundreds of scientist have criticized each other and searched arguments against an introduction by the aid of early man. But today the network of interdisciplinary research has become tighter and is not anymore only the field of archaeology.

ALREADY THOR HEYERDAHL has impressively demonstrated that prehistoric

rafts could easily cross the Atlantic Ocean in just two months. Our reed boat ABORA II could even tack 75 degrees against the predominant winds and make a back and fourth voyage in the difficult Eastern Mediterranean. The molecular biology made an exciting progress in creating a fantastic tool by tracing the spread lines of genes across the continents as well as the ocean. Not only because of the findings of modern archaeology, we got further indications with regard to the crossing of the Atlantic before Columbus. With the discovery of remains of tobacco-leaves and the evidence of nicotine as well as cocaine in Egyptian mummies we have the first physical evidences that a cultural exchange existed in the opposite direction as well. Just some years ago it wouldn't have been imaginable that achievements, artefacts and domesticated plants reached the Mediterranean world from the New World in the antiquity.

Therefore, it was a good opportunity to test also samples of the tobacco plant on its drift capability. The origin of tobacco is much more controversial then of any other plant which seems a candidate for transoceanic distribution. The toxicologist Dr. SVETLANA BALABANOVA believes that a kind of tobacco has existed in the Old World. So, MERXMÜLLER and BUTLER discovered probably a new tobacco plant in Southwest Africa in 1975. The authors called the plant *Nicotina africana* which could already have been imported and used in the ancient Egypt (26). However, another expert about culture and history of the tobacco-plant, Christian Räscht, criticizes: "There is absolutely no proof that there was *Nicotiana* of any kind before the conquista in Europe or North Africa"(27).

Nevertheless, there are not only pieces of the tobacco-leaves in Egyptian mummies, but also remains of the coleoptera of tobacco were found in the mummy. This insect is a typical parasite of the tobacco plant in Meso-America (28). Where did they come from?

But this is not the only evidence. Ethnobotanical literature reports about a clear presentation of pineapples in the 'sunken' city of Pompeii as well as large plantations of a pre-Columbian kind of maize in remote southerly valleys of the Himalayas.

IN ORDER TO reduce the speculation we also tested *Nicotiana tabacum* on its drift capability and found that it has a salt water resistance similar to the bottle gourd. In the same way the germination capacity decreased after two months of drifting. The seeds kept a germination capacity of about 43.3 %. The test samples show a germination rate of 78.1 %. And also the 26 days samples showed a lower rate of germination. These results lead us to the same conclusion as for the genus *Lagenaria*, namely that this species have a certain drift capability. But it is very unlikely that seeds (as well as the coleoptera of tobacco) drifted from the Gulf of Mexico across the Atlantic Ocean and then through the Strait of Gibraltar across the whole Mediterranean in front of the Nile delta, where it was found by an Egyptian farmer. We can prove that the seeds lost already a germination capacity of 34.8 % in just two months. A transfer of this stimulantia from America into the Old World would never happen by drifting.

OF COURSE we cannot directly prove that cotton and bottle gourd were shipped by ancient navigators from Africa to America who may have transported tobacco and cocaine as objects of exchange back into the Old World on their return journey. That some seeds of common ancestors occasionally drifted across the ocean for millions of years cannot be absolutely eliminated. However, our data are suggesting that the exchange of domesticated plants and genes did not happen by ocean drifting. The dispersal organs either died already after 63 days or had just a low germination rate. When germination rate starts the decreasing it is not a linear but a fast and intensive process. It may be concluded that this material did not have any

opportunity to drift across the Atlantic since the early Tertiary when both continents still were quite close to each other. Their late appearance in both hemispheres documents that an advanced navigation could have existed already in the Stone Age.

Circumatlantic voyages long before the Ancient Civilisations?

Quite new discoveries in some Spanish caves like Altamira, Cueva di Castillo or Lascaux (France) led to the assumption that the magic start line of deep sea navigation was already crossed before the last Ice Age. In these caves one can see presentations of ships, probably current systems, star maps and an intelligent orientation system which could probably have been used for navigation. The geographer Kai-Helge Wirth has postulated an astronomic theory that the ancient signs of the zodiac could have been maps which are presenting currents and the bearing of coast lines of the whole Northern Atlantic as well as the Mediterranean. Although not all constellations will pass an astronomical examination, two signs, the Ophiuchus – The Serpent Bearer – and the Virgo give strong indications that the main idea of this theory is right. Especially Ophiuchus perfectly presents the Canarian Gulfstream System in the centre of the Atlantic Ocean (29). This constellation sign copes perfectly well with another and much older drawing in the Cueva de El Castillo which also shows this current system, however, originating approximately by 15.000 to 10.000 BC. (30). Is this evidence a first indications for a pre-Ice Age navigation or just the exaggerated interpretation of a handful of *>Super-Diffusionists<?*

THE EXPERT for Cueva di Castillo iconography and astroarchaeology, Dr. MICHAEL RAPPENGLÜCK, explained his experiences about the Ice Age navigation:

“Now new reaserch work shows that my hypotheiseis about Ice Age people finding

their ways by stars at land and at sea could be right. It seems that there had been interactions between Paleolithic cultures in Europe (Cantabrian coast) and in North America, in Solutrean and Magdalenian time (19.000-10.000 BC). It is only a purely accident that the Cueva di El Castillo shows a circumpolar constellation which is excellent to help navigation and that the cave is situated at an ideal starting point of suggested connections between North and South America - the Cantabrian coast? No, I believe not...” (31). When Dr. RAPPENGLÜCK postulates a transatlantic navigation on base of rock drawings in several paleolithic caves then we have no distinct evidences of how the vessels were constructed in that early periods. Of course one can see some boat shapes drawings but they have mostly no superstructures and are not well presented. The quality of drawings is changing for some thousands of years during the Neolithic time. In that period you can find the first detailed drawings of seaworthy sailing boats. According to these neolithic pattern the two authors of that study constructed the reed boat ABORA II that sailed 1165 miles across the Mediterranean within two months. ABORA II was equipped with several leeboards which navigated the vessel under favourable conditions up to 70 degrees against the wind. It was constructed by the rush Totora - the Bolivian name of *Scirpus lacustris* – which is even today the construction material for little reed boats in Sardinia. Totora is growing all over the world. Totora rafts have a floating capability of at least 12-15 months. Experienced sailors could travel with such a rush boat to any place in the Mediterranean within the life span of such a boat. In the Mediterranean basin the maximum navigable distance is limited by unfavourable meteorological conditions although ABORA II did 1165 sm in just two months. According to our experiences with ABORA II we can estimate a maximum feasible distance of about 6000-8.000 miles per year. However, on the Atlantic Ocean the maritime conditions are

much better than in the Mediterranean. That means, a return journey across the Atlantic on a reed boat is theoretically possible. Maybe early navigators made a new vessel at the end of their stay on the other side of the Atlantic. The construction material is growing everywhere. They could easily utilize the superstructures for the new hull and continue their voyage two months later at the most.

THESE EXPLANATIONS are closing the circle around the transoceanic spread of crop plants. When the interdisciplinary research provides strong indications for a Paleolithic navigation between 19.000-10.000 BC.: Why then have most of the scholars so strong doubts to accept a transfer of crop plants around 4000 BC. across the Atlantic Ocean? In that period a seaworthy navigation has obviously existed. Moreover water crafts cannot only transport seeds and fruits better

from one coast to an other but also their methods of breeding and hybridisation. The transfer of that >immaterial methodes< is surely much more important than the genes or plants themselves. A successful plant-introduction would have been only possible with simultaneous spread of knowledge about plant-cultivation. All results of these drift and germinating experiments are highly significant and support the hypothesis that cultivated plants were spread over oceans by the intervention of man. Thus the ethnobotanic research supports the evidence of experimental archaeology and iconographical research that transatlantic voyages have begun long before the advanced civilisations in the Mediterranean World.

More information about these subjects under:
www.abora2.com

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Zusammenfassung:

Seit vielen Jahren führen Wissenschaftler leidenschaftliche Diskussionen über eine kulturelle Beeinflussung der vorkolumbianischen Völker Amerikas durch altweltliche Kulturen. Die Debatten sind vorwiegend von archäologischen Erkenntnissen geprägt, die nicht für alle Wissenschaftler eine befriedigende Antwort über eine mögliche Kulturbeeinflussung liefern. Einen Ausweg stellt die Ethnobotanik mit ihren vielfältigen Teildisziplinen, wie der Geobotanik und Pflanzengenetik, dar. Diese interdisziplinären Wissenschaften ermöglichen das Aufspüren und eine ungefähre zeitliche Datierung für die Ausbreitung von domestizierten Pflanzen. Menschen haben auf ihren Wanderungen über unseren Planeten immer Pflanzen mittransportiert, die ihr Überleben in ihrer neuen Heimat sichern sollten. Das Aufspüren der Urheimat der ältesten altweltlichen Kulturpflanzen und ihrer Verbreitungswege über die Meere bis nach Amerika ermöglicht auch eine Erforschung der kulturellen Diffusion in vorkolumbianischer Zeit.

Um die völlige autochthone Entwicklung der amerikanischen Landwirtschaft zu widerlegen, stehen zwei afrikanische Kulturpflanzen im Zentrum der Betrachtungen: die afrikanische Baumwolle und der Flaschenkürbis. Beide erscheinen sehr spät erst ab dem 5. Jts. v.Chr. in Amerika und haben dort keine natürlichen Vorfahren. Jedoch ist die wissenschaftliche Diskussion bisher sehr widersprüchlich. Streitpunkt ist nach wie vor die Frage, ob sie unabhängig oder mit Hilfe des Menschen den Atlantik überquerten. Eine realistische Beurteilung der transozeanischen Verbreitung setzt exakte Erkenntnisse über die Driftfähigkeit und Salzwasserresistenz beider Arten voraus. Außerdem muss die Rolle der Kontinentaldrift und Tierverbreitung mit einbezogen werden, wenn man die Einfuhr dieser beiden afrikanischer Kulturelemente in die amerikanische Landwirtschaft erforscht.

Mit der Durchführung der Schiffsbootexpedition ABORA II 2002 wurden zum zweiten Mal Samen und Früchte ausgewählter Kulturpflanzen auf ihre Driftfähigkeit unter Hochseebedingungen untersucht. In Zusammenarbeit mit dem Institut für Kulturpflanzenforschung Gatersleben wurden die Verbreitungsorgane von acht Kulturpflanzen präpariert, auf dem Mittelmeer 26 bzw. 63 Tage lang getestet und anschließend im Labor auf ihre Keimfähigkeit und Salzwasserresistenz geprüft. Im Unterschied zur ersten Feldstudie von 1999 wurden mehr Arten aus 115 geographischen Vorkommen und über einen größeren Zeitraum getestet. Diese Studie liefert eine Vielzahl neuer Daten zur Beurteilung der Driftfähigkeit jener Kulturpflanzen. Bisherige Forschungsarbeiten stützen sich nur auf Simulationsexperimente in Salzwasserbottichen. Unsere Experimente erbrachten für die Mehrheit der Proben keine Keimfähigkeit nach der Drift im Mittelmeerwasser, so dass unsere Ergebnisse im Widerspruch zu den gängigen Theorien stehen. Auf der Grundlage unserer Untersuchungsergebnisse muss die menschenunabhängige Verbreitung durch Ozeandriften von Kulturpflanzen angezweifelt werden. Die Ergebnisse werden durch neue Befunde der Pflanzengenetik untermauert, dass vor allem die Einfuhr der spinnfähigen afrikanischen Baumwolle in die frühe amerikanische Landwirtschaft auf das Konto seefahrender Menschen zurückzuführen ist.

Damit liefert die ethnobotanische und molekularbiologische Forschung einen ersten naturwissenschaftlichen Beweis für die Beeinflussung der amerikanischen Landwirtschaft

aus der Alten Welt. Sie erhielt frühzeitig Stimulationen in Form neuer Gene und Zuchtmethoden, die zur Verbesserung der Erträge und Züchtung neuer Kulturpflanzenarten führte. Umgekehrt kamen aus der Neuen Welt auch neue Pflanzen, wie die Drogenpflanzen/Produkte Nikotin und Kokain, zurück, welche sich mehrfach in ägyptischen Mumien nachweisen lassen. Selbst die Ausbreitungswege erscheinen nach den Gensequenzierungen an Baumwollpflanzen in einem neuen Licht, da durch den Nachweis des afrikanischen A-Genoms in amerikanischer Baumwolle die Übertragung viel wahrscheinlicher von Afrika über den Atlantik anstatt von Asien über den Pazifik erfolgte. Dieser Befund soll aber nicht den Pazifik als Kulturweg ausschließen, sondern lediglich darauf verweisen, dass sich der Baumwolltransfer auch in die entfernten Ackerbauzentren Südamerikas vom afrikanischen Kontinent und nicht wie lange vermutet vom Indus aus ereignete.

In Zusammenarbeit mit der Felsbildkunde, Astroarchäologie und Experimentalarchäologie kann die Ethnobotanik untermauern, dass bereits vor der Entstehung der ersten Hochkulturen in der Alten Welt eine transatlantische Seefahrt existiert haben muss, die unterschiedliche Kulturpflanzen und deren Nutzungsmethoden zu beiden Seiten des Atlantiks transportierte.

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