

STUDY OF THE DRIFT CAPACITY OF SELECTED CULTIVATED PLANTS FOR THE ASSESSMENT OF TRANSATLANTICAL CONTACTS IN THE EARLY YEARS

by

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Summary

The project team "Experimental Archaeology" has already occupied itself for over ten years with the research into pre-historical and early navigation in order to provide practical knowledge of the possible range of early migration at sea. Our research mainly uses methods of experimental archaeology, a science with interdisciplinary orientation towards archaeology, rock-painting research, geography, biology, astronomy, physics and further natural sciences. For many years, scientists discussed the origin of cultivated plants from the Old World in pre-Columbian America. The essential point of these debates has always been the question, whether these plants drifted over the Atlantic Ocean by themselves or with the help of man and how they became introduced to the ancient American agriculture. The remains of seeds and fruits found in archaeological excavations represent solid genetic proof to this question. Should it be possible to prove the influence of man on the appearance of cultivated plants in pre-historical America, this would produce important evidence for transatlantical contacts before Columbus. Due to the reed boat expedition ABORA 1999 we had the unique possibility to test the drift ability of seeds and fruits of selected cultivated plants under conditions of the high sea. In co-operation with the IPK Gatersleben, these plants were chosen, tested in the Mediterranean and then their germinating capacity was examined in the laboratory. Previous studies were only based on simulated experiments using sea-water. For the first time, the results of this survey provide facts for a realistic review of the drifting ability of these cultivated plants. In our studies, the majority of samples were not able to germinate after being exposed to the water, therefore our results are contradictory to the current theories and cast heavy doubts on the independent drift. These conclusions are also supported by the generalization of the island-biogeography.

1. Introduction

1.1 The beginning of agriculture in the Old World

THROUGH searching the beginning of our civilization we discover that the advanced cultures in the antiquity arose in the large valleys around the Arabian Peninsula approximately 5000 years ago. There the alluvial river valleys offered suitable ecological conditions for the first occupants as well as the wild living animals and plants. Scientists call this area the „*Asia anterior half moon*“, it is, according to the opinion of the archaeologists, the territory in which the first intensive agriculture on base of extensive irrigation has been developed. Without neglecting the other factors in the development of cultures the ancient agriculture played an enormous role for the evolution of the earliest cultural centres in Asia anterior.

According to the latest stage of investigation the cultivation of plants arose in Asia anterior about 9000 B.C. which does not mean that the first attempts were not made earlier. For generations biologists as well as archaeologists were occupied with the question why the first agriculture arose in Asia anterior as well as Asia Minor and why in this particular times? What was the reason for Stone Age men to chose to transform wild plants into cultivated plants?

THE CULTIVATION of plants means that a plant is changed in its genetic characteristics – intentional or unintentional – which makes it more useful for men than its wild forefathers. (1)

Today, the development of new crops is the field of activity of highly qualified scientists, who use their entire strength and know-how of the botanic genetics to breed new sorts of cultivated plants. However, the beginnings of the plant cultivation go back over 11 000 years which means that the first cultivators

had no possibility to use the knowledge of molecular biology. They did not even possess simple patterns like already existing crop plants which could have served as a model for breeding. (2)

So how did it come to plant cultivation? Why were Stone Age men motivated to cultivate plants in different places of the world?

The huge temporal differences in the various areas of crop and stock farming are very conspicuous. So, the pea was domesticated 8000 B.C., the olive about 4000 B.C. and the strawberry just since the Middle Ages. (3) Certain peoples did not ever or just very late turn to the agricultural way of life. We cannot always realize what reasons or conditions have carried out to the development of crop and stock farming. The answer to the question why the agriculture arose in several centres much earlier than in other regions actual offers only two but contrary explanations: Either the regional settlers or the regional supply of domesticable wild plants were responsible. (4)

Due to the species man generally possesses the common ancestors and therefore differences in intelligence and adaptability do not exist between the geographical races, we have to search the causes in the different conditions of development.

SO THE AREA of the *Asia anterior half moon* not only has almost all ancestors of domesticable crop plants and cattle but also especially climatical conditions which search their equals in the world. (5)

These unique conditions are the reason for the existence of the earliest centres of crop farming and the origin of almost all the important domesticated plants and animals in the area of the *Asia anterior half moon*. Obviously, the oldest source of a whole chain of developments can be found in this region. There, the first urban culture arose, which was the base for epoch-making-developments like the script, monumental

architecture, religion etc. – finally all that, what creates civilization. We call the transition from hunter and collector to the crop and stock farmer neolithic revolution or neolithication.

TODAY we know that the modern man did not start his career in Mesopotamia 5000 years ago. Going out from the Sumerian culture we can follow back the traces of cultures and find roots which have spread far away and sprout long preserving flowers. (6)

Many archaeological, biological and architectural evidences are speaking for the distribution of the cultural and material achievements of the neolithic crop farmer from Asia anterior to Northeast-Africa, Central-Asia and Europe.

One of the most exciting examples is the spreading of the Mesopotamian temple architecture. Even if the cultural carrier, who is responsible for the distribution of this typical ziggurats, is not exactly identified, the artificial temple hills on almost all Mediterranean islands and on the coasts of Europe give prove to the fact that they were not constructed independently. They are lined up like a line of pearls in the Mediterranean Sea along the westerly current from East to West. These locations suggest that a kind of a caste of priests with the aid of the pre-historical navigation has spread this culture by to the borders of the Old World. (7)

HOWEVER, long before the distribution of this late Neolithic or early Bronze Age cultures, a new way of life was spread. From the 6th millenium B.C. new domesticated species of plants and animals appeared, which have not had any natural ancestors before in the Mediterranean, North-Africa or Europe. The colonists transported them on the land as well as on the sea way because the new immigrant species should guarantee a sure and pleasant life in the new native country. The introduction of the crop and stock farming from Asia anterior to Europe

was well investigated in the last years. It is called the neolithication and it finds general acknowledgement among the biologists and the archaeologists.

But what about the spreading of the earliest agriculture beyond the borders of Europe? Did the Asian anterior cultural drift set up the basis for the distribution of crop and stock farming in still more distant areas? Did they even arrive the lands beyond the Atlantic? Perhaps even the pre-Columbian America?

1.2. Serious differences in the domestication in America

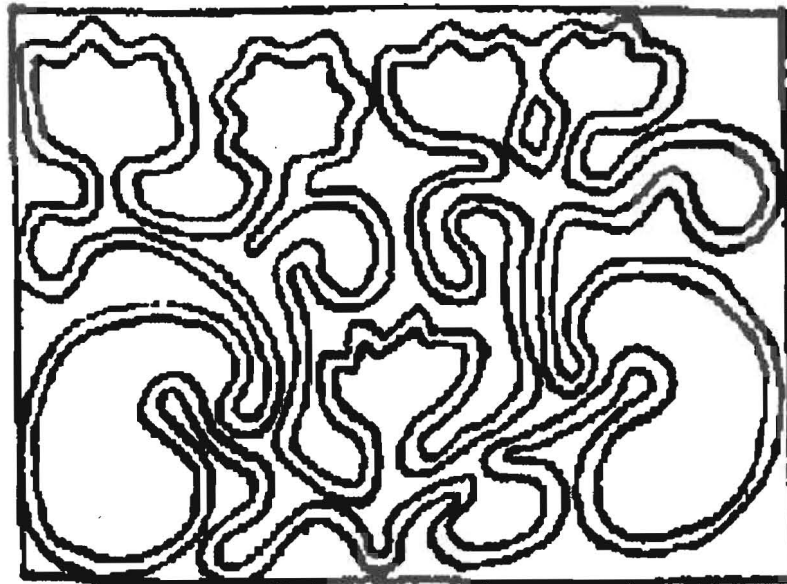
THE SCIENCE still supposes that the agriculture in pre-Columbian America arose autochthon. (8) So, there are a lot of differences in the agricultural systems, the used crop plants and apparently even in the time of appearance of the crop farming.

In Asia anterior mainly wheat and green peas were bred to cover the demand of proteins and carbohydrates. (9) The Americans were predominantly bothered with corn (maize), fire beans and green beans. The combination of these similar plants appears, on the first view, to be a parallel but the differences in the methods of cultivation exclude any influence. The peoples of the Old World quickly invented the plough and the wide sowing, whereas, in the New World, the fields were always cultivated with the aid of sticks or mattocks. The seeds were sowed single and not spread with full hands. Therefore, most of the American fields were not monocultures but looked like coloured gardens with varied growths. (10)

The circumstance that there were only few animals which man was able to domesticate, such as the dog, lama or turkey, delivered another reason for the differences. The lack of big mammals which were suitable to pull a plough prevented not only its invention but also the introduction of the waggon. In each case the Americans had known the principle



**The knowledge of the breeding of maize is proved in Mexico since 3450 BC.
The domestication of corn from the native teosinte was made in Tehuacán Valley.**



Probably an Indian representation from the Cuna Indian mola. Most of the botanists believe it is one of the oldest representation of a gourd in America. (redrawn from Eleanor Moore, Gourd Seed, Vol.XXXI, No.2 (1970)).

of the wheel: it is documented by toys which were found, that the Maya and the Inca had made this invention long before. (11) The turkey and the lama were small animals which delivered only few meat in comparison to cattle, goat or sheep and moreover, it was only possible to change them very slowly by breeding.

THE SAME big differences can be found in the domestication of the wild grains when we compare the quick evolution of wheat or barley in the Old World to the slow ascent of maize in the New World: „It is supposed that the teosinte is the ancestor of the cultivated maize. However, it has a lot of differences in seeds and flower so that the botanists have discussed a lot if the maize is really descended from the teosinte. The value of the teosinte should be not very high for the hunter and collector in the prehistoric time. It was not very bearable in the nature, produced only few seeds in its fruits. Their seeds were hidden in hard and uneatable seed shells. Until the teosinte could be an usefully cultivated plant their seeds must become bigger and the hard seed shell had to disappear. Even today the archaeologists still discuss very vehement how many centuries or even millenniums passed by before the former tiny corn had reached only the size of a thumb. The difference between the nature-given advantages of wheat and barley and the difficulties in the domestication of maize was one of the most important reasons why the development on the American continent went apparently so different.“ (12)

All these differences led to the fact that the intensive agriculture in Central-America probably just begun around 3500 B.C. and the first advanced culture even just arose around 1500 B.C.. However, this convincing explanation is disturbed by the appearance of contradictory cultivated plants which do not have their biological origin in America.

1.3. Crop plants from the Old World in America?

FOR MANY YEARS ethnologists, biologists and maritim histories lead passionate discussions about the origin of the bottle gourd, cotton and the yam root in the pre-Columbian America. The essential point of the discussion is the question whether they drifted independently or with the aid of man across the Atlantic, and how they became introduced in the old-American agriculture. The remark of the American geobotanist G.F. Cater expresses the importance of this topic: „An arrowhead can be made by each fool, but a plant only by god.“ Should it be found possible to prove the appearance of only one crop plant in the pre-historical America because of the influence of man from the Old World, then the dispute between diffusionists and isolationists could be settled. Therefore, let us turn to the bottle gourd problem which furthermore seems to be the best investigated cultivated plant with an unclear origin.

The bottle gourd and its ethnobotanical dilemma

The bottle gourd *Lagenaria siceraria* is part of the family *Curbitaceae*. This family contains 100 genus and is classified differently in the phylogenetic system. The genus *Lagenaria* is part of the tribus *Cucurbitaeae*, which contains nearly all cultivated kinds of the cucurbitaceous plants that are important for the human nourishment. On the contrary to the most pumpkins, bottle gourds are mainly used as containers for food and water, as scoops, bowls or even as music-instruments. (13)

Six different kinds are part of the genus *Lagenaria*. It is monophyletic (e.g. has an unique biological origin), and the region of its origin is suspected to be in Africa. The species *Lagenaria siceraria* is today cultivated pantropical (in the entire area of the tropics). Therefore, the question of the primary area of distribution is disputed, but most botanists believe that it is Africa. (14)

THE DISPERSAL units of the bottle gourds are, without any doubts, their fruits. The ripe shield berries possess the ability to swim and therefore they are adapted to the dispersal by water. That is why it is assumed, that the wild bottle gourds were at home at river banks or other habitats close to the water. (15) But the dispersal of fruits by rivers is proved for many families of plants. Nevertheless, this kind of dispersal does not immediately mean the ability for maritim dispersal. So far, it is not proved scientifically, that a bottle gourd drifting in sea-water keeps its reproductive ability.

Today, the bottle gourd is dispersed pantropical and therefore it is difficult to make an exact statement about its original gen-centre. Unfortunately, the archaeology can also not provide a satisfactory answer to the question of the centre of origin of *Lagenaria siceraria*, because the multitude of archaeological receipts is as immense as its contemporary dispersal. (16)

The oldest findings came from Africa and were dated from the 6th millenium B.C. (17) Although the gourds found at the archaeological places were used by man, it is not clear, wether they were wild or cultivated plants. The cultivation of plants in America started about 6000 B.C., so the gourds which were found could only have been cultivated after this time, if wild bottle gourds had reached the New World. (18)

THERE ARE hardly any doubts, that the bottle gourd has already been cultivated for a long time in the Old World, but the oldest African proofs are from the Egyptian time and were dated from the 5th dynasty. These obviously younger findings result presumably in the unfavourable climate, so that the early remains were not able to overcome the milleniums.

Because of the fact, that the occurence of all five related *Lagenaria*-species is limited to Africa, the majority of the botanists propose

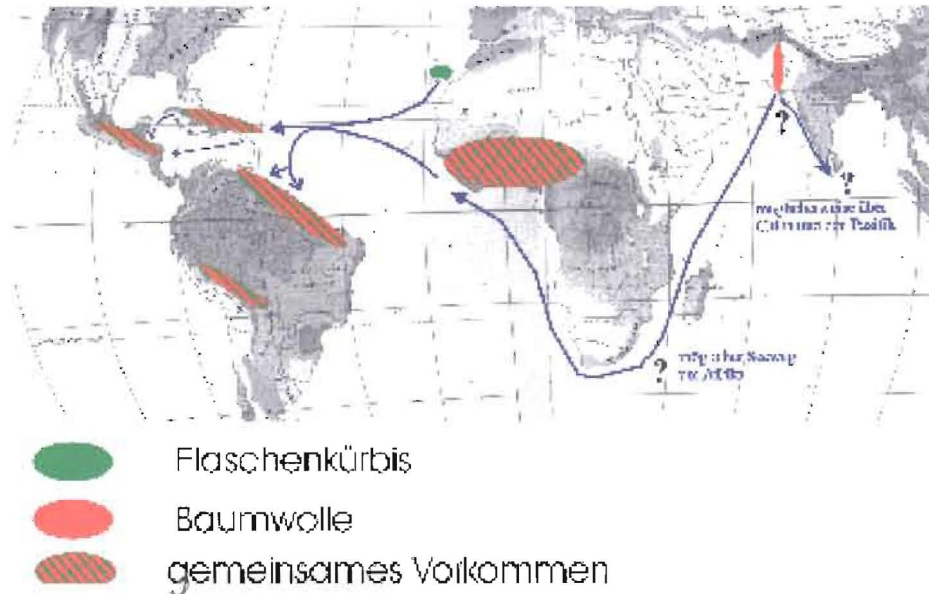
Africa as the primary region of origin. (19) Therefore it is assumed, that the ancestors of the domesticated bottle gourd were also originally dispersed in Africa. There, it could have possibly been domesticated long before 6000 B.C. and then spread in America. (20) Other scholars reject this theory, because it is not allowed to infer the primary centre of origin only from the existence of wild ancestors.

The centre of origin and the region of its earliest domestication remains controversial because of a lack of scientific evidence. But this controversy is not only limited to the question wether it reached the pre-historical America wild or domesticated but above all wether this occurred with or without the help of man.

The problem of its transoceanic origin

NO OTHER AREA of the natural sciences has been influenced so fundamentally by the prejudices of the Ethnologists as the Ethnobotanic. Therefore, the hypothesis of the origin of the bottle gourd are also characterized by the various standpoints to the problem of transatlantical contacts before Columbus. That is why botanists first ask ethnologists for advice when they assume plants with an origin overseas. But prejudices of the possible range of early migration across the sea, which especially arose at the beginning of our century because of incomplete knowledge, made a objective view to this topic nearly impossible.

IN 1937, the Ethnobotanist MERILL came to a momentous conclusion when writing: "Because of the agriculture in America being autochton, we can assume, that the cultures that are based on it are autochton,too." (21) This quite categorical explanation of the ,at this time, leading ethnobotanist had a deep impact on the contemporary colleagues. Furthermore, it was strengthened by the experiments of WHITAKER and CUTLER (1954), and that is why, even today, the



This map shows the spreading of the bottle gourd (green) and the cotton (red) in both hemispheres. The hatched areas in the New World show the presence of the tetraploid *Gossypium* species which was probably hybridised with species from the Old World. The blue lines hint possible ways of the introduction across the sea.



Due to the Atlantic currents we can draw conclusions for the voyage of simple vessel as well as a drift of the plant seeds across the Atlantic. However, on base of our experimental data it seems to be unlikely that the biological objects could drift the whole distance alone without any restriction of the germination ability.

majority of the botanists believes in a maritim drift from tropical Africa to the coast of Brasilia without the help of man. (22) WHITAKER had bottle gourds swim in sea-water for 224 days under conditions similar to an oceandrift, in which the seeds kept their full germinating capacity. The simulation experiment was long enough to explain a drift across the Atlantic, that is for sure, but this can never be the proof for the fact, that a bottle gourd drifting across the seas reaches the other side of the Atlantic undamaged. The robust shield berries can surely resist the salty sea-water but not the hungry shark. The question whether microorganismen can damage the bottle gourds has to be answered by real drift-experiments in tropical waters to reflect the real conditions in the eco-system sea. In 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, fall eatable things like bottle gourds 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 for about a thousand times come into the situation to be swallowed by a hungry shark or to be bored into by shipworms and lose the ability to germinate."

(HEYERDAHL, Wege übers Meer, S. 223)

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

It took some centuries until MERILL's conclusions were called into question by different plant geographers. New researches produced new arguments, that cultivated plants could have presumably been dispersed across the tropical ocean into the New World by natives.

In connection with an independent introduction, the question whether the sole drift of African plants was sufficient to explain their cultivation and dispersal over long distances. Is a cultivated plant able to spread the knowledge of its cultivation and use?

The transmission of cultivated plants and domesticated animals presupposes the transmission of methods of cultivation and use respectively proceed parallel. The effect of this "immaterial performance" is actually the prerequisite for the cultivation of far-fetched plants on foreign soil or for the domestication of formerly unknown animals. (23) Many Ethnologists give arguments that with the appearance of new cultivated plants also new ways of usage, that are not derived from nature, appear. The possibility, that African fishermen brought the bottle gourd to America is supported by amazing parallels in the special usage of this plant. At both sides of the Atlantic, fishermen used the gourds as buoy for the fastening of the cotton fishing nets. The peculiarity of this fishing method is, that the fishes are getting paralyzed by scattering toxic plants and then finally are getting caught. Even so the taxonomic classification and the origin of this toxic plants are so far not absolutely clarified, the bottle gourd, the spinnable cotton and the use of toxic plants and their common as well as their combined use for fishing can not only be explained by the accidental drifting of seeds and fruits.

The American cotton and its non-spinnable seed hair

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 Anden areas of Peru and Bolivia wore magnificent gowns made of coloured (polychrome) cotton cloths, which were woven on looms that were

of exactly the same kind as the ones used by cotton cultivators of the Old World. For many centuries, people believed in an interesting parallel of use: the indigios Amerikans were said to have gone the step towards cultivation of cotton and its use independently. Even though some botanists complained, that the first findings in Mexico, in Teotihuacan-Valley, from about 3500 B.C. appeared at a quite late point in time; this critical voices were either hushed up or suspended with the fact, that even this period marks the beginning of the American agriculture. The lack of preliminary stages of looms, from the easy, horizontal to the vertical loom as well as of artifacts from deeper, older layers did not seem to interest anybody or was simply ignored in the absence of interest.

In this manner the opinion of an indigenous cotton domestication on American soil had been established among botanists until 1947 when three young American phytotomy genetics, Houtchinson, J.B., Snow, R.A., Stephens, S.G., devoted to this little considered theme. That what science had thought impossible, the genetic material for the cultivation of spinable seed hair in American came, against all assumptions, from the Old World. How is this possible, 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 tribes from the New with those from the Old World, thereby stating that American non-spinable species distinguish from their relations in the number of chromosomes (carrier of the genes). All wild species in America are not spinable, contain 13 small chromosomes and are diploid. Apart from their species there are three cultivated tribes which are spinable 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 spinable fibres (24). The fact that spinable tetraploid cotton species only appeared in America about 3 500 B.C., although their relatives have been growing on the continent for million of years, leaves only little room for further explanations: The genetic material of the 13 big chromosomes seem, in some way, to have fallen into the hands of the early farmers in order to be crossbred With indigenous, non-spinable cotton plants. The bastardisation (biologically hybrid) can obviously be proved in archaeological material that has been found. All in all only three American hybrids were bred, all of them appeared for the first time about 3 500 B.C..

Where did the pre-historical Columbian farmers get the seed material for the cross-breeding from? Was a handful of seed sample that drifted across Atlantic Ocean enough 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 doubtless, that Africans have used these plants for their daily lives for aen and are still using them today. West-African tribes use the fibres of the stemform of all today's cultivated species in farming, *Gossypium herbaceum*, for many different purposes. 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 that strongly points to cultural contacts. But when these plants had to be introduced to Brazil from different country, because they

did not exist in Brazil, one can no longer proclaim 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 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 recognized its cultural value. (26)

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 surprising in the highest way of measure, that the Americans themselves, in their myth 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 leathern 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." (27) The reference, that the cultivation and harvest of large corn plants as well as of spinable cotton is to trace back to the presence of non-American, bearded strangers, is an important mythological proof, which verifies the genetic researches of HOUTCHINSON, SILOW and STEPHENS interdisciplinary. In the early phase of the developing cultures of the Indians, transatlantical seafarers must have introduced new plant material into the young farming culture of the Americas.

Therefore, the pre-historical navigation gains greater importance as "mediator" as assumed so far. At this point in time it is reasonable to examine the history and importance of the navigation, which has been developed much earlier as thought until now.

1.4. The early navigation contra the independent drift

THE PRESENCE of many animals and plants throughout the islands scattered across the ocean, has been a riddle for biologists for a long time and has lead to scientific speculations on their origins. (28) The favorable theory of the tectonics set again fire to the discussion: Is the spreading to be traced back to geological processes or to the accidently distribution by currents and man?

Several independent researches now prove with the help of reptiles from the Caribbean Sea and the South-Pacific, that the forces of nature as well as man played an important role in the spreading of new species. (29) It has always been assumed, that animals and plants have not only been dispersed by wind and water currents but also by the early navigation, but there has been no proof. With the latest observations, the dispersists, that have always believed in a distribution by man next to the dispersal by wind and water currents, gain impetus. Especially in the South-Pacific, the indications to a very fast dispersal of e.g. lizards and phalanger about 3000 years ago from New Guinea to the Marquesas-Islands increase. (30) The references have been scrutinized with molecular-genetical methods to carry out a temporal classification with the help of the "molecular clock". (31) Are there any of these unambiguous biogenetical indications of a pre-Columbian contact in the Atlantical area? Less known but even more important for the judgement of early contacts is the fact, that the people of America fell ill of tuberculosis before they could have been infected by coughing sailors from Spain in 1492. The founding of a one-thousand-year old mummy in Peru has finally furnished



The ABORA 1 Expedition. The main aim was to find out if these vessel could sail across and even against the predominant winds. Moreover, the team has tested cultivate plants during the expedition. Most of the plant species were constant 26 days in salt water.



The biologist Conny Lorenz prepares the fruits and the seeds for the investigation. All specimen were checked and put into water very carefully. In the middle of the picture you can see the big bottle gourd LAG 76 whose seeds of the control sample also died.

proof: The Indians also suffered from consumption for the mummy having a heavily-scarred lungtissue. Microbiologists took out some lungtissue and examined the genetic material with the help of the PCR-method and DNA-sequencing, they were able to detect the causative agent of TBC, which seemed at this point only to be spreaded throughout the Old World. (32)

THE ORIGIN of TBC is the *Mycobacterium bovis*, which is happening to cattle and "infected" man 8000 years ago in Asia anterior. Therefore, the question is, how the indigious Americans could have been infected by a bacteria when they have never had contact to domesticated cattle? This result of research does not only increase the assumption that there have been travels of Europeans to America before Columbus but also delivers new indications of further cultural parallels, which are not subject of this research. (33)

The dispersists are able to give a whole list of references for the importance of the early navigation for the dispersal of animals and plants and also for the fact, that not all new colonists must have been spread by wind and water currents or even by the continental drift.

According to the latest references of the rock-painting research, the first seaworthy vessel had already been invented before the end of the Stone Age. Long before occupying with the domestication of animals or founding cities, man concentrated on building boats. The oldest description of boats, like from the Tassili-plateau between 8000 and 4000 B.C., furnish proof to this hypothesis. In this early period, the artists only showed people, animals and boats. (34) At this time, boats were obviously more important than any kind of temple. Therefore, we can only imagine of what importance the pre-historical navigation was for the people of the Stone Age. From the huge arsenal of pre-historical paintings of boats, the project manager reconstructed the

sail of a Stone Age vessel to follow the foot prints of these maritim wanderers. Paintings of the vessels can be found in a large bow from the Algeric Sahara via north-east Africa to the Industral. They show the experienced skipper, that man knew how to use a variety of different types of boats. It is recognizable, that the artists used real vessels as models, because the paintings showed all features of a seaworthy sailing boat. Important structures like mast and sail, big cabins, one or more rudders and a large, massive hull can be discerned. (35)

ON SOME pre-dynastical rock-paintings, the leader of our project team discovered representations of centreboards, which he could, because of his sailing experiences with reed boats, identify as flank rudders. It remains unclear, why other scholars did not recognize them or only looked at them as rowing straps. Nevertheless, it is obvious, that these structures could have only be used for sailing: reed boats are rafts in the shape of boats. They do not have a careen. But like every other sailing boat, reed boats need a careen for steering, otherwise, it would be driven off course by the strong wind and it would be impossible to set an exact course. For this reason, flank rudders reduce the drifting off the course when sailing. These centreboards can be explained as rowing straps, which could have easily be made in the Stone Age and which were tied up on the sides of the hull. (36)

First motivated by the research of THOR HEYERDAHL, later by his own works, the project manager carried out several reed boat experiments to examine the sailing technic with flank rudders. THOR HEYERDAHL has already travelled the oceans of the world over 30 years ago and documented impressively, that reed boats are highseaworthy vehicles. Nevertheless, scholars of the antiquity and scientists were only amazed but did not rethink the abilities of early navigators. Furthermore, HEYERDAHL sailed most of

the time in front of the winds, supported by strong currents.

Early cultures, which spread their fortune by means of breeding animals and seeds across the Mediterranean to the borders of the Old World, must have used a vehicle that at least was steerable at right angles to the wind. Without this ability, the stormy Mediterranean would not have been captured. They would have never reached the Atlantic Ocean. THOR HEYERDAHL has always launched his famous papyrus rafts RA I & II in Morocco, because they did not possess the navigative capacity to cross the Mediterranean from East to West at right angles to the wind. For this reason, the reed boat expedition ABORA should stay on the track of the Stone Age seafarers:

The main goal of the expedition was to find out whether these vessels without a canoe were able to sail at right angles or even against the wind. That is one of the main questions of the navigation at all. Have there been any contacts between the civilisation of the Mediterranean and the countries beyond the Strait of Gibraltar? On the basis of our experimental data, we can today better explain where the Stone Age cultures came from and whether they were able to cross the windy Mediterranean.

FURTHERMORE, the project team carried out important tests on the drift capacity of selected cultivated plants on the Mediterranean. In an ecological-maritime experiment, the germination ability of seeds respectively fruits of the bottle gourd, the cotton, the yam root as well as the barley after

being exposed to the water for a longer time, was examined. The seed samples were launched in Santa Teresa di Gallura in North-Sardinia and were dragged behind the reed boat for 26 days via Corsica, Elba to Piombino on the coast of the Toscana.

The sowing together with the control samples in the IPK Gatersleben should produce important statements of the germination ability after the drift across the Mediterranean.

2. Main Part

2.1. Objective

The analysis of the previously discussed references showed, that man already exported cultivated plants from the first agricultural centers of the *Asia anterior half moon* at a point in time much earlier than assumed until now. The spreading of the first domesticated plants and the first herds of domestic animals occurred by land as well as by sea. The fact that in train of the neolithism even the most remote areas of the westafrican and the european continent were reached, is today generally expected by the majority of the ethnobotanists and zoographers. The question if a spreading of species bred by man reached beyond the Mediterranean and even across the Atlantic Ocean to the pre-Columbian peoples of America is the subject of this survey. For this study different cultivated plants were chosen, which on the one hand are in the center of attention of ethnobotanic research and on the other hand also appeared to be interesting objects of research. The majority of the plant samples were tested under water.

Table 1: Table of the examined species, their serial number in IPK, their origins and the characteristics of their tests during the voyage

SPECIES	SERIAL NUMBER	ORIGIN	REMARK	TEST
summer barley six-row <i>Hordeum vulgare</i> L. convar. <i>Vulgare</i> var. <i>Hybernum</i> Vib.	HOR 1938	Egypt	one of the oldest grains of the Near East	in drift-experiment
summer barley six-row <i>Hordeum vulgare</i> L. convar. <i>Vulgare</i> var. <i>Hybernum</i> Vib.	HOR 2473	Morocco	one of the oldest grains of the Near East	in drift-experiment
summer barley six-row <i>Hordeum vulgare</i> L. convar. <i>Vulgare</i> var. <i>Hybernum</i> Vib.	HOR 4146	Algeria	one of the oldest grains of the Near East	in drift-experiment
winter barley six-row <i>Hordeum vulgare</i> L. convar. <i>Vulgare</i> var. <i>Hybernum</i> Vib.	HOR 4184	Tunisia	one of the oldest grains of the Near East	in drift-experiment
summer barley two-row <i>Hordeum vulgare</i> L. convar. <i>Distichon</i> (L.) Alef. s.l. var. <i>nutans</i> (Rode) Alef.	HOR 4766	Lebanon	one of the oldest grains of the Near East	in drift-experiment
summer barley two-row <i>Hordeum vulgare</i> L. convar. <i>Distichon</i> (L.) Alef. s.l. var. <i>nutans</i> (Rode) Alef.	HOR 9724	Lebanon	one of the oldest grains of the Near East	in drift-experiment
summer barley two-row <i>Hordeum vulgare</i> L. convar. <i>Distichon</i> (L.) Alef. s.l. var. <i>nutans</i> (Rode) Alef.	HOR 11193	Jordan (Palaeobotan. reminds from Kiel)	one of the oldest grains of the Near East	in drift-experiment
bottle gourd <i>Lagenaria siceraria</i> (Monila) Standl. subsp. <i>Asiatica</i> (Kob.) Heiser	LAG71	Tunisia	ancient usefull plant, today pantropical	in drift-experiment
bottle gourd <i>Lagenaria siceraria</i> (Monila) Standl. subsp. <i>Asiatica</i> (Kob.) Heiser	LAG75	Italia	ancient usefull plant, today pantropical	in drift-experiment

bottle gourd <i>Lagenaria siceraria</i> (Monila) Standl. subsp. <i>asiatica</i> (Kob.) Heiser	LAG76	Nigeria	ancient usefull plant, today pantropical	in drift- experiment
african cotton <i>Gossypium herbaceum</i> L.	GOS14	Morocco	fibre plant	in drift- experiment
yam root <i>Dioscorea spec.</i>	DIO1	Korea	early asian/ african/ american usefull plant	germination and cultivation on deck
pumpkin <i>Cucurbita pepo</i> L.	Does not come from the IPK Genbank	Sardinia	earliest cucurbitaceous plant	in drift- experiment

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

1. How do these cultivated plants behave under the conditions of an oceandrift?
2. Which of the samples keep their ability to sprout after being exposed to the water?
3. Are there any differences between the subspecies respectively to the different geographical occurrence within one species?
4. Of what importance are the the tests of drifting and germinating for the ethnobotanical research?

2.2. Introduction to the methods of research

Due to the carrying out of the ABORA expedition 1999 we had the unique chance to examine the drift ability of selected cultivated plants under real conditions in the Mediterranean.

AS ALREADY described, the samples were launched in Santa Teresa di Gallura in Northsardinia and then they were dragged behind the reedboat for 26 days via Corsic and Elba to Piombino at the coast of the Toscana.

Unfortunately, it was not possible to launch the samples earlier because of technical problems during the beginning of the expedition. Only the yam root, which had already started to germinate in Sardinia during the building of the boat, was put up at a dry place on the boardshelf of the ABORA in the beginning of the expedition. All other samples were sewed into special small sacks made of linen, which garantied a constant surrounding by water. The two large pumpkins and the sacks were tied up in a big net which was dragged behind the boat with cords of three meters. The samples were continuously in the water except for the landing manoeuvres. Unfortunately, the samples were no longer exposed to the water then four weeks. Therefore the entire amount of time needed for a drift across the Atlantic Ocean, about four months, was fallen below. The plant material was being salvaged at the end of the experiment, it was dried by the sun and afterwards it was packed carefully and sent to the IPK Gatersleben. There, the sowing of the samples together with other samples from different stockassortments took place immediately. The germination attempts which followed were all made under the same conditions to exclude falsifications of the results. After the germinating, the samples



The main result of this investigation is that all samples of the African cotton species *Gossypium herbaceum* died completely during the experiment. This result contradicts the common hypothesis of its independent distribution across the Atlantic Ocean. (On the left side – red – the example after watering; on the right side – green – the control example of the laboratory)



We also tested three examples of the bottle gourd in the Mediterranean Sea. However, we could only investigate one fruit whose seeds were probably damaged before the drift. One of the seed examples (LAG 71) could survive the voyage of 26 days. The seed had a germination rate of 67%. (On the left side – red – the example of watering; on the right side – green – the control example of the laboratory)

were counted (see Table 2) and also photographically documented.

The valuation of their germination ability in per cent gives statistical returns as orientation for this ability after the drift across the Mediterranean. The germination and the counting of the samples occurred under authority of Dr. Andreas Börner, vice-chairman Genbank of the IPK Gatersleben.

2.3. Representation of results

THE RESULTS of the drift-experiments as well as the germination and analysis of most samples are shown in Table 2. Here, the rates of the germinating experiments of both groups of samples are represented by percentages.

The most important result of this survey is the fact that the representatives of cotton of the species *Gossypium* all lost their germination ability completely.

Upon the samples of barley of the species *Hordeum* only the assortment HOR 2473 from Morocco kept their germinative capacity, which was 71 % and therefore much above the rate of the samples of the cross-check which had a rate of only 64 %. All other species did not survive the voyage. The germination ability of the cross-check samples varied between 97 % and 49 %, which means it is intact seeding material.

AT FIRST GLANCE, the results of the bottle gourd, whose assortment LAG 71 showed a germinative capacity of 67 % after the voyage, seemed to be similar. The cross-check samples only reached 57 %. The sample came from Tunisia. Unfortunately, the Italian customs did not approve the introduction of a cargo load of young, fresh bottle gourds from Kenya, which was

particularly determined for the tests, to Sardinia. Therefore only a shield beery of the storage from the IPK could be taken on board, but it was already harvested a long time ago and dead, the seeds of the cross-check and of the test were both superimposed and showed no germinative capacity, but the state of the seeds within the shield beery was excellent. Throughout the time of the experiment, the water could not get through the hard fruit.

All other representatives showed, as seeds, no germination ability after the voyage. The relative pumpkin proved itself very instructive. It was launched to the water at exactly the same time like the gourd bottle, but it dissolved completely during the next five days. This process was quite fast and took only three days. Because of the soaked fruits, it was not possible to salvage any seeds. Therefore it does not show any ability to drift like the lignified shield beery of the genus *Lagenaria* does. But, contrary to the bottle gourd, the pumpkin was launched to the water, without drying, right after the harvest.

THE ONLY YAM root on board germinated already during the building of the boat. So, the plant was not taken into the net, whereas this would have meant its death. It took the best spot on board: on the boardshelf between the double mast, there, it was, depending on the position of the sail, more or less half shady. At the beginning of the expedition, the plant grew quite well but with increasingly long-distance trips, the yam root started to wither away. The reasons for this development are still not found. Finally, in Campolongo, after a voyage of 400 km, the plant died. It did not survive a journey of 34 days on board.

Table 2: Evaluation of germination experiments

<i>Serial Number</i>	<i>Germinating Ability of the Cross-Check in %)</i>	<i>Germinating Ability after Voyage (in %)</i>	<i>Picture before Germination Attempt*</i>	<i>Picture after Germination Attempt*</i>
HOR1938	83	0	Ja	Ja
HOR2473	64	71	Ja	Ja
HOR4146	49	0	Ja	
HOR4184	93	0	Ja	
HOR4766	89	0	Ja	
HOR9724	97	0	Ja	
HOR11193	85	0	Ja	
LAG71	57	67	Ja	Ja
LAG75	23	0	Ja	Ja
LAG76	0	0	Ja	
GOS14	90	0	Ja	Ja

*only some samples are photographically documented in the appendix

3. Evaluation of drift investigations and germination experiments

3.1 Interpretation of experimental results

With the ABORA expedition of 1999 we explored, in cooperation with IPK Gatersleben, the ability of selected cultivated plants, under realistic conditions, to spread by maritime drift. As yet experimental investigations have been based only on simulated experiments using sea-water. The results of our study are often in conflict with the contemporary majority opinion in these fields, especially with respect to the geographical and botanical origin of certain important, early American cultivated plants.

One well-known American plant geographer, CHARLES B. HEISER, states e.g. in his famous work "Seed to Civilization - the Story of Man's Food" that agriculture in the Americas had to have had, about 7,000 B.C., an autochthonous origin because, at this early epoch, there did not exist sea worthy vessels capable of transoceanic navigation (37). This unambiguous statement is typical of the view of most geobotanists with respect to the

problem of early transatlantic contacts even today, although Heiser made his statement already in 1973, i.e. at a time when it had not yet been realized that, because of modern calibrated C14 dates, the origins of agriculture in the Americas had to be dated about 2,000 years later.

WE FIND this isolationist position of leading scientists also in the latest edition of the URANIA PFLANZEN-ENZYKLOPÄDIE: "There can be no doubt that the cultivation of *Gossypium* species (cotton) took place absolutely independently in Asia and America".

Some sentences later, however, the authors bring a statement which, strictly speaking, contradicts their thesis of an independent cultivation: "A new problem, a solution to which is as yet scarcely in sight, arose when it was observed that, in the originally tetraploid cultivated species of the Americas, one of two chromosome sets is obviously identical with the chromosome outfit of *Gossypium arboreum* and *Gossypium herbaceum*". To resolve this contradiction or inconsistency, an argument is adduced of which it is hoped that it will, at one sweep,

invalidate all other pro-argumenta from the fields of cultural history and geobotany: "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" (38).

And it is exactly in the refutation of this assertion, wherein we see the value of our experimental investigation, because all cotton seeds of the species *Gossypium herbaceum* did not survive the 26 days of drift in the sea.

THE CONTROL specimens, which had been stored in the IPK Gatersleben cold storage warehouse, show a high germinating capability of 90 percent, which means that the seed material must have been of high quality. This first greater test in a realistic sea environment has shown that cotton seeds, contrary to what has been alleged by some, do not possess a more or less unlimited drifting capability but can totally lose its viability even in the course of a short maritime drift. Besides, this result shows that the simulated experiments in tubs with artificial sea saltwater arranged by CARTER & WHITTAKER in the sixties, did not meet real oceanic conditions during an oceanic drift, and were therefore assessed far too highly by most scientists.

In addition we have to bear in mind, that neither in our own nor in the US scientists' experiments the action of hungry sea fish and other marine life forms was taken into account. The ABORA carried our seed specimens along under its cover and protection, sewed up in linen bags. Especially in the region of the warm, mid-Atlantic North Equatorial Current, where nourishment for marine life is scarce, shoals of deep-sea fish and other marine life forms are continually patrolling the waters in search of something to devour, because far from continental land there the density and bioactivity of plankton is in no way comparable with e.g. that of the cold Humboldt Current in the South Pacific,

which Heyerdahl mentions so often. In view of our experimental investigations therefore, the probability that occasional stray seeds reaching the Atlantic via one of the African rivers and, then, reaching the Americas, has to be considered as practically zero indeed.

SIMILARLY RESULTS with respect to the interesting bottle gourds remain open to doubt. One of these results is the fact that seeds of the sample LAG 71 still showed a germinating rate of 67 percent after watering. Sample LAG 75, however, did not show any germinating capability after the voyage, although the control sample did show a germinating capability of 23 percent. Regrettably, besides the intact gourd LAG 76, no other intact samples had been available for this voyage. On first sight, the fact that the seeds within the intact gourd remained intact, too, might nourish hope that the lignified, protected seeds might be able to drift undamaged over long oceanic distances. We have, however, to be cautious.

Such a statement would be rather premature. Because first, the duration of the voyage has been, in relation to ocean voyages, relatively short, and second, because we had here the case of a very well-dried, i.e. very well-preserved fruit. Another possible explanation, why LAG 75 did not germinate, could be seen in the ability of certain seeds to survive intact long lasting adverse conditions, because they possess rather hard husks. If such samples do not germinate, it does not necessarily mean that those seeds were dead and had no longer any germinating ability. Many botanists infer from such observations "that in the course of domestication, several millennia ago, this species had probably been alienated from nature in such a fundamental manner that it can no longer exist in any natural habitat without the cultivation of man. This thesis is supported by observations in South East Asia, where the bottle gourd is one of the first cultivated plants to disappear after human settlements had been permanently abandoned." (39)

THE AMERICAN garden pumpkin, which does not lignify quite as much as its African relative, disintegrated within several days. This would not have happened with a completely dried garden pumpkin, because during the process of drying its surface would have become harder, too. Besides, we shouldn't perhaps rely too much on the thesis that the wild African bottle gourd is a river valley plant (40), which uses the waters of the rivers only for its spread. Even the coconut, optimally adapted for a spread by the sea, cannot drift for weeks in the ocean without losing its germinating capability. This has been shown already in 1941, in experiments off the Hawaii islands, where the coconuts, after 4 - 6 weeks had lost their germinating capability, because bacteria entered through their germinating pores so that the young sprouts died. (41)

There are two other most interesting cultivated plants, where we have to suspect that they have been brought to the island world of Polynesia by early American mariners: the yam root and its relative, the yam bean.

Both plants have been cultivated in the early agricultural centres in the Andes of South America as well as in Central America. (42) There is, however, an important difference. The yam bean *Pachyrhizus* is plainly of American origin, whereas the yam root *Dioscorea*, at least today, is present throughout the Tropics. The botanical geographer C.O. SAUER, who has studied this problem, is of the opinion that in the tropical zones of the Americas several wild yam species, some of them with edible tubers, are cultivated, especially because of their starch content. (43)

A GEOBOTANICAL analysis of this important cultivated plant leads, however, to the conclusion that the great majority of its more than 650 species have been present in the tropical, subtropical and temperate latitudes of the Old World, and only a few of

them in the Americas. We know that those few American species have been used as medicinal herbs (42-Urania), because of their steroid content. Domestication towards edible plants occurred primarily in West Africa and South East Asia. Only in the West Indies the plant was also used for food, to wit exactly in that very region, where also the Caribbean cotton *Gossypium barbadense* had been cultivated very early. (44)

All geobotanists are in agreement "that it can be stated with near- certainty that the yam has been unable to cross oceans by means of winds, currents, birds or other non-human agents, but that it has crossed the ocean in pre-Columbian times". (45) Our ABORA experiment did indeed show how endangered this plant is under conditions of the high seas. In spite of being well looked after on the ship, after 34 days the plant died. Neither would it have survived a similar drift in the waters of the Mediterranean, with its high salt content. It is therefore highly probable that the geobotanists are right who believe, with respect to the spread of the yam in the Pacific region, "that the yam root would have reached the Marquesas rather from the New World than from Melanesia by means of the indigenous peoples". (46)

The next cultivated plant, the barley *Hordeum*, is one of the most ancient cultivated plants of mankind, as evidenced by its presence in Jordan (8.200 B.C.) and Syria (7.800 B.C.). (47) Together with other cereals it spread over enormous distances during neolithic times, as far as the Atlantic coasts of Europe and Africa in the west. (48) Spanish archaeologists have several times found barley in Guanche graves. The problem, if barley did arrive in those distant Atlantic islands already during the Neolithic, or only as late as with the Phoenicians, is hotly debated among geobotanists and ethnologists.

IT IS DIFFICULT to be certain in this respect, because as yet archaeological

excavations have only yielded dates of 800 B.C. at most, (49) whereas the character of the Guanche culture and its remains are more indicative of a connection with the Neolithic peoples of the Mediterranean region. (50) According to one of the leading archaeologists of the Canaries, professor Antonio Gaspar, the cereals which have been found in the graves there, are similar to those of prehistoric times. (51)

Although this observation is of only limited botanical worth, our drift experiments were also intended to find out, if barley grains could possibly have drifted independently, by means of the Canary Current to the islands of the Guanches.

Of 7 barley samples which we tested HOR 2473 was found to be indeed salt water resistant (germinating rate 71 percent). The other samples showed no longer any germinating capability. Interestingly the sample HOR 2473 came from Morocco. We have thus to ask the interesting question: Is this resistance against salt water possibly the result of essential genotypical differences between barley grains of different origin? Or perhaps resulting from an adaptation to saliferous desert habitats?

AT THIS MOMENT these questions cannot be answered. The IPK is developing F₂/F₃ populations from crossings between HOR 2473 and samples which have been detrimentally influenced, with respect to germinating capability, by ocean water. We will test these during the next expedition. At any rate it is shown by the other samples that barley is not a cultivated plant which is adapted to a natural spread by means of drifting in the sea. It can, therefore, only have reached islands like Sardinia and Corsica by means of ships, beginning during the 4th millennium B.C. at the latest. Besides, during the Neolithic, it was not *Hordeum vulgare* L. convar *vulgare* var. *Hybernum* Vib., which today is cultivated in Morocco, but probably *Hordeum spontaneum*, which has been found

in all prehistoric agricultural centres of the Near East and the eastern Mediterranean, which was spread by man. Also, samples of *Hordeum vulgare* L. convar *vulgare* var. *Hybernum* Vib. from Egypt, Algeria and Tunisia have been tested, which likewise showed no longer any germinating capability.

All results from these drift and germinating experiments are highly significant. Our results with respect to cotton seeds and bottle gourds are not compatible with current geobotanical hypotheses to the effect that these cultivated plants have spread over oceans without the intervention of man. These hypotheses are therefore now open to doubt. We believe that further research is needed to find out, how these plants came to pre-Columbian America. With respect to barley, yam, but also the garden pumpkin, our studies corroborate the view that, in all probability, these cultivated plants could reach new regions of cultivation only through the intervention of man.

3.2 Analysis of results

AS FAR AS we know, these drift investigations constitute one of the earliest comprehensive experiments to test the drift capability of cultivated plants under realistic conditions of the high seas. Quite naturally there were practical limitations with respect to the manner in which we were able to prepare and realise our experiments, which have influenced our results, and which made the evaluation of results sometimes more difficult.

The most critical argument could be the fact that the expedition could test only one single, albeit wholly dried bottle gourd. To get statistically relevant data, we would have needed dozens of fruits of different origins, and also of the two sub species. Therefore the argument is valid that the expedition has only tested a rather small segment of all geographically relevant species. Only a few genotypes of the bottle gourd, and only one

genotype of cotton has been tested.

As yet these experimental results are insufficient to state with certainty that the pertinent, current geobotanical hypotheses have definitely been refuted. However, the results show that these hypotheses have now, in the light of our expedition experiences, to be regarded with marked suspicion.

ANOTHER FACTOR of uncertainty could be seen in the limited duration of our expedition of only 26 days, thus constituting only a rather incomplete simulation of a true drift in the Atlantic Ocean. Besides, the waters of the Mediterranean are normally of another composition than those of the Atlantic. This, too, constitutes a factor of uncertainty.

The unexpected demise of the yam root on deck shows that future expeditions should not only have test samples fastened to the vessels hull under the water line with it, but also samples in special containers on deck. Only in this manner these living organisms could be tested in a more comprehensive way under conditions of the high seas. Also, seeds should be set aside on board to offer them to fish and other marine life forms, to learn how they will react, i.e. if such "untypical" food will also be accepted, and how many of the seeds would be able to continue their drift in the direction of the Americas.

To sum up: we have tried to approximate our experimental conditions as nearly as possible to a realistic drift. Our main task in the case of this reed boat expedition, however, had to be the testing of the sailing characteristics of our vessel.

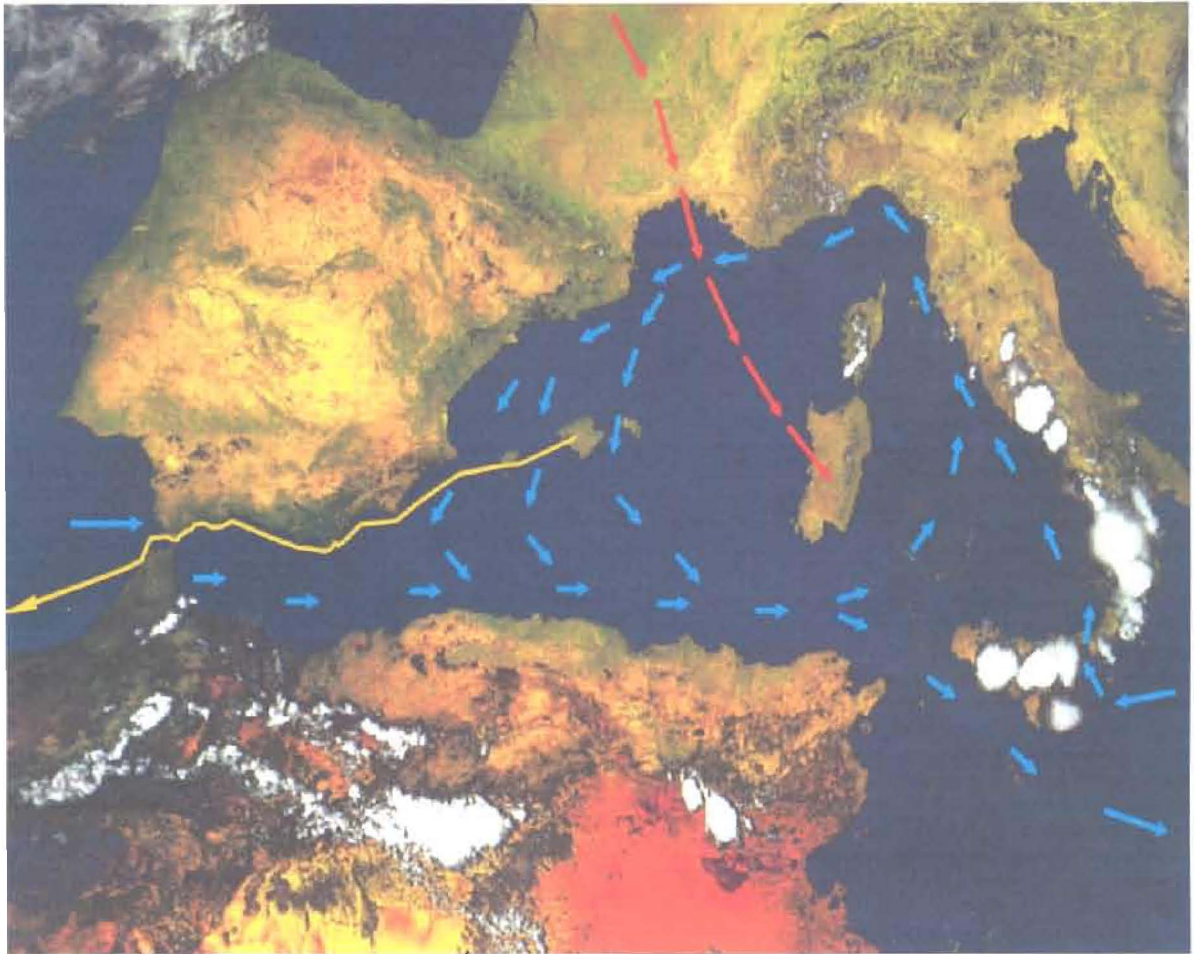
3.3. Implications for possible pre-Columbian, transatlantical diffusion

MANY SCHOLAR are prepared to admit that there do indeed exist many, really remarkable correspondences between the civilizations and cultures of the New and the

Old World. Sadly, however, the fact cannot be denied that important evidence of diffusionist influences on the Americas from outside is not evaluated and discussed with that objectivity, which is indispensable for any scholarly debate. Heinke Sudhoff, expert in transatlantic studies, is even more critical of the mainstream. She states "that this topic is regarded as suspect and unworthy of serious discussion, and that a scholar studying these problems can scarcely reckon on his colleagues' cooperation. New discoveries and informations are never mentioned or discussed, This is especially so in the case of Mexico, which is vehemently against any foreign influences on its own, American civilization" (54)

Because of this state of affairs, many scientists will probably react in a very irresponsible and critical manner with respect to the general topic of our study, to wit to investigate, by means of geobotanical experiments, possible transatlantic influences on the prehistoric agricultural civilizations of the Americas. Any interpretation of our experimental results will be coloured by the "Weltbild", which the respective scientists have with regard to the nautical abilities of those prehistoric seafarers. There are wide discrepancies of opinion with respect to prehistoric navigation.

ANYWAY, and quite obviously, the task of elucidation of the problem of pre-Columbian transatlantic ethnic and cultural diffusion cannot simply, and exclusively, be assigned to our archaeologists. Here we need the know-how of scientists in many fields of knowledge, especially of geologists and biologists. By means of the interdisciplinary cooperation of biologists and geologists e.g. undeniable progress has become possible with respect to our knowledge about the spread of plants and animals. Even a new scientific discipline has been born from such cooperation, to wit the biogeography of islands, which critically assesses the various arguments in favour and against human



The investigation of the transoceanic spreading of cultivated plants should be continued during the next reed boat expedition ABORA 2. This map shows the planned route which shall go out of the Mediterranean Sea. In the next trail we will test more samples of all species and test more geographical races on the long way to the Canary Islands in the Atlantic Sea.



The new vessel will be constructed by the famous reed boat builder from the Lake Titicaca. It shall be built by the totora reed plant which guarantees longer swim times of at least 3-4 months. This will correspond to the time of the drift across the Atlantic. The picture shows a bis reed boat on the Lake Titicaca which has already swum 6 weeks on water.

intervention in such cases. One of the most important questions in any discussion of intercontinental spreads of plants as e.g. in the case of the bottle gourd is the problem of the role of intercontinental drift. The theory of continental drift had been formulated in 1915 by ALFRED WEGENER, and it is today accepted by the great majority. Sadly, however, real knowledge among biologists about the origins of most of our plant families and their geographical Distribution during the Mesozoic is rather modest. It may, however, be stated with some hope of general agreement that during the Tertiary most families were fully developed. The most ancient ancestors of relatives of the gourd are known from the Oligocene (55), at which time Africa and America had already drifted apart. In view of the fact that all wild bottle gourds are exclusively endemic to Africa it seems probable that the species *Lagenaria* developed after the separation of both continental plates.

We have to ask the question: why did the bottle gourd and cotton appear in the New World exactly at the same age, in which ocean-going ships and oceanic navigation were developed in the Mediterranean region, i.e. between the 6th and the 3rd millennium B.C.? This can hardly be a chance coincidence, because their biological ancestors would have had time enough, since the Tertiary, to cross the Atlantic by natural means, as postulated by the mainstream.

The assertion, which we had found in the relevant literature, "that the cotton or the bottle gourd had drifted to America towards the end of the Pleistocene" is a mere, unsubstantial conjecture. Because earliest finds of both cultivated plants from the relevant excavation levels in the valley of Teotihuacan in Mexico, which have formerly been dated to circa 7000 B.C., are now given a date of between 5000 and 3500 B.C., and there is not the slightest evidence (fruits, pollen) for their earlier presence, i.e. before their cultivation in the Teotihuacan valley.

ON THE CONTRARY, the synchronism

between the development of ocean-going ships and oceanic navigation in the Old World and the first appearance of African cultivated plants in America makes the conclusion nearly unavoidable that these cultural parallels have been due to transatlantic diffusion. (The list of these cultural parallels is rather long. It comprises architectonic, mythological, artistic, biological, and other parallels, vide authors like Heyerdahl, Sudhoff, or Braem).

Island-biogeographic considerations provide further important arguments against independent arrivals by natural means. Quite obviously, generalizations of these island-biogeographic considerations do not only apply in the case of islands, but also of continents, and of island-like habitat, on the mainland. (56) Some more important aspects of this matter are as follows:

Island populations show the limitations of passive spread.

"On islands far from any mainland we find almost exclusively plants and animals which arrived there on natural rafts, by means of the winds and currents... Even birds with a wide radius of action did, most often, not arrive actively, because they do not voluntarily cross wide, uninterrupted expanses of water". (57)

THE RATE of new arrivals is all the greater, the nearer and the richer in species the next mainland.

This obviously evident thesis is extended by biogeographers' statements that stable populations are developing only in the course of a long period of time, which remain, however, "disharmonious", because many an ecological niche remains unused. "Such island species are far more threatened by extinction than their relatives on the mainland. In addition the first arrivers did not bring with them the full genetic diversity and, therefore, adaptability of their mainland

congeners. Advantageous genes, which are present only in a few individuals, can easily get lost when the latter have accidentally died (gene drift)". (58)

Colonizing of islands is rendered all the more difficult, the more competition.

MANY SPECIES of plants and animals settle a new territory only in a chessboard-like manner, although "we cannot find any explanation for this kind of geographical distribution with respect to compliance with known demands of the species. It seems as if only the first arriver among several related or ecologically similar species can successfully establish its presence". (59)

These considerations may be condensed into the generalization that it is rather difficult for a newly arrived species to establish a "bridgehead" so to speak, in a new territory. With respect to central Europe, where many species have been imported by man, and the rather well-known history of its flora, as far as we know there have been 115 species which have become, since Neolithic times, as it were "naturalized" denizens. (60)

We have, however, to take into account "that of these 'naturalized' members of the central European flora the great majority is tied to habitats, which have been created by man". (61) In addition, all these species have arrived passively, having been brought by man from the Near East to central Europe after the introduction there of agriculture and livestock farming. The decisive role of man with respect to the spread of cultivated plants to distant lands can be deduced from the observation that, of the many imported species, only a small fraction succeeds in becoming a permanent denizen of the flora in its new home country.

It is, however, not the intention of this paper to deny that, during the long duration of the evolution of the plant kingdom of many millions of years, there may not have been

quite a number of species who were able to "migrate" long distances and conquer several continents (so-called mega disjunctions). But in the case of the American cotton, the bottle gourd and the yam root we have domesticated, cultivated plants, which have arrived in the Americas only very lately, in geological terms.

Already THOR HEYERDAHL has formulated the paradox or selfcontradictory statement that, of two African cultural elements, to wit the terrestrial bottle gourd and the maritime boat, the gourd allegedly should have been able to drift to America, but not so the boat. This shows clearly the quasi-scientific manner in which the topic of transatlantic cultural diffusion before Columbus has been treated. It is true: botanists as well as archaeologists insist again and again that mariners from the Mediterranean couldn't have influenced the evolution of agriculture in the Americas, because they were unable to go beyond the Strait of Gibraltar and cross the Atlantic. However, they have never been able to adduce even the slightest tangible proof for such an assertion.

HEYERDAHL's expeditions as well as our voyage with the ABORA have shown that neolithic reed boats have a lifetime of months, and are easily navigable even against the wind. In view of the biogeographical evidence it has to be considered as highly improbable that several domesticated, cultivated plants should have reached the Americas, and should have been able to establish themselves there, without the intervention of man. Especially so since we speak here of a, geologically speaking, extremely short period of only about 7000 years.

As a result of our study, and especially in view of certain parallel cases, we have to state our conviction that there have indeed been very early transatlantic contacts between the Old and the New World, which

led to the transfer of certain species from one continent to the other.

THAT THESE contacts did not only go in the East-West direction, but probably also from the Americas to Europe and Africa, is evinced again by biogeographical evidence. Svetlana Balabanova, a biochemist, has discovered traces of nicotine and cocaine in Egyptian mummies at first, and later also in ancient European human remains. (62) Both alkaloids are typical of American plants and have been dated to shortly after that epoch, during which the Old World species appear in America. Even a complete tobacco beetle has been discovered, when the mummy of Ramses II. was examined in Paris. This is solid evidence of a pre-Columbian Old World presence of an American animal species.(63) It had been also found that Ramses' mummy had such a high alkaloid dose in its tissues that it would kill a man. Probably these alkaloids were not used for daily consumption, but for the preparation and conservation of the dead Pharaoh's body. In

the course of this preparation the tobacco beetle, a notorious pest in American tobacco plantations, has probably unintentionally been wrapped up into the mummy. As yet we do not know how the Pharaonic physicians had obtained these alkaloids and the tobacco beetle.

Sadly, such discoveries do not often find their way into the pages of internationally known newspapers. Most often they are known only to a select circle of scientists who, in the majority of cases, have little interest in an elucidation of such enigmas. Such "anomalous" discoveries are, however, of the greatest significance, exactly because they contradict the conventionally held "Weltbild". We feel that all researchers are called upon to help getting such unsolved enigmas of the history of mankind solved. The project group hopes that this study may be of help in enlightening us a little about the as yet rather dark problem of the spread of ethnobotanically important cultivated plants.

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Zusammenfassung

Die Geobotanik - ein Schlüssel zum Wiederauffinden vorgeschichtlicher Wanderungen der Menschen

Seit vielen Jahren führen Wissenschaftler leidenschaftliche Debatten über den Ursprung altweltlicher Kulturpflanzen in der vorkolumbianischen Landwirtschaft Amerikas. Kernpunkt der Diskussionen ist immer die Frage, ob sie unabhängig oder mit Hilfe des Menschen über den Atlantik drifteten und in die altamerikanische Landwirtschaft eingeführt wurden. Überreste von Samen und Früchten stellen solides genetisches Beweismaterial dar, das mehrfach durch archäologische Grabungen geborgen wurde. Sollte es möglich sein, das Erscheinen einer Kulturpflanze im prähistorischen Amerika durch den Einfluss des Menschen nachzuweisen, könnten wichtige Belege für transatlantische Kontakte vor Kolumbus erbracht werden. Für die Erforschung dieses Themas bestand mit der Durchführung der Schiffsbootexpedition ABORA 1999 die einmalige Möglichkeit Samen und Früchte ausgewählter Kulturpflanzen auf ihre Driftfähigkeit unter Hochseebedingungen zu untersuchen. In Zusammenarbeit mit dem IPK Gatersleben wurden diese Pflanzen ausgewählt, auf dem Mittelmeer getestet und anschließend im Labor auf ihre Keimfähigkeit geprüft. Bisherige Studien stützten sich auf Simulationsexperimente in Salzwasserbottichen. Die Ergebnisse dieser Arbeit liefern erste sichere Daten zu einer realistischen Beurteilung der Driftfähigkeit jener Kulturpflanzen. Unsere Studie erbrachte für die Mehrheit der Proben keine Keimfähigkeit nach der Wasserung, so dass unsere Ergebnisse im Widerspruch zu den gängigen Theorien stehen. Auf der Grundlage unserer Untersuchungsergebnisse muss die menschenunabhängige Ausbreitung stark angezweifelt werden. Diese Schlussfolgerung wird auch durch die Verallgemeinerungen der Inselbiogeografie unterstützt, welche die passive Verbreitung von domestizierten Tier- und Pflanzenarten ohne Hilfe des Menschen in ferne Lebensräume im höchsten Maße als unwahrscheinlich bewertet.

Damit kann die ethnobotanische Forschung vielleicht einen ersten direkten Beleg für eine kulturelle Beeinflussung und Übertragung immaterieller Methoden erbringen, daß es vor der Entdeckung Amerikas durch Kolumbus nicht nur zufällige Kontakte, sondern tatsächlich eine Beeinflussung der frühen Indianerkulturen gegeben hat.