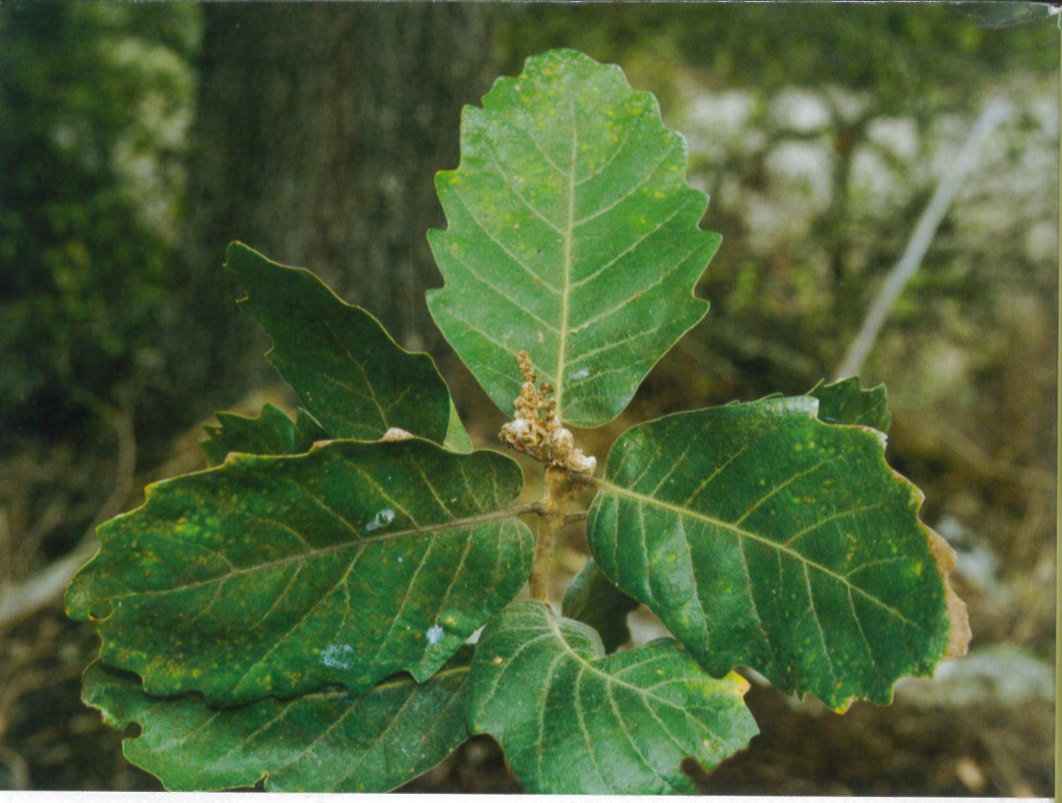

Quercus alentejana (a new species), foliage and fruits
Photos by Michel Timacheff

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Oak Diversity and Ecology on the Island of Martha's Vineyard

Timothy M. Boland,
Executive Director,
The Polly Hill Arboretum,
West Tisbury, MA 02575 USA

Martha's Vineyard is many things: a place of magical beauty, a historical landscape, an environmental habitat, a summer vacation spot, a year-round home. The island has witnessed wide-scale deforestation several times since its settlement by Europeans in 1602; yet, remarkably, existing habitats rich in biodiversity speak to the resiliency of nature. In fact, despite repeated disturbances, both anthropogenic and natural (hurricanes and fire), the island supports the rarest ecosystem (sand plain) found in Massachusetts (Barbour, H., Simmons, T, Swain, P, and Woolsey, H. 1998). In particular, the scrub oak (*Quercus ilicifolia* Wangenh.) dominates frost bottoms and outwash plains sustaining globally rare lepidopteron species, and formerly supported the existence of an extinct ground-dwelling bird, a lesson for future generations on the importance of habitat preservation.

European Settlement and Early Land Transformation

In 1602 the British merchant sailor Bartholomew Gosnold arrived in North America having made the six-week boat journey from Falmouth, England. Landing on the nearby mainland the crew found abundant codfish and Gosnold named the land Cape Cod. Further exploration of the chain of nearby islands immediately southwest of Cape Cod included a brief stopover on Cuttyhunk Island, also named by Gosnold. The principle mission was to map and explore the region and it included a dedicated effort to procure the roots of sassafras (*Sassafras albidum* (Nutt.) Nees) which were believed at the time to be medicinally valuable (Banks, 1917).

Upon reaching New England, Gosnold and his crew were approached and greeted by the aboriginal inhabitants of the region, the Wampanoag tribe, and they traded back and forth. Gosnold would eventually land and name the island of Martha's Vineyard. A report from the ship's journal reads, "an incredible store of vines, as well in the woodie part of the Island, where they run upon every tree, as upon the outward parts, that we could not goe for treading upon them." (Banks, 1917).

The wild vines on the island still persist today and the designation of Martha's Vineyard is in tribute to Gosnold's wife's grandmother, Martha Golding, and his infant daughter, who died in 1598 prior to the journey (Bachler and Thurston, 2007).

Gosnold and his crew would explore for less than a month, then depart back to England. He would never return to the region but would eventually sail back to North America in 1607 to found Jamestown, Virginia, and begin the colonization of America. Gosnold died in Jamestown during the winter of 1609-10.

Geology and Edaphic Conditions

The topography and soils of Martha's Vineyard are the result of past glacial episodes that produced a band of terminal moraines stretching across south coastal Massachusetts, Rhode Island, and Long Island, NY. Today the two principle landforms found on Martha's Vineyard are the raised moraines and the flat outwash plains. Both are characterized by free-draining, gravelly, acidic soils, poor in organic matter and coarse in texture.

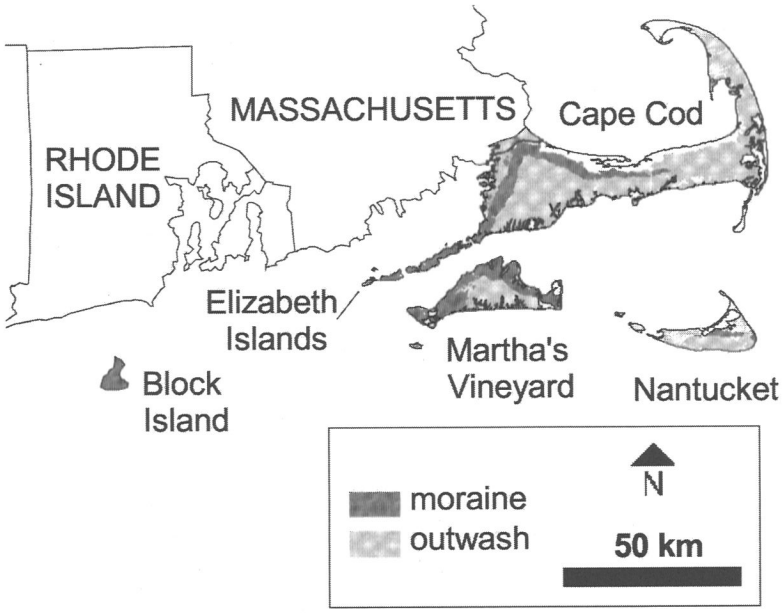
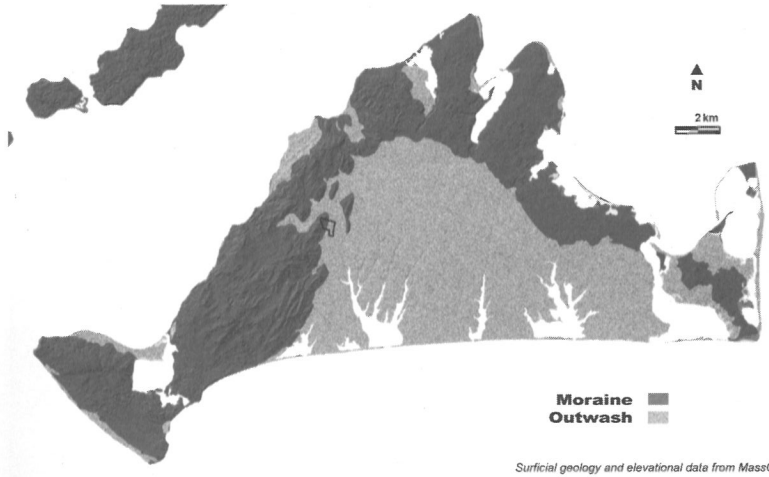


Figure 1. Map of the coastal region from Cape Cod, MA to Long Island, NY. (Motzkin, G, and D. R. Foster, 2002).

The island's forest cover is dominated by oaks. The distribution of oak species is strongly influenced by the soils and exposure to the marine climate.

Oak Diversity and Ecology

Martha's Vineyard supports 6 species of oak and 4 documented hybrids. Given the influence of geology, topography, elevation, and exposure to wind and salt, oak habitat is varied on Martha's Vineyard. With a maximum elevation of only 311 feet above sea level, the moraine forests support a dominant canopy of black oak (*Quercus velutina* Lam.) and white oak (*Quercus alba* L.). The vast outwash plains of the interior of the Island are dominated by scrub oak, (*Quercus ilicifolia* Wangenh.), post oak (*Quercus stellata* Wangenh.), and to a lesser extent the dwarf chinkapin oak (*Quercus prinoides* Willd.). Scarlet oak (*Quercus coccinea*



Surficial geology and elevational data from MassGIS

Figure 2. Surface Geology of Martha's Vineyard. Darkened outline represents the Polly Hill Arboretum.

Münchh.) is the least common oak and it appears sporadically as isolated trees. This species is abundant on nearby Cape Cod.

The appearance of the post oak on Martha's Vineyard represents one of its northernmost populations on the continent. The trees are often found as ancient oak stools from repeated cutting for firewood or the result of stump sprouts from past episodes of fire. Although tree ring counts provide estimates up to 80 years of age, the nature and quantity of stool formation suggest that some post oak stands date back before European settlement. The dwarf chinkapin oak is a woodland edge tree and rarely reaches over 1.5m (c. 5ft.) in height. It is not abundant but grows side-by-side with scrub oak in the outwash plains and as an understory tree in the morainal woodlands of the island. The white oak does not obtain the grandeur of specimens found on the mainland. Hurricane force winds, ocean salt, and dry soils produce trees that grow wider than tall, although some achieve spectacular forms.

The black oak is the most common species on the island, appearing in woodland moraines, outwash plains, and coastal seaside areas. Typically considered an upland species of dry forest or sand dune, on the island it abuts the ocean and is tolerant of tidal fluctuations of brackish water. Perhaps the tallest naturally occurring trees on the island, black oaks can also display a short spreading habit.

The scarlet oak is an unusual tree to find in great number anywhere on the island and it is more commonly found as separate isolated trees, never in groves.

The scrub oak is often maligned as the tree of the barren lands. Historical accounts of the great monoculture of scrub oak in the outwash plains describe a tree of little value, and a sign of lowlands frequented by frost. "A barren ragged plain of no town." (Athearn, 1698). The outwash plains remained, both before and after European settlement, a sort of no man's land. With scarce access to water and drought-prone soils, they provided little incentive for growing agricultural

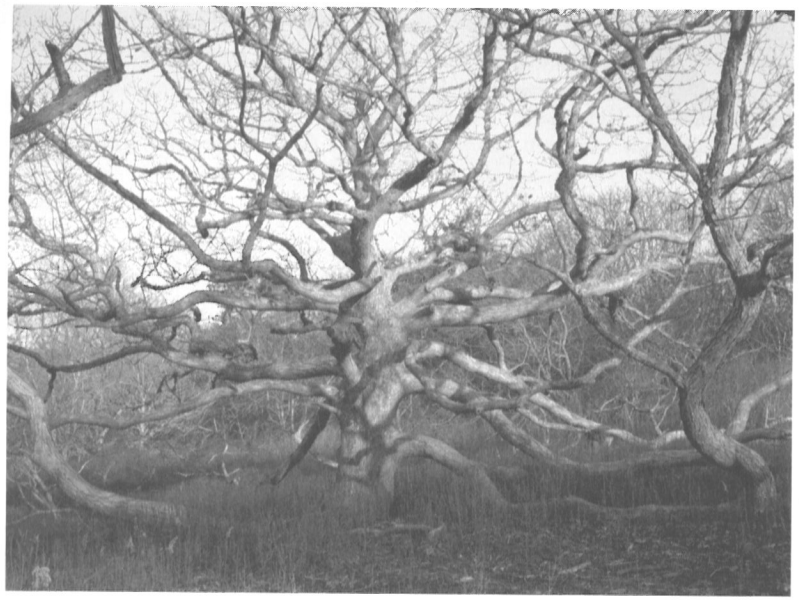


Figure 3. Wide-spreading Form of White Oak on Martha's Vineyard. Photo by the author.

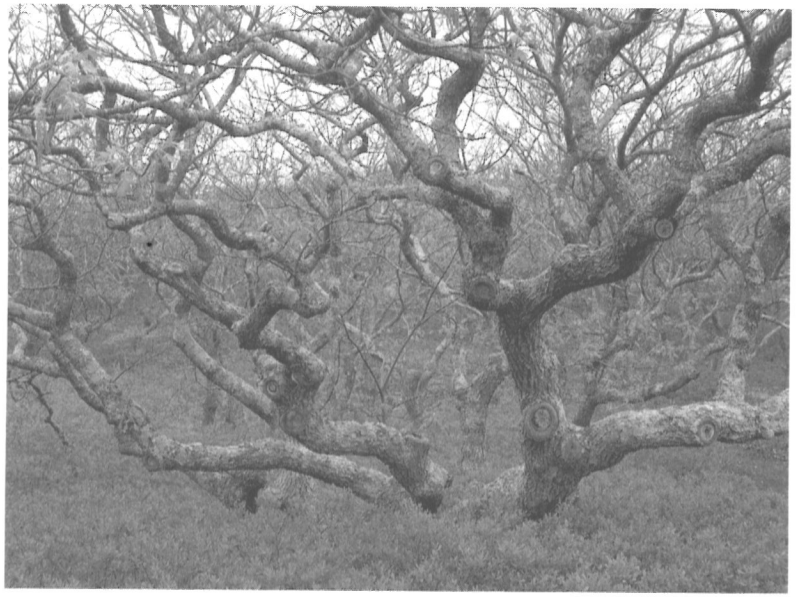


Figure 4. Wind-induced Spreading Form of Black Oak. Photo by the author.

crops or supporting grazing animals. Agriculture in the form of crop or livestock production occurred historically on the perimeter of the island. Despite its perceived lack of value, the outwash plain on Martha's Vineyard would later become valued primarily as the last breeding ground of a now extinct bird, the heath hen.

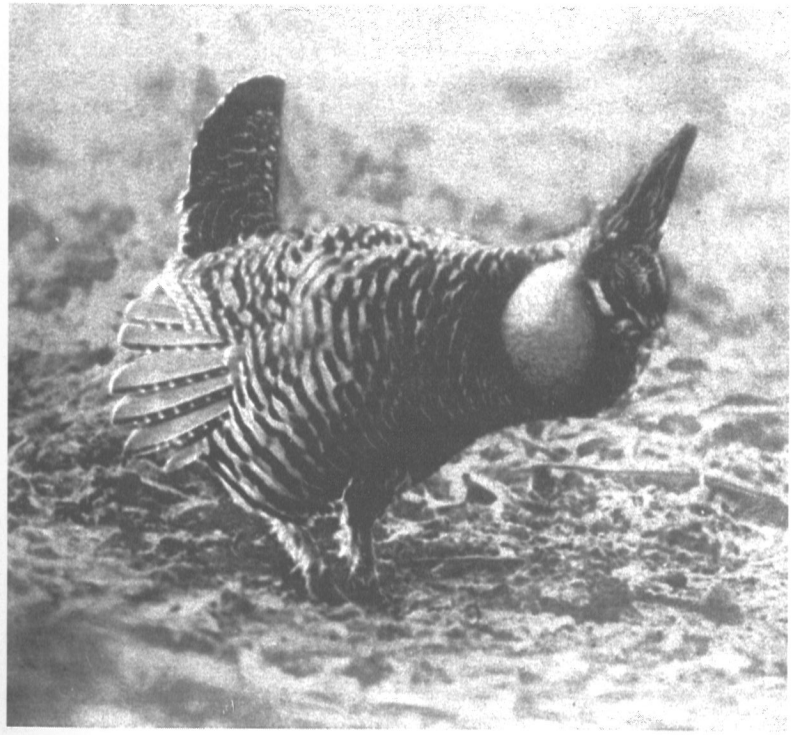


Figure 5. The Male Heath Hen. Photograph by Dr. George W. Field. (Gross 1928).

The Heath Hen Reservation and the establishment of the Manuel F. Correllus State Forest

In 1908, the Commonwealth of Massachusetts purchased 612 acres in the central portion of the island in an effort to conserve the last remaining population of heath hen (*Tympanuchus cupido cupido* L.). Considered at the time a subspecies of the greater western prairie chicken, it was abundant in coastal North America from Maine to Virginia at the time of European settlement. Through the combined effects of habitat loss and hunting to near extinction, by 1870 the remaining populations of heath hen found refuge on the great plains of Martha's Vineyard. The story of the heath hen and the efforts to save it was compiled by Dr. Alfred O. Gross in his book titled, *The Heath Hen,* published in 1928. The introduction

frames the situation as it existed in the last years of the heath hens existence on Martha's Vineyard.

"In the history of the animal kingdom, species of animals that have been unable to adapt themselves to the changing conditions of their environment have become extinct. Even within the memory of man, species of birds that at one time were eminently successful in the competition for existence have completely disappeared.....When the first colonists came to our shores the heath hen was abundant in many places in New England and the Middle Atlantic States but it was unable to adapt itself to the new conditions imposed by civilization. It was soon driven out from place after place and by the middle of the nineteenth century it was forced to entrench in its last stronghold on Martha's Vineyard. There on the sandy scrub-oak plains in the central portion of the island, the Heath Hen has up to the present withstood the encroachments of man." (Gross 1928).

An ornithologist, Gross would study the habits of the last 100 Heath Hens in existence and among his noteworthy findings was the use of scrub oak acorns as its major food source. While good intentions and efforts were made to save the Heath Hen, the last male bird died in 1932, signifying the extinction of this unique bird. Despite the failed efforts to preserve the heath hen, in subsequent years the Commonwealth of Massachusetts would add adjacent parcels of conservation land and would eventually turn over the ownership to the Massachusetts Department of Conservation. Today the Manuel F. Correllus State Forest consists of a total land area of just over 5200 acres. Island conservationists consider it the crown jewel of conservation lands on the island. Rich habitats comprised of sandplain grasslands, frost bottoms, and pitch pine forest are found within its boundaries. The central location provides protection of the one freshwater aquifer that provides drinking water for island inhabitants.

Interspecific Hybrids on Martha's Vineyard

The pioneering botanical work of Alfred Rehder and Ernest Palmer of the Arnold Arboretum left a strong legacy in the New England region. In 1901 Rehder published work describing the hybrid oaks of New England, most found within the Boston area. His work would eventually extend to Cape Cod, Martha's Vineyard, and Nantucket Island. Later Palmer would delve deeper into the complex nature of the introgression of sympatric oak species and their highly variable offspring (Palmer 1937, 1948).

Taxonomists struggle with the concept of "mongrel" populations of plants, yet Rehder and Palmer created type specimens in an attempt to define as best they could these hybrid groups of trees (Hill, P. and Buck, P. 1980). Taxonomists approach these hybrids with the overlying concept of the nothotaxon. The most current International Code for Botanical Nomenclature defines nothotaxon as "when all the parent taxa can be postulated or are known, a nothotaxon is circumscribed so as to include all individuals (as far as they can be recognized) derived from the crossing of representatives of the stated parent taxa (i.e. not only the F_1 but subsequent filial generations and also back-crosses and combinations of these)." (ICBN 2006).

This concept has wide application on Martha's Vineyard. Personal observations and botanical voucher collections reveal a wide spectrum of morphological expressions, some grading more heavily to one parent versus the other.

The first hybrid described by Rehder in 1901 (*Quercus ×rehderi* Trel.) is a hybrid between black and scrub oak; it is common on Martha's Vineyard (Trelease, W., 1924). The remaining hybrids were all described by Palmer and are much more difficult to circumscribe. The table that follows outlines the documented hybrids found on Martha's Vineyard with voucher specimens that exist in New England herbaria, including the Polly Hill Arboretum (PHA).

Quercus × *rehderi* Trel. (*Q. ilicifolia* × *Q. velutina*)	Rehder Hybrid Oak
Quercus × *faxoni* Trel. (*Q. alba* × *Q. prinoides*)	Faxon Hybrid Oak
Quercus x fontana Laughlin *(Q. coccinea x Q. velutina)*	
Quercus × *fernowi* Trel. (*Q. alba* × *Q. stellata*)	Fernow Hybrid Oak
Quercus × *stelloides* E. J. Palmer (*Q. prinoides* × *Q. stellata*)	

Figure 6. Interspecific oak hybrids documented by New England herbaria. (Angelo R. and Boufford, D., 2010).

Recent Oak Mortality and Climate Change Implications

In recent years a native insect pest, fall cankerworm (*Alsophila pometaria* (Harris), has caused significant damage on the island. An estimated 40% tree mortality occurred in the PHA natural areas as a result of 3 successive years of defoliation (2005, 2006, 2007) combined with summer drought. A study of the long-term forest dynamics of the PHA woodlands (40 acres – 16 hectares) has been initiated in collaboration with the Harvard Forest of Harvard University. PHA is confident that the local study of our woodland can inform or provide a perspective on island-wide conservation of oak forests for the future. Nine study plots have been designated at the Arboretum and an additional 11 plots on neighboring conservation property. Key aspects of the study will include forest succession, soil nitrogen availability, monitoring of populations of defoliating insects and keystone soil invertebrates (ants and beetles), and recording environmental variables such as light and temperature.

Many questions remain as to the intensity of the insect outbreak and the significant collapse of our mature oak forest. While global climate change continues to be debated, one way to engage in the process is the long-term

Figure 7. Author in the midst of oaks lost to fall cankerworm. Polly Hill Arboretum, 2009.

ecological study of our oak woodland. We look forward to sharing our findings in the years ahead.

This paper is a revised version of a presentation given by the author at the 6th International Oak Conference 20-22, October 2009, Puebla, Mexico.

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A Botanic Oak Collection Recruited for Science

Béatrice Chassé
Arboretum des Pouyouleix, France
arboretum.pouyouleix@wanadoo.fr

What do you do if you are a geneticist studying the evolution of the genus *Quercus* and in great need of DNA samples of several hundred different oak species found nearly everywhere in the northern hemisphere from 0 to 4500 metres above sea level?

For Antoine Kremer, Research Director at l'Unité Mixte de Recherche BIOGECO (INRA, Université de Bordeaux) and François Hubert, who is preparing his doctoral thesis, the solution is at hand: not two hours from their laboratory in Pierroton near the city of Bordeaux, the oak collection at l'Arboretum des Pouyouleix (St. Jory de Chalais) offers a vast choice of botanic species of oak, grown from wild-collected seeds and for which the seed collection data has been scrupulously recorded.

Created in 2003 by Béatrice Chassé and Gérard Lionet, l'Arboretum des Pouyouleix covers 25 ha in the north Dordogne region of France. Bordered on one side by the river Côle, the altitudinal variation is from 270 to 210 m above sea level. Situated between the Aquitaine basin and the Massif Central, it is a metamorphic region in which the soils are largely the product of mineral decomposition. There are different soil types locally at the Arboretum (although the pH is always below 7): in the valleys as well as alongside the river the soil is rich and deep, whilst in other places the soil is sandier and shallower, and still others are composed of a coarse clay. Over the past 7 years rain fall has varied from 716 mm (2005) to 1021 mm (2007). The Arboretum is at the northern limit of USDA Hardiness Zone 8.

The wild-collected biological resources that are now available in the oak collection at the Arboretum des Pouyouleix represent an invaluable contribution to the research in progress in the phylogeny of the genus *Quercus*. "This Arboretum is a clear demonstration of the scientific value of a botanic oak collection" declares Antoine Kremer, underlining the importance of the work carried out by Béatrice Chassé and Gérard Lionet over the past 7 years.

Systematics

Systematics is that branch of biology that attempts to classify living things. Since Linnaeus (1707-1778) and up until very recently, all living things were classified based on morphological criteria. Thus, much as one would separate out forks, knives and spoons, systematics identifies separate categories for frogs, dinosaurs, human beings and so on for birds, roses, baobabs, etc...

As of the second half of the 19th century, two major events have greatly influenced the science of systematics. The first one is the formulation of the theory of evolution and its central fact that all species are related, and the second is the development of the science of genetics based on the discovery of DNA (deoxyribonucleic acid).