Abstract: A climax community in the Beskid Mountains is a forest. The natural mountain landscape has been changed considerably by agriculture, which lasted for many centuries. As a consequence of political and socio-economic changes, which have been taking place currently in Poland, land use has been modified. Reforestation is a quite common phenomenon in case of exclusion from agricultural use. This process was examined in two mountain areas in Polish Carpathians: Lower Beskid and Gorce. It was found out that there is a few specific ways in which reforestation may occur. As a result of field research in Gorce, four models of succession were created. Apart from that, the phenomenon of frontal reforestation was examined in detail in Lower Beskid. This resulted in distinction of four types of forest-field boundary and two types of elements configuration.

Key words: reforestation, succession, forest-field boundary, glades

Introduction

Land use is the consequence of contemporary socio-economic conditions and changes parallel to the economy transformations. The natural mountain landscape has been changed considerably by agricultural tradition, which lasted for many centuries. Nowadays, reverse tendency is observed. It concerns both abandonment of mowing and grazing as well as soil cultivation. In the areas which were excluded from agricultural use secondary vegetation succession takes place. Reforestation is a quite well-known phenomenon which has been studied by many scientists of different disciplines. This process in the Polish Carpathians was described among others by J. Kozak (2010), whereas specific conditions and phases of glades succession were investigated in the Tatra Mountains by J. Dziewolski (1985) and W. Ciurzycki (2004, 2005), in the Pieniny by L. Bartoszek et al. (1990) and in Gorce by S. Michalik (1990). The forest-field boundary in terms of its structure was described by P. Skolud (2008) and some criteria for its typology were distinguished by S. Balcerkiewicz et al. (1990). However, none of those studies included typology of forest succession broader than distinction between the frontal and the areal type. It is interesting that reforestation processes not always occur in the same way. The aim of the study was to describe and classify observed examples of these phenomena.

Methods

The research was conducted in two study areas in the Carpathian Mountains – Lower Beskid and Gorce. In case of Lower Beskid only one subregion – Pasma Magurskie was taken into account, whereas in Gorce glades localized in upper montane belt were analyzed. In both study areas environmental conditions are relatively similar, including the same geological unit – Magura Nappe and the dominant types of soils – Cambisols. The study areas were located in different altitudinal zones – foothills and lower montane in Pasma Magurskie and...
upper montane in Gorce. Research concerning types of reforestation was based on a field study carried out on 46 upper montane belt glades in Gorce. Glade was understood as grassland patch naturally limited by forest. Every glade was mapped in terms of the succession type. The characteristic features of encroaching shrubs and trees patches were taken into consideration. As a result, four different types of reforestation were distinguished. Additionally, in 12 test areas in Pasma Magurskie forest-field boundary was examined, taking into consideration the phenomenon of frontal reforestation. Test areas included 500 m broad transects along the valley’s axis. Four types of forest-field boundary structure proposed by S. Balcerkiewicz et al. (1990) occurred in the study area. Also, two types of elements configuration were distinguish. Additionally, in order to supplement the studies photographic documentation was collected.

**Models**

As a consequence of research in upper montane belt in Gorce, four ways of reforestation were distinguished. Their models including frontal, areal, linear and associational type are presented in figures 1-8.

![Fig. 1. A model of frontal reforestation](image1)
![Fig. 2. A model of areal reforestation](image2)
![Fig. 3. A model of associational reforestation](image3)
![Fig. 4. A model of linear reforestation](image4)

In case of the frontal reforestation, trees and shrubs encroach sequentially from the edge of the forest (fig. 1, fig. 5). It is the most common way of succession. What is more, it concerns not only abandoned glades, but also those which are being mowed. Areal reforestation occurs when trees and shrubs are more or less evenly distributed within the glade (fig. 2, fig. 6). They do not form clearly separated clusters. It was found out that this type of the reforestation is characteristic for large glades on which reforestation process began relatively long ago. Associational way of reforestation is when trees and shrubs form distinct clusters of various sizes within the glade (fig. 3). It is quite common that this biogroups are created only by plants of the same species (fig. 7). Linear reforestation occurs when trees and shrubs form elongate patches, referring to the roads and oblong landforms (fig. 4, fig. 8). It is a quite rare type of reforestation.

Apart from that, frontal succession was analyzed on the base of the forest-field boundary structure. Models and corresponding examples of the boundary structure from research area in Lower Beskid are presented in figures
9-16. Complete forest-field boundary consists of five belts i.e. trees, young trees, shrubs, herbs and agricultural field (fig. 9, fig. 13). It is the most common type of forest-field boundary within the research area. At the same time complete boundary is the most natural example of frontal succession as all its phases reflected in different boundary belts are present. Depleted forest-field boundary of 1st level consists of four belts, which means that one of the elements of transition zone is missing (fig. 10, fig. 14), whereas depleted of 2nd level consist of three belts – there is a lack of two transition zone elements (fig. 11, fig. 15). Enlarged forest-field boundary consists of six or more belts. Apart from the basic ones, at least one zone is repeated (fig. 12, fig 16). Depleted and enlarged boundary types also occur quite frequently. Their structure is most often an effect of human activity which may involve planting additional boundary belts, grubbing or mowing them. Undoubtedly, the way of managing has a crucial role when it comes to forest-field boundary structure and possibilities of succession occurrence.

Taking into account configuration of forest-field boundary elements, two types of boundary were distinguished. Piled up boundary (fig. 17, fig. 19) in which elements of the specific belts i.e. trees, young trees, shrubs, herbs and agricultural field overlap and mix with each other is much more widespread than separated boundary (fig. 18, fig. 20) in which elements of the specific belts do not overlap or mix. Piled up boundary seems to be a natural phenomenon in environment, whereas separated boundary thus the isolation of specific belts is characteristic for plant nurseries.
Conclusions

1. Four different ways of reforestation were distinguished within the study area. The most common was the frontal succession, whereas areal encroaching characterized rather large glades with a far-reaching succession. Linear and associational reforestation occurs rarely.

2. Forest-field boundary structure might be a way of investigation of the frontal succession.

3. During the study four types of forest-field boundary were observed. Occurrence of the specific type of forest-field boundary was directly related to the way of managing. The most widespread type of forest-field boundary was complete boundary, but all other types also occur fairly frequently.

4. Among two types of boundary elements configuration, the piled up boundary is more common than the separated boundary. Piled up boundary also seems to be the more natural type of the succession.

References


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