

# *Tussilago farfara* L. in sand quarries: coenotic role and mycorrhization

A.O. Gorbunova

Laboratory of Ecology of Symbiotic and Associative Rhizobacteria / All-Russia Research Institute for Agricultural Microbiology, Saint Petersburg, Russia

*Tussilago farfara* (common coltsfoot) is a perennial plant with a long, highly branched creeping cord-like rhizome and adventitious roots. The species is biologically plastic and tolerant to many environmental factors, due to which it is able to colonize a variety of substrates. This pioneer plant quickly populates free habitats, but at subsequent stages of succession yields to other species. Intense environmental disturbances are a necessary condition for the survival and expansion of its populations. In nutrient-poor habitats, the density of plants or their clones often remains low, probably due to extensive rhizome growth. The success of a species in pioneer habitats depends mainly on the ability to quickly disperse vegetatively by forming clones. In subsequent stages of succession, plants receiving additional nutrition through arbuscular mycorrhiza (AM) may gain an advantage. **The purpose of the study** is to analyze the change in the coenotic role and mycorrhization of *Tussilago farfara* during restorative succession in two sand quarries in the Leningrad region.

The studies were carried out at the sand quarries of different ages: Bolshoy Kuzmolovsky and Kalelovo in Vsevolozhsky district of the Leningrad region. The survey of quarries was carried out using a detailed route method with a vegetation description on the test sites. *Tussilago farfara* grows there in plant communities belonging to three stages of succession: “pioneer” (the total projective cover (TPC) did not exceed 17%), “grass” (with the dominance of *Agrostis tenuis* Sibth.) and “shrub” (the upper storey was formed by shrubs and undergrowth trees). Samples of roots for mycorrhizal analysis were collected on 9 sites 5x5 m, of which 5 were “pioneer” (4 - Kalelovo, 1 - Kuzmolovo), 2 “grass” (1 - Kalelovo, 1 - Kuzmolovo) and 2 “shrub” (Kuzmolovo). The frequency of sampling was 5-11 individuals from the site.

To prepare mycorrhized roots, the method of maceration (clarification) and staining of roots in trypan blue was chosen (Phillips and Hayman, 1970). Calculation of mycorrhization indices was conducted according to the method of light microscopy (Trouvelot et al., 1986). For each preparation, an average of 100 microscope fields of view were analysed. In the program for calculating mycorrhization indices of plant roots (Vorobiev et al., 2016), the following mycorrhization parameters were automatically calculated (Trouvelot et al., 1986; Mycorrhiza Manual, 2001; Yurkov et al., 2010; Yurkov, Semenov, 2019):

- 1) occurrence of mycorrhizal infection in studied root fragments (F, %);
- 2) intensity of mycorrhizal infection in studied root fragments (M, %);
- 3) intensity of mycorrhizal infection in mycorrhizal root fragments (m, %);
- 4) abundance of arbuscules in studied root fragments (A, %);
- 5) abundance of arbuscules in mycorrhized root fragments (a, %);
- 6) abundance of vesicles in the studied root fragments (B, %);
- 7) abundance of vesicles in mycorrhized root fragments (b, %).



Fig. 1. *Tussilago farfara*: 1 - in the «pioneer» plant community, 2 - in the «grass» community, 3 - in the «shrub» community



The coenotic role of *Tussilago farfara* in the studied communities is mostly insignificant and changes little. The exceptions are the «pioneer» communities in Kalelovo with 15-17% TPC and the most dense (TPC 85%) «shrub» community in Kuzmolovo, where the projective cover (PC) of the species reaches maximum, and *Tussilago farfara* becomes a «filler», according to the dominance scale of V.S. Ipatov (Ipatov and Mirin, 2008). The highest PC of the species is in «pioneer» communities (PC up to 3%, plants up to 15 cm tall, see Fig. 1-1). In the community of the «grass» stage in Kuzmolovo, plants become larger, up to 22 cm in height (see Fig. 1-2), but their PC decreases to 1%. The minimum PC of the species is in a «shrub» community with aspen-birch undergrowth (only a few plants/clones up to 2 cm tall, see Fig. 1-3).

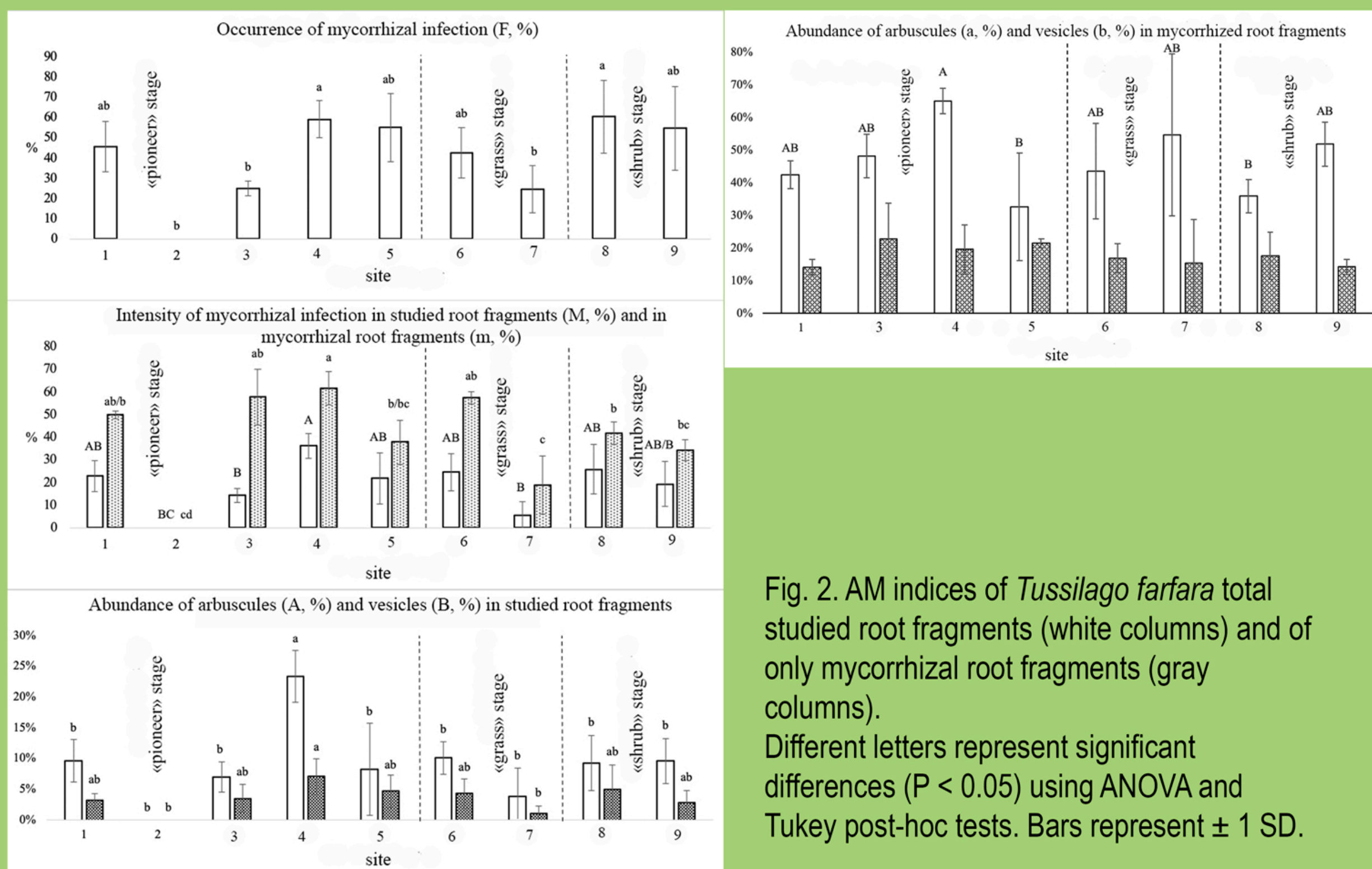


Fig. 2. AM indices of *Tussilago farfara* total studied root fragments (white columns) and of only mycorrhizal root fragments (gray columns). Different letters represent significant differences (P < 0.05) using ANOVA and Tukey post-hoc tests. Bars represent ± 1 SD.

At the «pioneer» stage, the occurrence of AM in the roots of *Tussilago farfara* varies the most, from the complete absence of the fungi to 60%, and the intensity of mycorrhization also varies significantly. At the site 4 in Kalelovo, significantly higher values of the intensity of root mycorrhization (36±2.2%) and the abundance of arbuscules in the root system (23.4±1.7%) were noted, the abundance of vesicles on average was also higher (7.1±1.2%) (see Fig. 2). In the communities of the «grass» and «shrub» stages, the parameters of mycorrhization intensity and the abundance of arbuscules and vesicles in the roots decrease on average (see Fig. 2). The abundance of vesicles in the mycorrhized part of the roots (b) remains at a level of about 20% during succession. A decrease in the AM extent in the roots of *Tussilago farfara* during succession is also evidenced by a decrease in the number of large arbuscules and large vesicles (see Fig. 3) and an increased AM fragmentation.

Thus, *Tussilago farfara* is most typical for the pioneer stage of restorative succession: PC in these sites is maximum, and in the community with large vegetative clones, significantly higher values of the intensity of root mycorrhization and the abundance of arbuscules were observed than in other communities. However, a relatively high occurrence and intensity of mycorrhization in roots were also observed at subsequent stages, which probably indicates the important role of AM in the preservation of this species in communities during restorative succession.

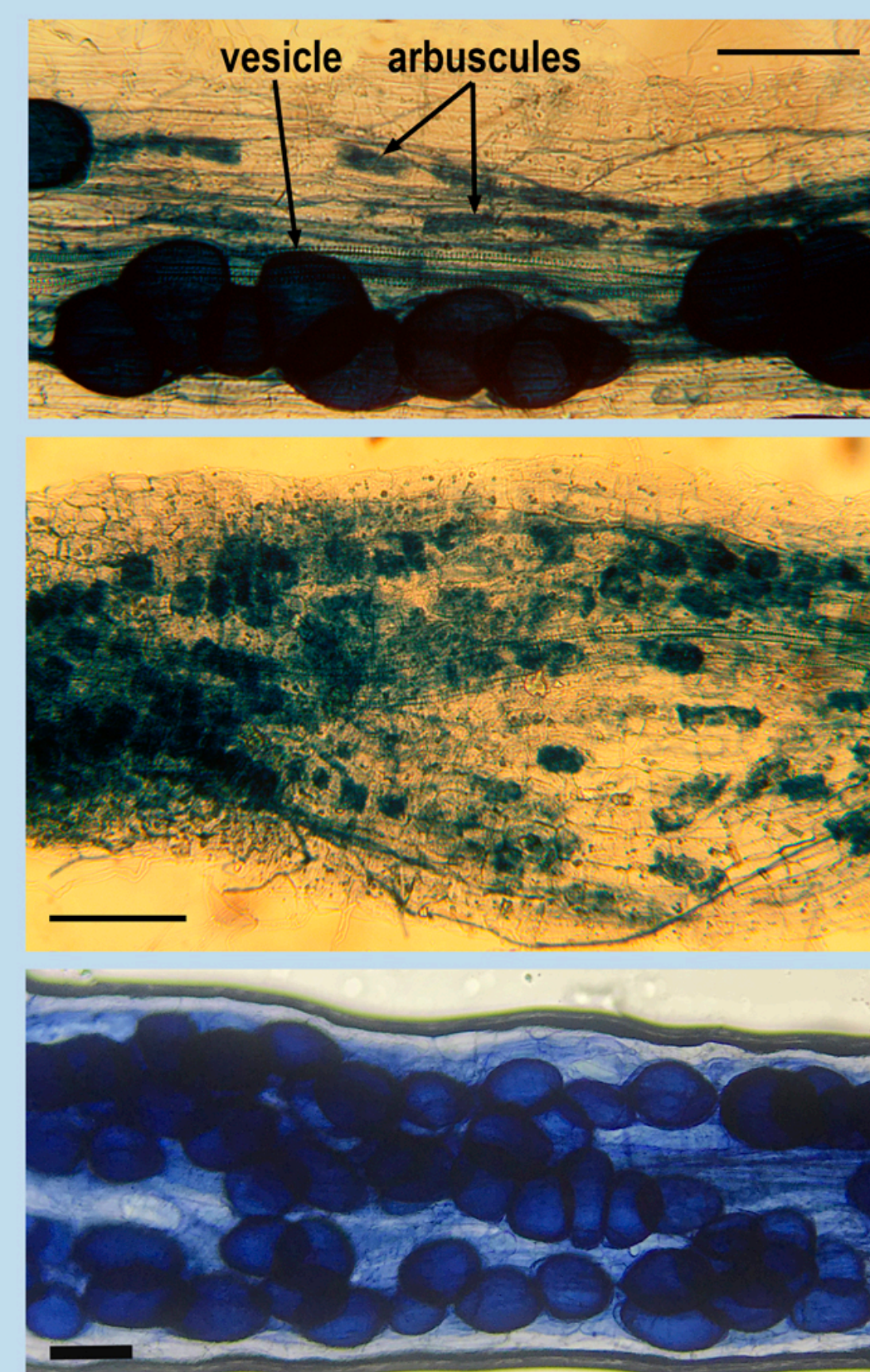


Fig. 3. Arbuscular mycorrhiza in the roots of *Tussilago farfara*. Top picture is a fragment with vesicles and arbuscules from site 4 of «pioneer» stage, picture in the middle is a fragment with arbuscules from site 6 of «grass» stage, and bottom picture is a fragment with vesicles from site 8 of «shrub» stage. The scale indicates 100 microns.

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**Correspondence:** gorbunova.anastasia93@mail.ru