Disentangling the ecology of *Aucoumea klaineana* Pierre to improve its sustainable management

a methodological poster on rhizosphere and light

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Context

The Okoumé (*Aucoumea klaineana* Pierre), almost endemic to Gabon, is the most important commercial timber species in Central Africa. Long-lived, pioneer and light-demanding, it colonises open areas such as savannahs, fallow land, roadsides and forest gaps. By anemochory, it establishes itself in gregarious populations and forms monospecific stands when young. Ultimately, it gives way to mature forest species and persists only sparsely. The ageing of the tropical forest therefore hinders the natural regeneration of okoumé. Moreover, its artificial regeneration gives limited results in terms of tree growth and shape.

The OKOUME project aims to expand our knowledge of the ecology of the species in order to ensure the sustainable management of its populations through optimised silvicultural techniques. In order to maintain a consistent growth of the tree, several development stages are being studied.

During the seedling stage, the species is assumed to be strictly light-demanding. However, studies on the growth of seedlings of other commercial tree species in Central Africa report optimal irradiance values ranging from only 10 to 44%, regardless of the species behavior (e.g. Agyeman et al., 1999).

By the age of 6-7 years old, monospecific stands are formed. The creeping roots develop, come into contact with the root systems of neighboring individuals and form anastomoses (fusions of vascular tissue) (Leroy Deval, 1973). The rhizosphere of these stands thus seems to have a significant role in the ecology of the species.

During the rest of the stand's life and even after thinning, some of the light-deprived individuals are kept alive by the trees reaching the canopy. This includes the overtopped trees but also the thinned trees (**Fig. 6**), of which the stumps can be kept alive for more than 40 years after they have been cut. In return, the dominant tree can benefit from an extensive root system.

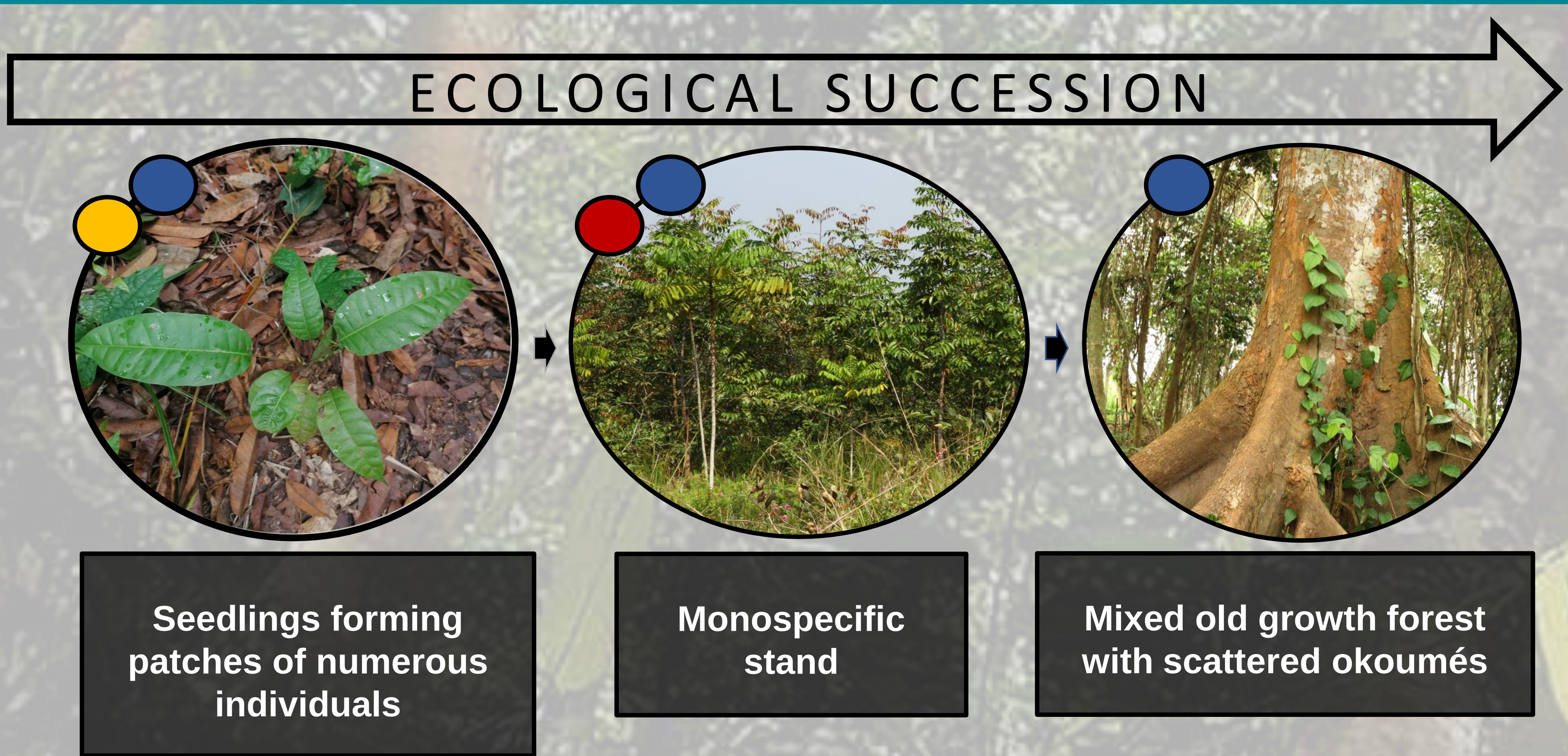
Throughout the life of the tree, mycorrhizal symbioses can occur between its roots and soil fungi, affecting its growth. The potential absence of fungal species present in natural forest may also explain the poor success of planting trials with this species.

Objectives

Objective A1: Clearly quantify the light requirements of okoumé.

Objectives A2:
→ Determine the frequency and parameters that influence the formation of root anastomoses.
→ Understand the relationship between stand stratification and anastomoses formation.
→ Identify the growth rings common to two roots of a root graft section and thus prove the exchange of sap between two trees.
→ Study the width of graft rings and stem sections to link this phenomenon to the growth dynamics of connected trees.

Objective A3: Identify the species that form mycorrhiza at different stages of development of the species.



Acknowledgement

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More about the context and issues

Guidosse Q., du Jardin P., White L.J.T., Lassois L. & Doucet J.-L., 2022. **Gabon's green gold: a bibliographical review of thirty years of research on okoumé (*Aucoumea klaineana* Pierre).** *Biotechnol. Agron. Soc. Env.* 26(1), 30–42.

References

- Agyeman V.K., Swaine M.D. & Thompson J., 1999. **Responses of tropical forest tree seedlings to irradiance and the derivation of a light response index**. *J. Ecol.* 87(5), 815–827, DOI:10.1046/j.1365-2745.1999.00400.x.
- Gaspard D.T. & DesRochers A., 2020. **Natural root grafting in hybrid poplar clones**. *Trees* 34(4), 881–890, DOI:10.1007/s00468-020-01966-z.
- Leroy Deval J., 1973. **Les liaisons et anastomoses racinaires**. *Bois For. Trop.* 152, 37–49.

Experiments

(A1) Optimal irradiance for seedling development (ongoing)

→ An experiment under shadehouses at the seedling stage was set up under different irradiance ranges (1%, 4%, 10%, 25%, 40%, 60%, 100%) (**Fig. 1,2**).
→ 30 seedlings per shadehouse are monitored monthly for one year for growth, mortality and biomass.

↑ Fig. 1 : Experimental design composed by six shadehouses and a platform receiving 100% irradiance.

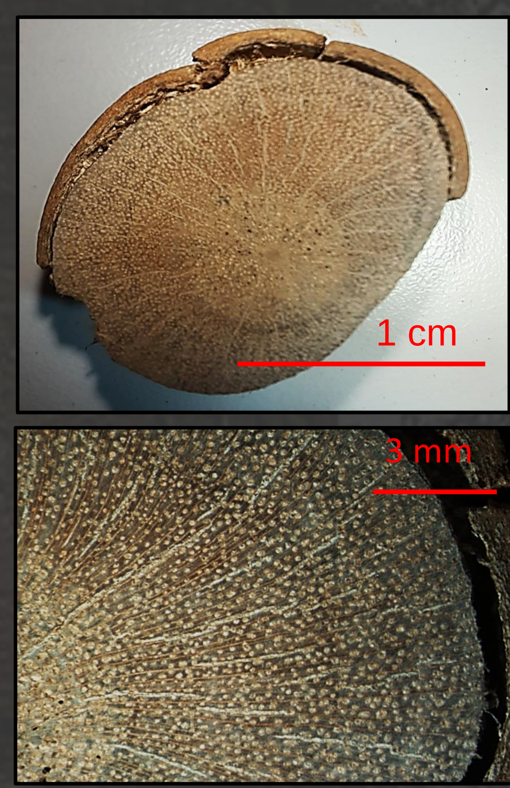
↑ Fig. 2 : Distribution of 30 seedlings in a shadehouse receiving 40% of the total irradiance. Plants are 11 months old.

(A2) Root anastomoses formation and modalities (août 2022)

→ Stands between 5 and 15 years old are selected
→ Study plots are inventoried on 50 to 100 acres and clearcutted
→ Root systems are excavated using a hydraulic pump (**Fig. 3,4**)
→ Sections of stems, roots (**Fig. 5**) and root grafts are collected
→ Ring analyses are carried out on collected samples by vessel density variation

↑ Fig. 3 : Protocol test. Excavation of a root system by high pressure jet.

↑ Fig. 4 : Expected outcome (illustration by Gaspard et al., 2020 on *Populus sp.*).



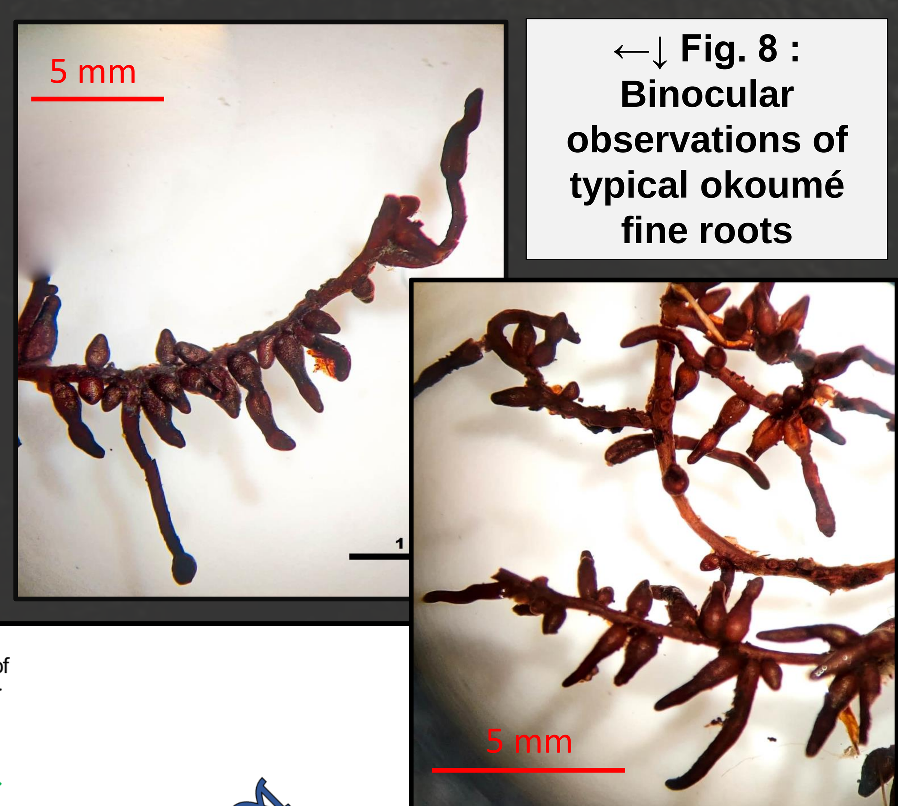
↑ Fig. 5 : Root sections.

← Fig. 6 : Example of an okoumé stump from a thinning and kept alive by a dominant neighbor

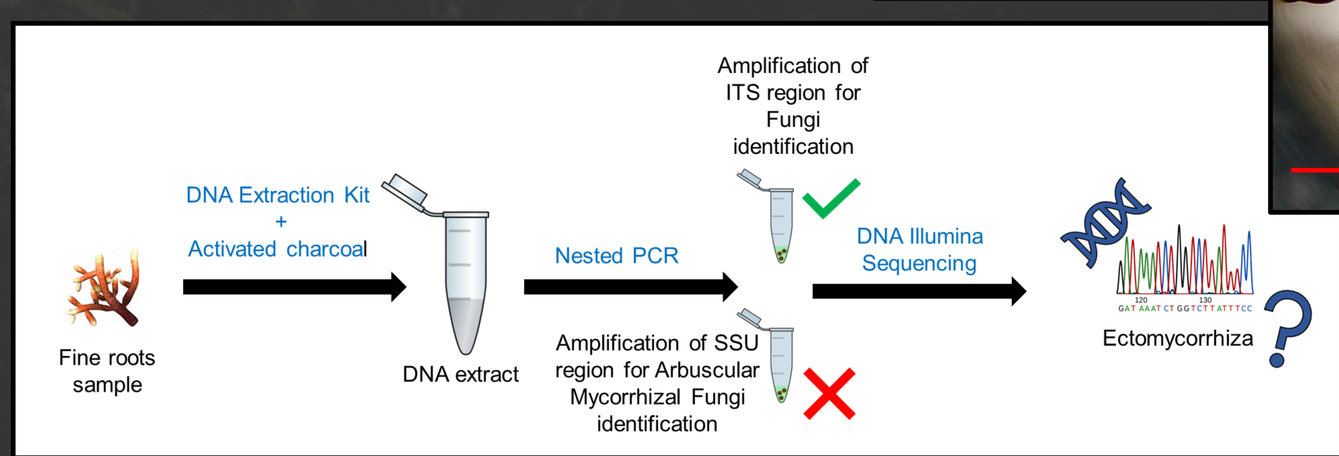
(A3) Caracterisation of mycorrhizal communities (ongoing)

→ Fine roots are collected from stands of different ages in plantations in the Democratic Republic of Congo and in a nursery and natural stands in Gabon (**Fig. 7,8**).
→ Mycorrhizal DNA is sequenced (**Fig. 9**) with the aim of identifying community differences between individuals, types and origins of populations and between isolated or connected trees.

↑ Fig. 7 : Harvesting fine roots (<2mm Ø) from a dominant okoumé tree in the D.R.C.



←↓ Fig. 8 : Binocular observations of typical okoumé fine roots



↑ Fig. 9 : Molecular processing chain for fine roots. Although sequencing has not been carried out yet, PCRs seem to provide information on the type of fungi.