

Clarification on the Taxonomic Position of *Sciadopitys verticillata* Among Coniferophytes Based on Seed Oil Fatty Acid Compositions

Sir:

The fatty acid compositions of seed lipids from gymnosperms (principally from Coniferophytes) have proven to be valuable chemometric markers for the taxonomy of this class (1–4), not only at the level of families but also at the level of sections, and we believe that they might also be useful for their phylogeny.

Unfortunately, the study of gymnosperm seed lipids has considerably lagged behind that of angiosperms. Our knowledge is limited to approximately 150 species, for which complete and detailed data are available (approximately one-fourth of all extant gymnosperm species). A great number of genera, and even a few entire families (i.e., Araucariaceae, Phyllocladaceae, and Cephalotaxaceae), still remain completely unexplored. This dearth of information is regrettable, because researchers have here the opportunity to examine vegetables that are known from fossils for about 300 million years, a few of which have probably not considerably evolved for as much as 200 million years. This may be exemplified by the persistence of 14-methylhexadecanoic acid in Pinaceae and *Ginkgo biloba* seed lipids (5), a group and a species that have evolved independently for about 300 million years. Moreover, all analyzed Coniferophyte species (including *G. biloba*) contain $\Delta 5$ -olefinic acids in their seeds, whereas the great majority of angiosperms have lost the ability to synthesize such compounds. $\Delta 5$ -Olefinic acids are the rule in Coniferophytes, whereas they are exceptional in angiosperms (6).

We wish to comment here on a particular point that escaped us and that is significant. In a previous publication (1), where we began a systematic study of gymnosperm seed lipids, we included *Sciadopitys verticillata* (umbrella pine, from the Greek *sciados*, umbrella, and *pitys*, pine; known as kouya-maki in Japan) in the Taxodiaceae family, based on outdated classifications. Takagi and Itabashi (7), who were the first researchers to undertake a systematic study of gymnosperm seed lipids, also made the same error. In fact, *S. verticillata* is now regarded as the sole living representative of its own separate family, the Sciadopytiaceae (8). From fossil evidences, this distinct family of conifers was already quite developed at the time the Taxodiaceae appeared. Now, *S. verticillata* is geographically limited to central and southern Japan.

On reexamination of its seed fatty acid composition, and in light of the preceding reevaluations, it becomes clear that

S. verticillata is indeed completely different from Taxodiaceae species. The main distinctive feature is the abundance of α -linolenic acid, which is low in *S. verticillata* (ca. 2%), as in all Pinaceae and most Taxaceae, but high in Taxodiaceae (range, 17–46%). Also, the level of 5,11,14-20:3 acid is high in *S. verticillata*, 14%, instead of less than 7% in Taxodiaceae. It is for this reason that the name sciadonic acid was proposed for this peculiar $\Delta 5$ -olefinic acid (9).

When processing the fatty acid compositions of the seed lipids from 82 conifer species (2) through multivariate analyses, *S. verticillata* clearly lay outside the family Taxodiaceae, which was otherwise overlapped with Cupressaceae (Fig. 1). In fact, *S. verticillata* is completely isolated from other conifer families. This did not attract our attention at the time

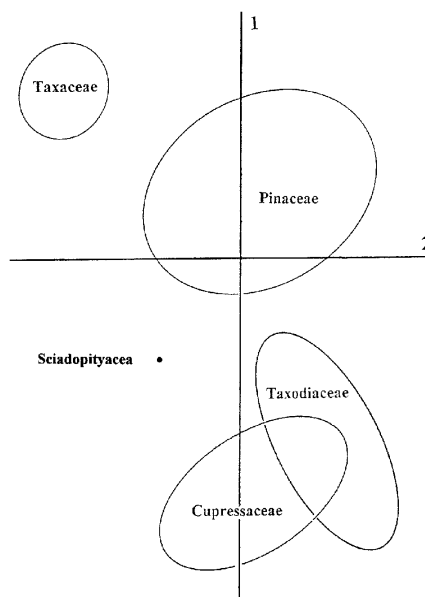


FIG. 1. Graphical representation of a principal component analysis of 82 conifer species based on the fatty acid compositions of their seed lipids. Modified from Reference 2.

we published our results (2), but we noted earlier that Taxodiaceae and Cupressaceae were distinct from other Conifer families by their exceptionally high level of α -linolenic acid, associated with fairly high levels of 5,11,14,17-20:4 acid (1).

The resemblance between Taxodiaceae and Cupressaceae seed oils fits well with other evidence that indicates that the two families perhaps originated from a common line (issued from the Pinaceae), which later differentiated into the two families (10). Owing to the relatively recent appearance on a geological scale of these two families, the presence of α -linolenic acid and of its derivative 5,11,14,17-20:4 acid in high amounts in the seeds would appear as a modern character. However, the latter acid is also abundant in some Ephedraceae (11), belonging to the Cycadophytes, which have evolved independently from the Coniferophytes for over 350 million years.

Our two previous reports (9,12) on the stereospecific distribution of fatty acids in conifer seed triacylglycerols, which indicated that *S. verticillata* was representative of Taxodiaceae, should thus be reread according to the present clarification. *Sciadopitys verticillata* is representative only of itself.

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