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# The stability of pyridine upon chemical attack under the conditions of primitive Earth

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Pyridine is a heterocyclic aromatic molecule of gross formula $C_5H_5N$ where the N atom is included in the aromatic ring. The molecule as such is not abundant in nature, but its derivatives are often part of important biomolecules. For instance, it is one of the basic units in the nicotinamide adenine dinucleotide, NADH, which is an essential reducing agent in various biological processes. Interestingly, pyridine derivatives (e.g. 2,4,6-trimethylpyridine and pyridine carboxylic acids) were identified in carbonaceous chondrites [1-4] along with many other molecules of biological significance. In addition to that, nicotinonitrile (3-cyanopyridine) as well as 2- and 4-cyanopyridine have been synthesized in a version of the Miller experiment by the action of electric discharges on ethylene and ammonia, with an intermediate step being the synthesis of pyridine [5]. The possibility that nicotinonitrile hydrolyzed in the primitive ocean to nicotinamide and nicotinic acid reinforces the prebiotic potential of pyridine.

In conclusion, either formed locally on Earth from simple precursors or brought by extraterrestrial carriers, the presence of pyridine or of one of its derivatives could have played an important role in the organic chemistry that triggered the origin of life on Earth. Pyridine formation can also be seen as an intermediate step towards the formation of pyrimidine ($C_4H_4N_2$), a species constituting the molecular skeleton of important nucleobases (cytosine, uracil and thymine). Pyridine and pyrimidine are also expected to share similarities in their chemical behavior because of the presence of N in the aromatic ring in the place of one (pyridine) or two (pyrimidine) methine groups (=CH−).

For the above reasons, in our laboratory we have undertaken a systematic experimental investigation to address pyridine stability in the conditions of primitive Earth. In a first series of experiments, we have exposed isolated pyridine molecules to the attack of very reactive species, namely atomic oxygen and nitrogen. The aim is to verify whether the N-containing aromatic ring of pyridine is preserved after the chemical attack of reactive transient species like O and N atoms that might have been relatively abundant under the conditions of primitive Earth when the $O_2$/$O_3$ UV shield was not present yet. The employed experimental technique is the one described in Ref. [6]. The implications for the stability of pyridine and its derivatives, or of other molecules for which pyridine can be considered as a proxy, will be noted.

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