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Diversity and paleogeographic distribution of Early Jurassic plesiosaurs

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Early Jurassic plesiosaurs, a group of extinct marine reptiles, were one of the first groups to be described in the history of vertebrate paleontology. Nevertheless, the paleogeographic distribution and the taxonomic diversity of these forms are still unclear, particularly because most descriptions and taxonomic attributions were realized during the mid 19th to early 20th century. Here we investigate the paleodiversity and paleogeographic distribution of Early Jurassic plesiosaurs using an extensive taxonomic and anatomical revision of most known Early Jurassic specimens. We also present an examination of the biostratigraphic and sedimentological framework of deposits in which these specimens were discovered, in order to decipher whether their fossil record reflects primary paleobiological trends or taphonomic/discovery biases. Early Jurassic Plesiosaur diversity appears to reach its maximum during the Toarcian (falciferum-bifrons ammonite zones). Nevertheless, the inclusion of ghost lineages into the diversity curves indicates that this pattern likely reflects discovery and taphonomical biases rather than primary biodiversity trends. Indeed, most strata where numerous plesiosaurs species were discovered correspond to sediments that were deposited under poorly-oxygenated conditions and exploited at least in a semi-industrial way during the 1800's-1950's. The Lower Jurassic fossiliferous localities that yielded identifiable plesiosaur species are only found in Western Europe (England, Germany, and France). In Europe, the Toarcian stage is the only interval where more than one fossiliferous locality is known (the Hettangian, Sinemurian and Pliensbachian stages being each represented by only one locality where specimens are identifiable at the species level). The different Toarcian fossiliferous sites of Europe do not bear any single common taxon, suggesting a high degree of endemism in Early Jurassic plesiosaurs. Nevertheless, these sites are fundamentally diachronous at the ammonite zone level; this absence of shared taxa might hence reflect temporal changes rather than paleogeographic trends. Further data are required to determine whether if this pattern is a consequence of truly limited paleobiogeographic ranges or the result of high rates of turnover. In addition, future fossil discoveries and refinements of the phylogenetic relationships are required to precise the evolution of this diversity at a higher stratigraphic resolution, and hence determine how plesiosaurs responded to severe environmental change that punctuated this period (i.e. Early Hettangian and Early Toarcian mass extinction events).