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Singlet Carbenes

Reply to “Recently Reported Crystalline Isothiazole Carbenes: Myth or Reality”

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The comments and results of G. Bertrand and co-workers in their communication[1] to our recent report on stable isothiazole carbenes[2] are an important contribution to the understanding of carbene reactions. In particular, their findings on a rapid transformation of our isothiazole carbenes into the 2-imino-2*H*-thiete isomers demands revision of our results. To our knowledge this reaction type has been found in isothiazole chemistry for the first time.[3] The arguments and experimental data of Bertrand and co-workers are convincing and can be accepted in most points. However, some aspects require further comment. The various carbene dimers described by us, but doubted by Bertrand and co-workers, are available in good yields by addition of some crystals of the isothiazolium salts to a solution of the isothiazolium salts with potassium *tert*-butylate, whereby the carbenes are formed in situ. Evidently, dimerization according to the mechanism suggested by Alder et al.[4] is possible before isomerization to 2-imino-2*H*-thietes. The appearance of the parent peak of the dimers in the mass spectra is a clear indication of dimer formation, which demands the isothiazole carbenes as intermediates. Bertrand and co-workers convincingly show by reaction of the isothiazolium perchlorates with the lithium salt of morpholine that the morpholino (and piperidino) derivatives that we obtained could be formed directly from the isothiazolium salts by base-assisted addition of morpholine (or piperidine). However, this result does not exclude our alternative that in the presence of potassium *tert*-butylate instead of the lithium salt of morpholine the isothiazole carbenes are formed by deprotonation of the salts in a first step, as is generally assumed in the formation of numerous stable carbenes,[5] followed by the morpholine or piperidine attack.

In light of the results of Bertrand and co-workers, our isothiazole carbenes cannot be considered to be stable. Evidently they are intermediates, which rapidly isomerize to the 2-imino-2*H*-thiete isomers. Nevertheless, it is possible to obtain their dimers and to postulate their contribution in the formation of morpholino or piperidino derivatives. We congratulate Bertrand and co-workers on their excellent contribution to carbene chemistry.

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