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Title:	Syntheses, Characterization and Applications of Bicyclic (Alkyl)(Amino) Carbene (BICAAC) Complexes of Iridium and Some Selected Elements from Group 13-15
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**Abstract:** Carbenes represent distinctive compounds characterized by a neutral divalent carbon possessing six electrons in its valence shell. Over the past three decades, several stable singlet carbenes have been isolated. The pioneering research conducted by the groups led by Arduengo and Bertrand have significantly contributed to the evolution of novel class of carbenes, encompassing N-heterocyclic carbenes (NHCs), mesoionic carbenes (MICs), cyclic (alkyl) (amino) carbenes (CAACs), and recently discovered bicyclic (alkyl)(amino) carbenes (BICAACs). Due to their commendable  $\sigma$ -donor and  $\pi$ -acceptor properties, carbene scaffolds find extensive applications across various realms of chemistry. These applications include, but are not limited to: a) carbene metal complexes, proven to be efficacious catalysts for diverse organic transformations; b) stabilizing metals and non-metals in unconventional oxidation states in their complexes supported by carbenes; c) carbenes, also demonstrate the activation of enthalpically strong bonds under standard conditions and also serve as effective organocatalysts. The focus of the thesis is towards an in-depth exploration of the ligand capabilities of the recently synthesized singlet bicyclic (alkyl)(amino) carbene. Consequently, we have synthesized and characterized a range of BICAAC complexes based on B(III), P(III and 0), Sb(III and 0), Ge(II and 0), Sn(II), and Ir(I) complexes. The 1 st chapter presents an overview of the literature pertaining to carbenes their electronic structure and reactivity patterns. In the 2 nd chapter synthesis and characterization of low-valent diborane, diborene, and coinage complexes of diborene derived from BICAAC have been explored. The next section of the 2 nd chapter delves into the synthesis and characterization of a series of BICAAC-borenum cation equivalents, elucidating their application as catalysts for the hydrosilylation of carbonyls. The third and fourth chapters encompass the synthesis and characterization of BICAAC-supported group-13 (P and Sb) and group-14 (Ge and Sn) complexes, respectively. These chapters offer in-depth perspectives on the syntheses of low-valent P-P and Sb-Sb bonded complexes, as well as the formation of a Ge(0) complex. Conclusively, the last chapter is centered around the synthesis and characterization of neutral and cationic Ir(I)-complexes, emphasizing their application as catalysts in the transfer hydrogenation of carbonyls and imines.

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