ADVANCES OF 1,2-MIGRATIONS IN BORONATE COMPLEXES

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1,2 MIGRATIONS ENABLED BY α-LEAVING GROUPS

The Matteson and Aggarwal Reactions

Though the first reports of 1,2-boronate migrations were known almost two decades prior, it would not be until 1980 that the Matteson group would demonstrate the synthetic utility of such a method for alkyl and aryl migrations. The addition of $LiCHCl_2$ carbenoids to chiral boronic esters afforded α-halo boronic esters with high diastereoselectivity, which could then undergo diastereospecific 1,2-migrations after forming the corresponding boronate complex, depicted in ***Figure 1***.[1,2] Further development of this chemistry would be developed by others attempting to resolve limitations to the method. Various sources of stereo-induction beyond auxiliaries have been explored, including attempts at enantiodifferentiation through chiral Lewis acids and the advent of a catalytic enantioselective Matteson reaction.[3] The development of the "aza-Matteson" would expand the boronate 1,2-migrations from alkyl or aryl to now featuring secondary amines.[4] Further efforts to optimize iterative additions would also see the advent of rapid in-flow chemistry to perform consecutive homologations.

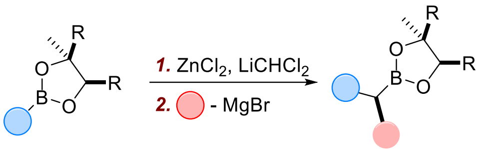

Figure 1: The Matteson Homologation

The advent of reagent-controlled chirality in 1,2-boronate migrations can be attributed to the work of the Aggarwal group. Asymmetric deprotonation of an achiral α-center to a carbamate, depicted in ***Figure 2***, enables broad utility in the formation of stabilized boronate complexes which provide excellent control over 1,2-migrations. These Hoppe-type carbamates were demonstrated to also have utility in allowing the addition of stereo-defined tertiary centers to boranes or boronic esters, thus allowing for stereo-retentive or invertive addition via 1,2-migrations to form quaternary centers.[5] This chemistry would be elaborated and demonstrate immense synthetic utility in forming contiguous stereocenters through iterative additions. The scope of this chemistry would be further developed and show utility in dual functionalization of vinyl boronic esters.[5]

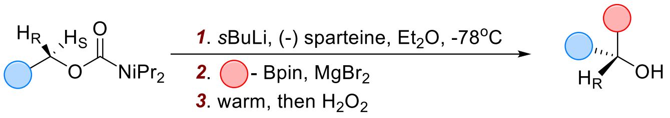

Figure 2: The Aggarwal Reaction

1,2 MIGRATIONS FOR THE DIFUNCTIONALIZATION OF VINYL BORONIC ESTERS

The Zweifel Olefination

The flagship demonstration of 1,2-migrations for dual functionalization came from Zweifel in 1967, converting anti vinyl boranes into syn difunctionalized olefins. The reaction, depicted in ***Figure 3***, has since been expanded to selectively form anti olefins, trisubstituted olefins with good stereoselectivity, and has seen application in the synthesis of numerous interesting scaffolds.[6] This concept of 1,2-migration into a sp^2 carbon center in tandem with electrophile capture at the vicinal position birthed numerous impressive innovations which harness the power of this reactivity.

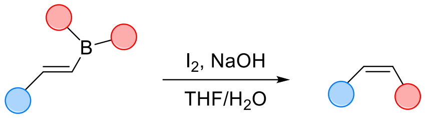

Figure 3: Zweifel Olefination

Vicinal Dual Functionalization

Utilizing the 1,2-migration as an elementary step provides a nucleophilic vicinal position, which could be leveraged for further functionalization, depicted in ***Figure 4***. The Morken group leveraged this reactivity to perform enantioselective catalytic conjunctive coupling with vinyl boronic esters. Combining this migration with cationic Pd^{II} catalysis and chiral ligands, enantioselective 1,2-migrations could occur and lead to carbopalladation of the vinyl boronic ester, which would further undergo conjunctive coupling.[5] The Aggarwal group demonstrated pre-functionalization of the vinyl boronic ester with PhSeCl, where 1,2-migration from the boronate would open the seleniranium ring diastereoselectively from the opposite face.[5] The Denmark group developed an enantioselective carbosulfenylation of these vinyl boronic esters, by facilitating a 1,2-shift into a highly enantiopure thiiranium ion.[5]

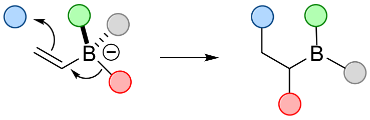

Figure 4: General Dual Functionalization

While two electron processes have guided 1,2-migrations over the previous decades, recent reports have sought to capture the power of photoredox catalysis and radical polar crossover to perform these identical disconnections from a mechanistically distinct perspective. From the initial 2017 report from Studer using radical polar crossover, numerous reports have begun to surface attempting to develop this young chemistry. With efforts from Aggarwal elucidating some mechanistic insight into photoredox processes for 1,2-shifts, the future looks ripe for innovation and further insight into the utility of these transformations.[5]

References:

[1] Matteson, D. *J. Am. Chem. Soc.* **1980**, 102, 7590.
[2] Matteson, D. *J. Am. Chem. Soc.* **1983**, 105, 2077.
[3] Jacobson, E. *Science.* **2021**, 374, 6558.
[4] Dong, G. *J. Am. Chem. Soc.* **2021**, 143, 36.
[5] Aggarwal, V. *Angew.* **2020**, 59, 39.
[6] Aggarwal, V. *Synthesis.* **2017**, 49,15