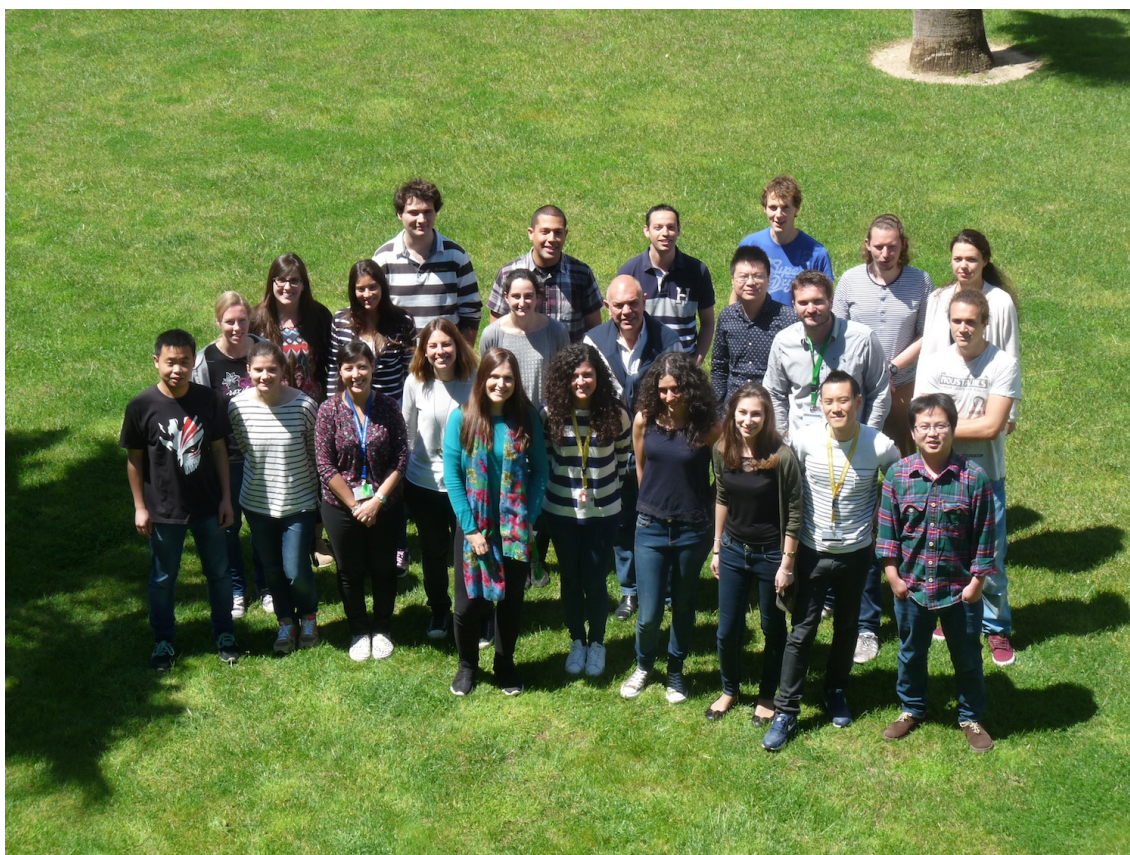


Echavarren Research Group



Group Leader: Antonio M. Echavarren

Postdoctoral researchers: Javier Carreras / Michael Muratore / Oscar Pablo (until Oct.) / Jose Ma Muñoz (until Feb.) / Beatrice Ranieri / Estíbaliz Coya (until July) / Philipp Holstein (until Nov.) / Juan Sarria / Ana Pereira/Hanna Bruss / Andrey Konovalov / Fedor Miloserdov

PhD students: Anna Homs (until Jan.) / Carla Obradors (until Feb.) / Katya Smirnova / Masha Kirillova / Pili Calleja / Ruth Dorel / Bart Herlé / Zhouting Rong / Sofia Ferrer / Elena de Orbe / Cristina García Morales / Xiang Yin / Elvira Santangelo / Eric Tan / Giuseppe Zuccarello / Alejandro Bermejo

Master students: Maria Millán (until Feb.)

Laboratory engineer: Imma Escofet

Visiting students: Olga Sokolova (July-September)/Hilary Kerchner (June-August)

Summer fellows: Mauro Mato

Administrative support: Sònia Gavaldà

Abstract

Our research group works in the “OMCOS” (*organometallic chemistry directed towards organic synthesis*) arena, mainly on gold catalysis, with a focus on the discovery of new

catalytic transformations, the understanding of their mechanisms, and the application of these catalytic reactions for the synthesis of biologically active natural products and polyarenes of importance in material science.

As part of a broader program on the development of new gold(I)-catalyzed transformation of broad synthetic utility, we have focused part of our studied on the 1,n-enyne cycloisomerization. Using for the first time in the context of total synthesis of natural products the gold(I)-catalyzed oxidative cyclization of a 1,5-enyne, we have completed the enantioselective total synthesis of (–)-nardoaristolone B, a sesquiterpene isolated in 2013 from *Nardostachys chinensis batal*, a plant of the genus *Nardostachys* endemic of the Himalayan mountains, which exhibits protective activity on the injury of neonatal rat cardiomyocytes (Figure 1). This synthesis also features the implementation of an enantio- and diastereoselective copper(I)-catalyzed conjugate addition/enolate trapping sequence.

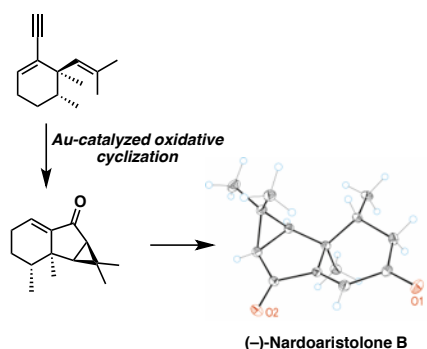


Fig. 1 – Total synthesis of (–)-nardoaristolone B.

We have also extended this approach to the synthesis of other derivatives by Kumada cross-coupling and gold(I)-catalyzed oxidative cyclization (Figure 2).

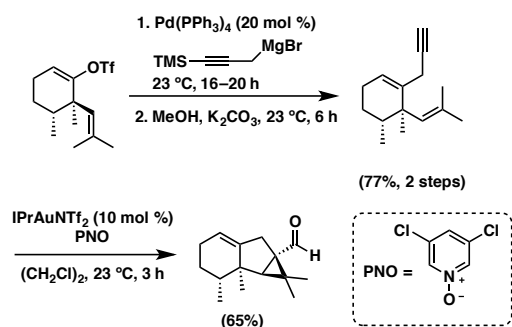


Fig. 2 – Exo-selective gold(I)-catalyzed oxidative cyclization.

Other synthetic targets whose syntheses has been under study using different gold(I)-catalyzed reactions, include rumphellaone A, a seco-caryophyllane sesquiterpenoid that shows cytotoxicity against human T-cell acute lymphoblastic leukemia tumor cells, related hushinone, cannabimovone from *Cannabis sativa*, and the lundurines, isolated from plants of the genus *Kopsia* (Fig. 3).

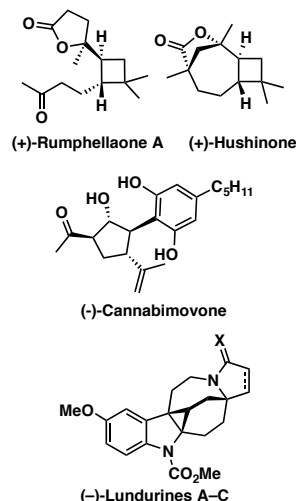


Fig. 3 – Other natural products synthesized by using gold(I)-catalysis.

Gold(I) carbenes are common intermediates in many gold(I)-catalyzed processes, including enyne cyclizations and retro-Buchner reactions (decarbenation). We have recommended to use the term gold carbene to describe gold carbene-like intermediates, regardless of which of the carbene or carbocation extreme resonance dominates (Figure 4). Gold carbenes, because of the weak metal to carbene π -back-donation and their strongly electrophilic reactivity, could be classified into the broader family of Fischer carbene, although their behavior and properties are very specific.

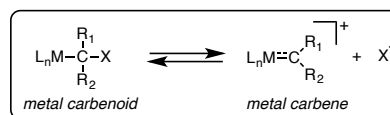


Fig. 4 – Carbenoid and carbene equilibrium.

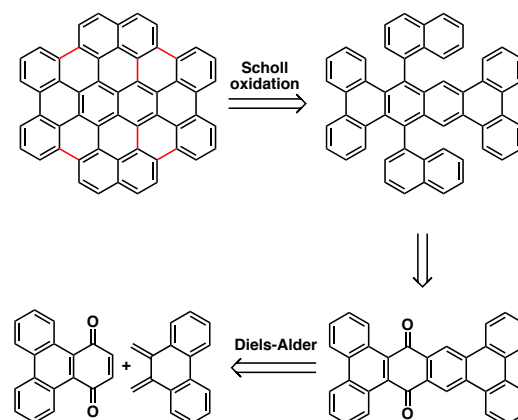


Fig. 5 – Synthesis of disc-shaped highly symmetric $C_{54}H_{20}$ nanographene.

A second major objective of our work is the development of new strategies for the synthesis of polyarenes of potential interest in molecular electronics. Thus, a disc-shaped highly symmetric $C_{54}H_{20}$ nanographene,

tetrabenzocircumpyrene, has been synthesized (Figure 5) and characterized by scanning tunnelling microscopy, demonstrating the potential of this technique for identifying highly insoluble graphenic molecules (Figure 6). The concise synthetic approach to $C_{54}H_{20}$ nanographene included a Diels-Alder cycloaddition as the key step to construct the central core of the molecule and a Scholl cyclization in the final step in which six C-C bonds are formed.

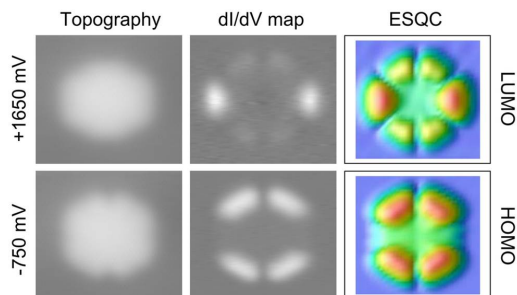


Figure 6 –Topographic STM images of tetrabenzocircumpyrene and ESQC computed images calculated at energies corresponding to its HOMO and LUMO.

Articles

“Towards the Ideal Synthesis of Homoallylic Ketones”

ChemCatChem (2015), 7, 228–229

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“Enantioselective Total Synthesis of (–)-Nardoaristolone B via a Gold(I)-Catalyzed Oxidative Cyclization”

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Y. Wang, M. E. Muratore, A. M. Echavarren

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