Some reactions of bicyclo[6.1.0]non-4-enes and–133 tricyclo[7.1.0.4^{4,6}]decanes

J. Chem. Research (S), 2001, 131–132
J. Chem. Research (M), 2001, 0451–0463

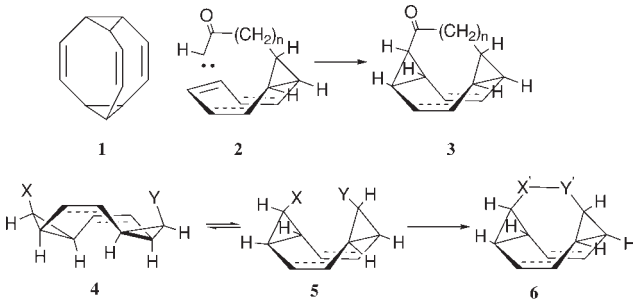
Eckehard Volker Dehmlow* and Olaf Plückebaum

Fakultät für Chemie, Universität Bielefeld, Postfach 1000131, D-33501 Bielefeld, Germany

Synthetic pathways toward the saturated skeleton of tetracyclo[4.4.2.0^{2,10}.0^{5,7}]dodeca-3,8,11-triene (**1**) or compounds close to it were probed *via* derivatives of the title carbon skeletons.

Keywords: bicyclo [6.1.0] non-4-enes, tricyclo [7.1.0.0^{4,6}] decanes

The title compounds are possible precursors of the saturated carbon skeleton of compound **1** which is one of the more interesting structures among the 357 $(CH)_{12}$ isomers listed by Balaban *et al*.[2] We report here on experiments towards the construction of this system. Its preparation can be envisaged at least, in principle, *via* an intramolecular carbene/carbenoid addition **2** → **3** or a ring closure **4** → **6** (Scheme 1). Intramolecular ring closures of these types would be more likely from high energy *endo* tub-like conformations (**2** and **5**). But the inverted conformation of **2** and conformation **4** instead of **5** are expected to be preferred. In the present context, it was hoped that the desired ring closures would become possible out of a small equilibrium concentration of the less stable conformations provided the linking arms were long enough. We undertook therefore several attempts with compounds having pendant chains of different numbers of atoms.



Scheme 1

Although its base catalysed isomerisation is facile, compound **7**[6] or the respective acid could be reduced to the alcohol **8a** with $LiAlH_4$ with retention of the *endo* stereochemistry. **8a** was converted into the bromide **9a** either with PBr_3 at –20°C (82%) or with Ph_3 PBr_2 (86%), and subsequent standard operations allowed the preparation of nitrile **10a** and acid **11a**. The related diazo ketone **12a** was decomposed in dichloromethane or in petroleum ether (b.p. 60–80°C) in the presence of rhodium acetate, copper sulfate, copper powder, or the copper(I) chloride–trimethyl phosphite complex. In all cases, the product of intramolecular insertion into the CH bond next to the cyclopropane ring **(13)** was formed. Keto alcohol **14a** (minor product) was obtained only when $Rh_2(OAc)_4$ was the catalyst in CH_2Cl_2. Best yields of **13** were found in the latter case. No traces of the desired compound of type **3** were observed unfortunately (Scheme 2).

To test the next higher homologue, the sequence of reactions was repeated starting with acid **11a** *via* **8b, 9b, 10b, 11b,** and ending with diazo ketone **12b**. Carbenoid decomposition of this compound was carried out again with rhodium acetate in dichloromethane. Here insertion into the geminal cyclopropane CH bond – to give compound **15** – was the main reaction pathway. Formation of keto alcohol **14b** was also noted. Thus, in spite of the longer sidearm, CH insertion to give a five membered ring prevailed and the formation of a **3**-like tetracyclic compound could not be realised.

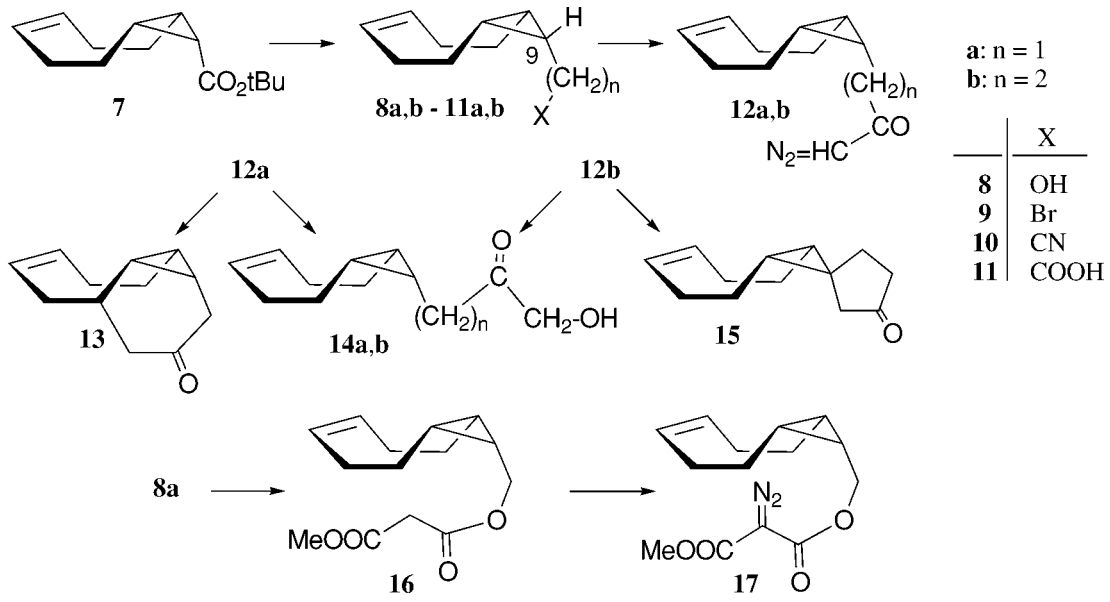
Finally, a hetero-analogue with a four atom side-chain was tested: **8a** was converted with malonic ester half chloride into **16**, and a diazo transfer reaction with tosyl azide led to compound **17**. Carbenoid decompositions with $Cu(acac)_2$ or $Rh_2(OAc)_4$ gave very complex mixtures. The unchanged olefinic signals in the IR and NMR spectra indicated that no intramolecular additions to the double bond had occurred.

Preliminary experiments showed that **8a, 9a,** or **11a** did not react with the carbenoid derived from diazoacetic ester at the double bond, but **7** did. Selecting therefore X=Y - COOMe in **4** and deciding for an acyloin ring closure, we thought to force close contact of the two reactive groups on the metal surface. Our sequence started with the reaction between *endo* ester **7** and *tert*-butyl diazoacetate under rhodium salt catalysis. Along with *ca* 10% of *tert*-butyl fumarate and maleate, 70% of a mixture of the four possible tricyclic esters (*syn-endo-endo* **(18a)**, *syn–endo–exo*, *anti-endo–endo*, and *anti-endo–exo*) was obtained (Scheme 3). Based on our experience in the preparation and purification of **7,**[6] it was presumed that **18a** would be present as the most abundant isomer (found: *ca* 50% of the mixture) and furthermore that it would resist basic saponification more strongly than the other isomers. After some optimisation experiments, **18a** could be isolated in 37% yield based on **7**. Acid hydrolysis under conditions developed earlier[6] allowed the preparation of the diacid **18b** which was converted into the dimethyl ester **18c** with diazomethane. This was considered to be better suited for the acyloin reaction than **18a**. In the event, the ring closure was attempted under all known standard conditions, with or without high dilution and with or without the presence of chlorotrimethylsilane.[7] Unfortunately only decomposition and polymerisation were observed.

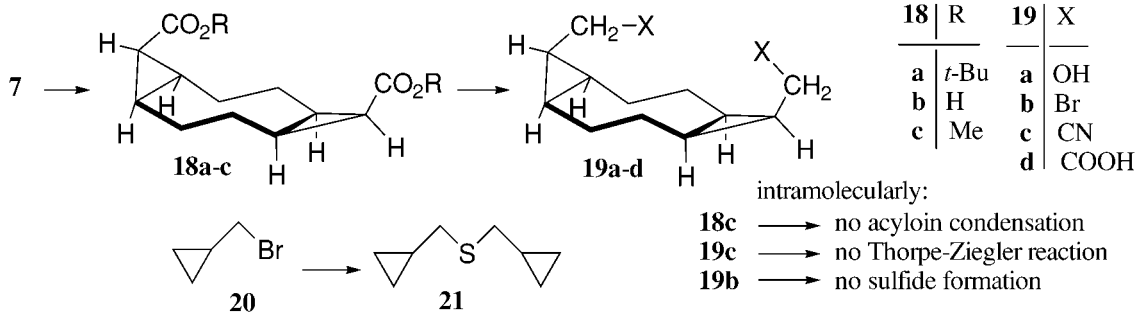
For a second approach of this general type, a different length of the reacting side arms and a Thorpe–Ziegler reaction were selected. **18a** was converted into **19c** *via* diol **19a** and dibromide **19b** similarly to the previous sequence **7** → **10a**. Facile saponification to the diacid **19d** was possible. Nevertheless, the reaction with sodium *N*-methylanilide in ether[8] led to polymer instead of the sought intramolecular ring formation (Scheme 3).

Finally, a ring closure *via* intramolecular formation of a sulfide bridge was attempted. Oxidation and a Ramberg–Bæcklund reaction of the product might generate a derivative of **6**. For that purpose, dibromide **19b** was to be reacted with sodium sulfide under phase transfer catalysis. Beforehand, the conditions were tested with bromomethylcyclopropane **(20)**. A 79% yield of sulfide **21** was obtained. **21** had been prepared by a different route previously.[9] The crucial experiment with **19b**, alas, gave only a sticky solid of obvious polymeric character.

* To receive any correspondence. E-mail: dehmlow@post.uni-bielefeld.de



Scheme 2



Scheme 3

These experiments show that the conformational inversion of the *endo* substituted bicyclo[6.1.0]non-4-enes and tricyclo[7.1.0.0^{4,6}]decanes (and presumably also of the more unsaturated congeners) cannot be forced by the methods employed here. Entirely different approaches towards **1** are called for.

Partial support by the Fonds der Chemischen Industrie is acknowledged.

Received 21 October 2000; accepted 10 February 2001
Paper 00/561

References cited in this synopsis

2 M. Banciu, M. C. Popa and A.T. Balaban, *Chem. Scr*. 1984, **24**, 28–37.
6 E.V. Dehmlow and O. Plückebaum, *J. prakt. Chem.* 1996, **338**, 303–306.
7 R. Rühlmann, *Synthesis* 1971, 236–253.
8 K. Ziegler and R. Aurnhammer, *Liebigs Ann. Chem.* 1934, **513**, 43–64.
9 I.V. Kazimirchik, K.A. Lukin, G.F. Bebikh and N.S. Zefirov, *J. Org. Chem. USSR* (Engl.transl.) 1983, 2209–2212.