

Synthesis of Cyclopenta[*c,d*]pyrene *via* a High Yield One-step Preparation of Pyren-4-ylacetic Acid from Pyrene

Kees Tintel, Johan Lugtenburg, and Jan Cornelisse*

Gorlaeus Laboratories, University of Leiden, P.O. Box 9502, 2300 RA Leiden, The Netherlands

In a single step and in 95% yield pyrene can be converted into pyren-4-ylacetic acid from which subsequently cyclopenta[*c,d*]pyrene (CPP) can be obtained in an overall yield of 60%.

Cyclopenta[*c,d*]pyrene (CPP) (**4**) is a component of car engine exhaust gases^{1,2} and it occurs in a large variety of carbon-black soots.^{3–5} It has been proved that this widely spread environmental contaminant has a high mutagenic activity,⁶ although it is a weak tumour initiator towards mouse skin.⁷

In order to study its chemical and biological properties, a convenient synthetic route is required. Five syntheses of CPP have hitherto been reported.^{8–12} One of these,⁸ the pyrolysis of 2-(pyren-1-yl)ethanol at 850 °C, is only suitable for small-scale preparations, whereas the other methods take at least eight steps from pyrene, give small overall yields, and sometimes include hazardous procedures (liquid HF). In each synthetic route, with the exception of the pyrolysis reaction, the key intermediate is pyren-4-ylacetic acid (**2**). The reported preparation of this intermediate from pyrene^{9,11,13} involves at least five steps and tedious procedures are necessary. Once the pyren-4-ylacetic acid has been obtained, conversion into CPP is relatively straightforward. We therefore tried to find a method to convert pyrene as simply and efficiently as possible into pyren-4-ylacetic acid.

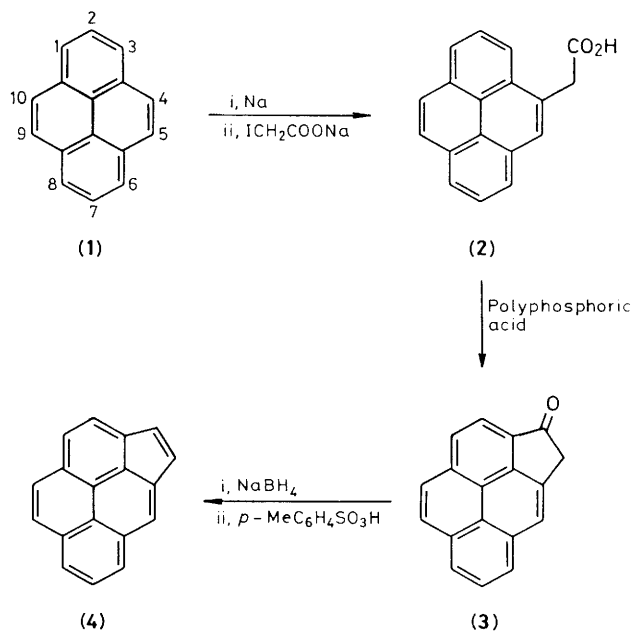
It has been reported that pyrene can easily be converted into the paratropic, antiaromatic dianion.^{14,15} On the basis of theoretical considerations¹⁵ one would predict that the dianion

would undergo *S*_N2 alkylation at position 4 possibly leading to the required pyren-4-ylacetic acid in one step.

This did indeed prove to be the case and we were able to synthesize pyren-4-ylacetic acid (**2**) in one step from pyrene by the following procedure. In diethyl ether–liquid ammonia (1 : 1) pyrene was converted into its dianion upon addition of sodium (2 equiv.) at –78 °C. This dianion reacted almost quantitatively with sodium iodoacetate (1 equiv.) to give pyren-4-ylacetic acid accompanied by variable amounts of 4,5-dihydropyren-4-ylacetic acid. This could easily be converted into pyren-4-ylacetic acid by treatment with dichlorodicyanobenzoquinone (DDQ) in refluxing toluene. The total yield of pyren-4-ylacetic acid was 95%. No 1- or 2-substituted products could be detected. We have performed the reaction on a 10 gram scale and we do not expect any problems in further scaling-up.

Cyclisation of (**2**) to (**3**) was performed in polyphosphoric acid (PPA). In contrast with earlier observations^{10,13} we found that this reaction proceeded in relatively high yield (70%). The ketone (**3**) was reduced with NaBH₄ in ethanol and the resulting alcohol was dehydrated upon treatment with toluene-*p*-sulphonic acid in refluxing toluene giving CPP (**4**) in 90% yield from the ketone.

Thus by means of our procedure pyrene can be converted



into pyren-4-ylacetic acid in one step in 95% yield, while the overall yield of CPP amounts to 60%. The u.v., n.m.r., and mass spectral data of the product are identical with those reported in the literature⁸⁻¹² and the analytical data of the intermediates are in complete agreement with the proposed structures.

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