

A NEW SYNTHESIS OF PARA-TERPHENYLS

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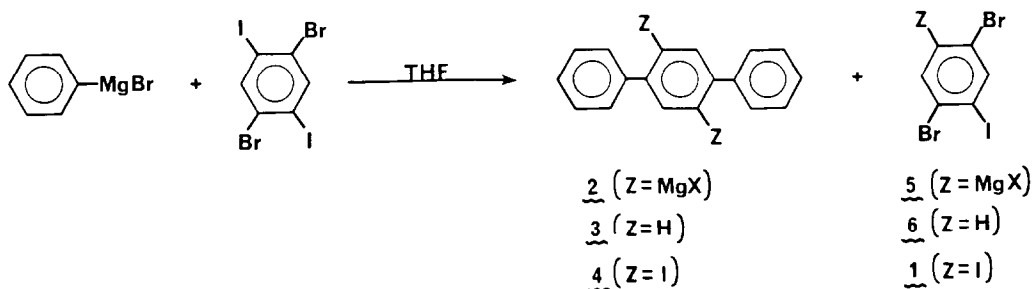
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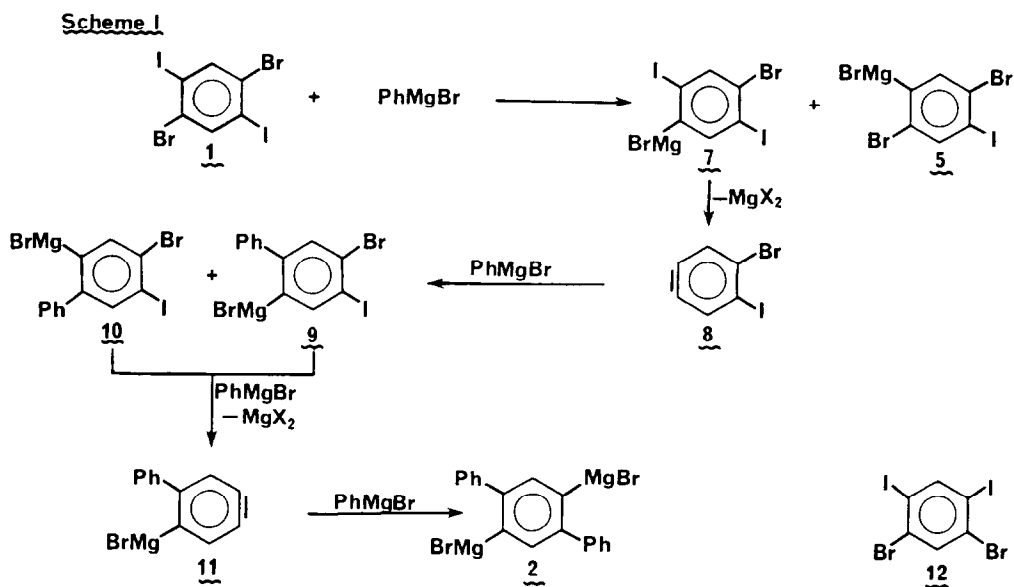
Abstract: *A new, one-step synthesis of para-terphenyls from aryl Grignards and 1,4-dibromo-2,5-diiodobenzene 1 as a di-aryne equivalent is described.*

The formation of aryl-aryl bonds continues to be an important problem in organic synthesis.¹ We describe here a new method for the synthesis of *p*-terphenyls^{2,3} and related oligoarenes⁴ which has considerable synthetic potential and the following unique features: (1) two aryl-aryl bonds are formed in a one-pot reaction, (2) although the potential for forming both *m*- and *p*-terphenyls exists, the reaction is regioselective and only the latter are formed, (3) the reaction proceeds via a novel two-aryne sequence, using 1,4-dibromo-2,5-diiodobenzene **1** as a di-aryne equivalent,⁵ (4) aryl Grignard reagents are used both to generate and to trap the aryne intermediates,⁶ and (5) the product terphenyl contains functionality which allows elaboration of the 'central' ring.⁷

The method is illustrated by the following example. Addition of 1,4-dibromo-2,5-diiodobenzene **1**⁸ in tetrahydrofuran (THF) to four or more equivalents of phenylmagnesium bromide in THF at room temperature gave, after aqueous quench, *p*-terphenyl **3** (54%) and 1,4-dibromo-2-iodobenzene **6**⁹ (43%). Quenching with iodine gave instead the diiodoterphenyl **4**¹⁰ (55%) and **1** (30%). Hence the actual reaction products are the terphenyl di-Grignard **2** and the trihalo mono-Grignard **5**.

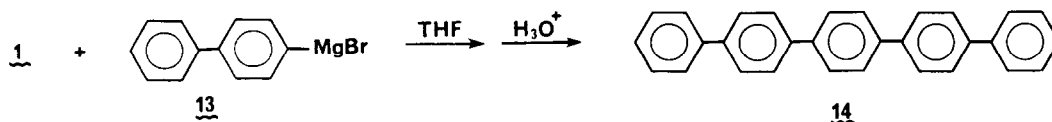


Scheme I rationalizes these results. Grignard exchange occurs at iodine or bromine, giving 5 or 7. Whereas 5 remains as a final reaction product, 7 loses MgX_2 to form aryne 8, eventually leading to the other observed product 2. Addition of phenylmagnesium bromide to the novel organometallic aryne 11 is regioselective, because of the need to keep like charges as far apart as possible.¹¹

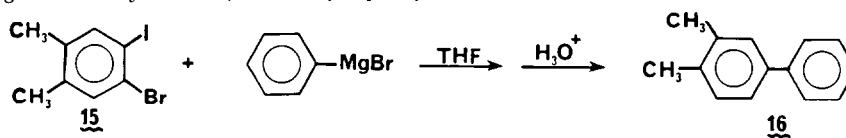


Support for aryne intermediates comes from the observation that 1,5-dibromo-2,4-diiodobenzene $\text{12}^{10,12}$ reacts similarly with excess phenylmagnesium bromide to give mainly *p*-terphenyl.¹³

The method is general, and has been applied to many aryl Grignard reagents.¹⁴ For example, addition of **1** to excess 4-biphenylmagnesium bromide **13**, followed by aqueous quench, gave a 53% yield of *p*-quinquephenyl **14**, mp 387.5–388.5°C. This one-pot route to **14** represents a substantial improvement over the best literature method.¹⁵



The method can also be used to prepare unsymmetric biaryls.¹⁴ For example, addition of 1-bromo-2-iodo-4,5-dimethylbenzene **15** to excess phenylmagnesium bromide, followed by aqueous quench, gave a 66% yield of 3,4-dimethylbiphenyl **16**,¹⁶ mp 28°C.



The only drawback of this new *p*-terphenyl synthesis is the simultaneous formation of by-product **6**, from which a single chromatographic separation is required. However preliminary results indicate that addition of at least one equivalent of either lithium 2,2,6,6-tetramethylpiperidide or potassium *t*-butoxide to the reaction mixture and stirring for 1–2 h prior to aqueous quench increases the terphenyl yield to about 75%, and reduces the amount of **6** to less than 10%. Presumably these reagents convert **5** to **8**, though their exact mode of action remains to be determined.

The method we describe here has great synthetic potential for constructing aryl-aryl bonds. Furthermore, since the primary reaction products are mono- or di-Grignard reagents, they can be elaborated with a variety of electrophiles including carbon electrophiles, allowing substituents to be placed on the 'central' ring. We are currently exploring many of these ramifications.

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References and Notes

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- Chem. Soc.** 1983, **102**, 185, 241; Mallory, F. B.; Mallory, C. W. **Org. Reactions** 1984, **30**, 1.
- The synthesis and chemistry of terphenyls is briefly reviewed by Cheeseman, G. W. H.; Prail, P. F. G. in Rodd's Chemistry of Carbon Compounds, 2nd Ed., Elsevier, Amsterdam, 1974, **III F**, 51-57; MacBride, J. A. H. *ibid.* 1982 supplement 322-323.
 - p*-Terphenyls are of considerable current interest because of their extensive use in liquid crystals; see Saeva, F. D., Ed. "Liquid Crystals", Marcel Dekker, Inc., New York, 1979.
 - For an extensive series of papers on oligophenyls which relies mainly on two older aryl-aryl bond-forming reactions (the Ullmann reaction, and oxidative coupling of aryl Grignards with aryl iodides using Ni-catalysis), see Ozasa, S.; Fujioka, Y.; Hashino, H.; Kimura, N.; Ibuki, E. **Chem. Pharm. Bull. Japan** 1983, **31**, 2313 and references cited therein.
 - For recent uses of di-aryne equivalents in synthesis, see Hart, H.; Raju, N.; Meador, M. A.; Ward, D. L. **J. Org. Chem.** 1983, **48**, 4357; Hart, H.; Nwokogu, G. C. **Tetrahedron Lett.** 1983, **24**, 5721 and references cited therein.
 - This type of reaction with aryllithiums, though seminal in the discovery of arynes (Wittig, G.; Pieper, G.; Fuhrmann, G. **Chem. Ber.** 1940, **73**, 1193; Wittig, G. **Naturwiss.** 1942, **30**, 696) has been relatively little used in synthesis; for reviews, see Hoffmann, R. W. "Dehydrobenzene and Cycloalkynes", Academic Press, New York, 1967, Ch. 2; Heaney, H. **Fortschr. Chem. Forch.** 1970, **16**, 35. If phenyllithium is used in place of phenylmagnesium bromide in our procedure, the terphenyl yield is much lower.
 - In contrast, electrophilic substitution in *p*-terphenyls, generally occurs in the 'outer' rings.
 - Prepared from 1,4-dibromobenzene (5.8 g, 24.6 mmol) and iodine (24 g, 94.5 mmol) in 80 mL of conc. H₂SO₄ stirred at 125-135°C for 6 h, then quenched with ice-water and worked up and recrystallized from benzene to give 8.4 g (70%) of **1**, white needles, mp 163-165°C.
 - Varma, P. S.; Shankarnarayanan, S. **J. Ind. Chem. Soc.** 1936, **13**, 31
 - All new compounds gave correct elemental analyses and spectra in accord with the assigned structures.
 - No *m*-terphenyl was detected by gas chromatography (detection limit <1%).
 - Prepared from 1,3-dibromobenzene, iodine and sulfuric acid as described in footnote **8**; mp 166-167°C.
 - In this case a small amount of *m*-terphenyl was also formed; the *p*/*m* ratio was >6:1. The origin of the *m*-product is not yet clear. Consistent with Scheme I, the other product (corresponding to **6**) was 1,3-dibromo-4-iodobenzene (46%).
 - Numerous examples will be described in a full account.
 - Campbell, T. W.; McDonald, R. N. **Org. Syn.** 1960, **40**, 85 and references cited therein.
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