

CONDENSED HETEROAROMATIC RING SYSTEMS. X.<sup>1</sup>

## SYNTHESIS OF BENZINDOLES FROM o-BROMONAPHTHYLAMINES

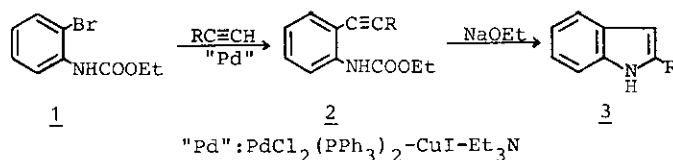
Takao Sakamoto, Yoshinori Kondo, and Hiroshi Yamanaka\*

Pharmaceutical Institute, Tohoku University,

Aobayama, Sendai 980, Japan

**Abstract**—Benz[f]indole, of which few effective preparative methods are known, was easily synthesized by palladium-catalyzed reaction of ethyl 3-bromo-2-naphthylcarbamate with trimethylsilylacetylene and subsequent cyclization with sodium ethoxide in ethanol. By the same method, benz[g]indole and benz[e]indole were obtained from 2-bromo-1-naphthylcarbamate and 1-bromo-2-naphthylcarbamate, respectively.

Previously, we reported<sup>2</sup> a facile method for the synthesis of indole derivatives (3) from ethyl o-ethynylphenylcarbanilates (2), prepared by the palladium-catalyzed reaction of ethyl o-bromophenylcarbanilate (1), as shown in Scheme 1.

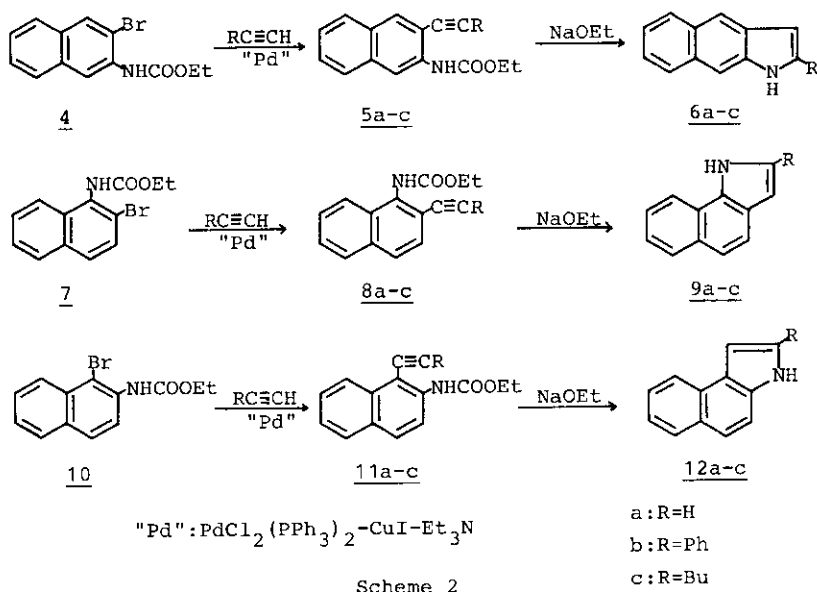


Scheme 1

As an extension of the above method, we now report the synthesis of three kinds of benzindoles (6, 9, and 12), among which few preparative methods are known for benz[f]indoles (6a-c).

Firstly, 3-bromo-2-naphthylamine,<sup>3</sup> 2-bromo-1-naphthylamine,<sup>4</sup> and 1-bromo-2-naphthylamine<sup>5</sup> were converted into the corresponding carbamates (4, mp 110-111°C, 86 %; 7, mp 132-133°C, 82 %; 10, mp 87-89°C, 65 %) by treatment with ethyl chloroformate in pyridine. When the crude ethyl 3-(trimethylsilylethynyl)-2-naphthylcarbamate (5a), prepared by the condensation of 4 with trimethylsilylacetylene in the presence of dichlorobis(triphenylphosphine)palladium, was treated with sodium

ethoxide in ethanol, benz[f]indole (6a), mp 188-190°C,<sup>6</sup> was obtained in 48 % overall yield from 4. Similarly, benz[g]indole (9a), mp 169-170°C,<sup>7</sup> and benz[e]indole (12a), mp 201-203°C (picrate)<sup>8</sup> were synthesized from 7 and 10 in 53 and 54 % yields, respectively. The physical constants and spectral data of all these compounds are in good agreement with the reported values.



When 1-hexyne and phenylacetylene were employed instead of trimethylsilylacetylene, the benzindoles possessing a substituent at the 2-position were easily synthesized. The yields and melting points of the 2-substituted benzindoles (6b, 6c, 9b, 9c, 12b, and 12c) are listed in Table I.

#### General Procedure for the Preparation of Benzindoles

A mixture of an o-bromonaphthylcarbamate (4 mmol), an acetylene (6 mmol), PdCl<sub>2</sub>(PPh<sub>3</sub>)<sub>2</sub> (100 mg), CuI (50 mg), and Et<sub>3</sub>N (1 ml) was heated in a sealed tube at 80°C for 2 h. The mixture was diluted with water and extracted with ether. The ethereal extract was purified by SiO<sub>2</sub> column chromatography using C<sub>6</sub>H<sub>6</sub> as an eluent. The product obtained from the C<sub>6</sub>H<sub>6</sub> eluate, was added to an EtONa-EtOH solution [prepared from Na (460 mg, 20 mmol) and dry EtOH (30 ml)], and the mixture was refluxed for 4 h. The ethanol was removed under reduced pressure, and the residue was diluted with water. The mixture was extracted with CHCl<sub>3</sub>, and the CHCl<sub>3</sub> extract was purified by SiO<sub>2</sub> column chromatography using hexane-C<sub>6</sub>H<sub>6</sub> (2:1) as an eluent to give the product.

Table I. Benzindoles from o-Bromonaphthylcarbamates

No.	Yield(%)	mp (°C)	Lit. mp (°C)	<sup>1</sup> H-NMR (CDCl <sub>3</sub> ) δ (ppm)
<u>6a</u>	48	188-190	192 <sup>6</sup>	6.5-6.8 (1H,m), 7.1-8.2 (8H,m)
<u>6b</u>	45	253-255	260 <sup>7</sup>	7.0-7.7 (6H,m), 7.8-8.3 (7H,m) <sup>a)</sup>
<u>6c</u>	33	viscous oil <sup>b)</sup>		0.9-1.2 (3H,m), 1.3-1.9 (4H,m) 2.3-2.7 (2H,m), 6.6-6.8 (1H,m) 7.1-8.1 (7H,m)
<u>9a</u>	53	169-170	170-171 <sup>8</sup>	6.5-6.7 (1H,m), 7.1-8.3 (8H,m)
<u>9b</u>	42	165-167	165-167 <sup>9</sup>	7.0-8.4 (13H,m)
<u>9c</u>	30	viscous oil <sup>c)</sup>		0.8-1.2 (3H,m), 1.3-1.8 (4H,m) 2.3-2.8 (2H,m), 6.6-6.8 (1H,m) 7.0-8.2 (7H,m)
<u>12a</u>	54	viscous oil <sup>d)</sup>		6.6-6.8 (1H,m), 7.1-8.2 (8H,m)
<u>12b</u>	38	180-182	175 <sup>7</sup>	7.1-8.6 (13H,m)
<u>12c</u>	26	viscous oil <sup>e)</sup>		0.9-1.3 (3H,m), 1.3-1.9 (4H,m) 2.3-2.8 (2H,m), 6.6-6.8 (1H,m) 7.1-8.0 (7H,m)

a) In DMSO-d<sub>6</sub>. b) Picrate (red needles): mp 235-240°C (dec.).<sup>10</sup>

c) Picrate (brown needles): mp 217-223°C (dec.).<sup>10</sup> d) Picrate (red

needles): mp 201-203°C (dec.); lit.<sup>8</sup> mp 205°C (dec.). e) Picrate

(brown needles): mp 236-238°C (dec.).<sup>10</sup>

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10. 6c: Anal. Calcd for C<sub>22</sub>H<sub>20</sub>N<sub>4</sub>O<sub>7</sub> (picrate): C, 58.41; H, 4.46; N, 12.38. Found: C, 58.23; H, 4.53; N, 12.16. 9c: Anal. Calcd for C<sub>22</sub>H<sub>20</sub>N<sub>4</sub>O<sub>7</sub> (picrate): C, 58.41; H, 4.46; N, 12.38. Found: C, 58.36; H, 4.60; N, 12.22. 12c: Anal. Calcd for C<sub>22</sub>H<sub>20</sub>N<sub>4</sub>O<sub>7</sub> (picrate): C, 58.41; H, 4.46; N, 12.38. Found: C, 58.19; H, 4.37; N, 12.35.

Received, 22nd April, 1986