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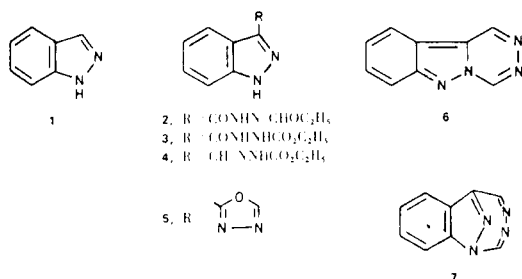
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The main nmr parameters of 1,2,4-triazino[4,5-*b*]indazole derivatives were measured on the basis of their <sup>13</sup>C nmr spectral analysis compared to indazole models. <sup>1</sup>J<sub>C-H</sub> coupling constants were studied and the correct structure of 1,2,4-triazino[4,5-*b*]indazoles was elucidated.

*J. Heterocyclic Chem.*, 16, 53 (1979).

The structural elucidation of indazole (1) and its derivatives is rather difficult due to the fact that they are potentially tautomeric heterocycles (1-5). Recently (6), the influence of both steric and electronic effects on the methylation of simple indazoles in alkaline medium was studied, and it was pointed out that the N-1 methylated derivatives predominated. On the other hand, selective synthesis of 1-acyl and 2-acyl indazoles was accomplished by modifying the reaction conditions (7). The low temperature enhances the 2-substitution whereas the higher one favours 1-substitution.

In our general study of the triazinic tricyclic structures (8-10), we have reported the synthesis of some derivatives via the rearrangement of indazole hydrazides or hydrazones, such as 2, 3 and 4, and also by the rearrangement of oxadiazolylindazole 5 (11). However, it is worthy to mention that these unequivocal reactions may theoretically lead to triazino[4,5-*b*]indazole derivatives 6 or to a bridged tetraepine structure 7 depending on the involvement of the indazole nitrogen.



Obviously, the latter structure 7 is unlikely, and recently we have collected some evidence in favour of structure 6, based on <sup>1</sup>H nmr studies (11). For the triazinoindazolone structure 14, we mostly used the N.O.E. (12,13).

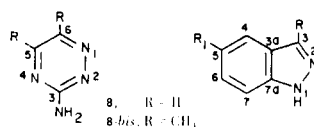
The ambiguity of structure is finally reconciled through <sup>13</sup>C nmr studies and measurement of the main parameters, chemical shifts and coupling constants J<sub>C-H</sub>. The study of 1,2,4-triazino[4,5-*b*]indazoles and the interpretation of the spectral data were realized by comparison with those of simpler substituted heterocycles, e.g., 1,2,4-triazines and indazoles. Coupling constants and chemical shifts in

ppm, referred to TMS of two 1,2,4-triazines, 8 and 8-*bis*, and four indazole derivatives 1, 9, 10E and 10Z, were measured in DMSO-*d*<sub>6</sub> at 20° and are listed in Table I [the indazole spectrum was previously reported (14)]. For the triazine derivatives 8 and 8-*bis*, the assignments

Table I

<sup>13</sup>C Nmr Chemical Shifts and J<sub>C-H</sub> of 1,2,4-Triazines and Indazoles

|                 | Chemical Shifts (ppm) |               |       |       |       |         |
|-----------------|-----------------------|---------------|-------|-------|-------|---------|
|                 | 8                     | 8- <i>bis</i> | 1 (b) | 9     | 10E   | 10Z (d) |
| C3              | 163.6                 | 162.3         | 133.6 | 137.1 | 136.5 | 137.2   |
| C4              |                       |               | 120.7 | 123.7 | 123.5 | 123.7   |
| C5              | 153.3                 | 159.2         | 120.4 | 114.6 | 115.2 | 114.8   |
| C6              | 141.0                 | 147.3         | 126.1 | 129.4 | 129.7 | 129.6   |
| C7              |                       |               | 110.3 | 113.1 | 113.3 | 113.1   |
| C7a             |                       |               | 140.2 | 139.2 | 140.0 | 139.8   |
| C3a             |                       |               | 123.1 | 123.3 | 123.2 | 123.2   |
| CH <sub>3</sub> |                       | 18.2          |       |       | 15.5  | 14.2    |
|                 |                       | 21.3          |       |       |       |         |
| C=O             |                       |               |       |       | 157.2 | 158.0   |
| =CH             |                       |               |       |       | 146.4 | 155.2   |
| CH <sub>2</sub> |                       |               |       |       | 67.8  | 62.6    |



1. R = R<sub>1</sub> = H  
 9. R = CONHNH<sub>2</sub>, R<sub>1</sub> = BR  
 10. R = CONHN=CHOC<sub>2</sub>H<sub>5</sub>, R<sub>1</sub> = BR

Coupling Constants (Hz)  
(J<sub>C-H</sub>) (a)

|       | 8     | 8- <i>bis</i> | 1 (b) | 9   |
|-------|-------|---------------|-------|-----|
| C3-H5 | 10.3  |               |       |     |
| C3-H3 | 1.5   | 1.5           | 186   |     |
| C3-H1 |       |               | 2.5   |     |
| C3-H4 |       |               | 6.5   | 2   |
| C4-H4 |       |               | 161   | 168 |
| C4-H6 |       |               | 8     | 5.5 |
| C4-H5 |       |               | 2.5   |     |
| C5-H5 | 184.0 | 12.5          | 164   |     |

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|        |       |      |     |     |
|--------|-------|------|-----|-----|
| C5-H6  | 10.3  |      |     | 4   |
| C5-H7  |       |      | 8   | 8   |
| C6-H6  | 189.0 | 12.5 | 164 | 170 |
| C6-H5  | 9.1   |      | 2   |     |
| C6-H4  |       |      | 7.5 | 4   |
| C7-H7  |       |      | 163 | 168 |
| C7-H5  |       |      | 7.5 |     |
| C7a-H4 |       |      |     | 8   |
| C7a-H6 |       |      | (c) | 7   |
| C3a-H7 |       |      | (c) | 4.5 |

(a)  $J_{C-H}$  are measured with  $\pm 1$  Hz after expanding of the signals.  
 (b) The spectrum of **1** has been previously described (5) (**14**).  
 (c) Multiplet not resolved. (d) The product studied was a mixture (3/1) of E and Z isomers.

are as follows: C3, having no  $^1J_{CH}$ , is easily recognised; C5 and C6 are distinguished by their positions in relation to the heterocyclic nitrogen atoms: C6,  $\beta$  to two nitrogen atoms, is expected at a higher field than C5.

The spectra of indazole **1** (**14**), bromohydrazide **9** and of the two isomers (E and Z) of **10** (raw material of 9-bromo-1,2,4-triazino[4,5-b]indazolone **12**) are analysed on the basis of bromine substituent effects on the aromatic ring (**15**): -5.4 ppm on the bearing carbon, +3.3 ppm on the *ortho* carbons, +2.2 ppm on the *meta* carbons and -1.0 ppm on the *para* carbon. These assignments are confirmed by  $J_{C-H}$  values. On the other hand, the lowering of  $J_{C3-C4}$  when C3 is substituted (as in **9**) is noticeable.

C1 and C4 are identified on the basis of their chemical shifts and especially by their different  $^1J_{C-H}$  coupling constants values. Benzenoid carbons are assigned according to the results obtained on the previous indazole models and particularly the comparison of  $J_{C-H}$  coupling constants. The 6-6a double bond is ascertained by its influence on the C7, C8, C9, C10, C10a and C6a shifts.

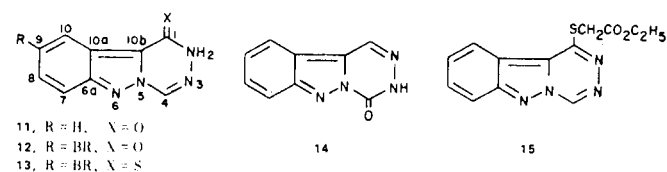
The remaining carbon is the tetrasubstituted C10b; in the spectrum of **11** it appears as a triplet (actually a doublet of doublets with two very close coupling constants).

The spectrum of **14** is consistent with its structure: the carbonyl chemical shift is lowered by 9.5 ppm by comparison with that of the C1 of **11** for the two  $\alpha$ -nitrogen atoms, whereas the C1 shift is very close to the shift of C4 in **11**.

Two noticeable coupling constants were noted:  $^1J_{C1-H1} = 195$  Hz, which is lower than the  $^1J_{C4-H4}$  value in **11**, **12**, **13** and  $^2J_{C4-H3} = 7$  Hz, revealing a very slow exchange of H3.

In the spectrum of **14**, C10b shows two coupling constants:  $J_{C10b-H10} = 12$  Hz and  $J_{C10b-H1} = 2$  Hz. When in **15**, this carbon is coupled with H10 ( $J = 5$  Hz) and H4 ( $J = 4.5$  Hz).

Table II

 $^{13}C$  Nmr Chemical Shifts and  $J_{C-H}$  of Triazino Indazoles Derivatives

|                 | Chemical Shifts (ppm) |       |       |       |       |
|-----------------|-----------------------|-------|-------|-------|-------|
|                 | 11                    | 12    | 13    | 14    | 15    |
| C1              | 154.4                 | 154.7 | 172.9 | 130.8 | 113.7 |
| C4              | 129.6                 | 130.3 | 133.9 | 144.9 | 137.8 |
| C7              | 117.7                 | 120.4 | 120.1 | 118.3 | 117.7 |
| C8              | 129.0                 | 132.6 | 133.0 | 130.0 | 130.4 |
| C9              | 124.9                 | 118.1 | 118.5 | 124.7 | 124.9 |
| C10             | 120.4                 | 122.7 | 123.9 | 121.0 | 120.4 |
| C10a            | 118.0                 | 119.5 | 120.8 | 116.7 | 123.9 |
| C10b            | 126.0                 | 125.7 | 123.9 | 129.6 | 154.7 |
| C6a             | 148.5                 | 147.3 | 148.0 | 149.6 | 149.0 |
| CH <sub>2</sub> |                       |       |       |       | 31.4  |
| CO              |                       |       |       |       | 167.9 |
| CH <sub>2</sub> |                       |       |       |       | 61.3  |
| CH <sub>3</sub> |                       |       |       |       | 14.0  |

|          | Coupling Constants (Hz) |     |     |     |     |
|----------|-------------------------|-----|-----|-----|-----|
|          | 11                      | 12  | 13  | 14  | 15  |
| C1-H1    |                         |     |     | 195 |     |
| C1-H3    |                         |     |     | 7.5 |     |
| C4-H4    | 224                     | 224 | 220 |     | 218 |
| C4-H3    |                         |     |     | 7   |     |
| C7-H7    | 163                     | 169 |     | 167 | 168 |
| C7-H8    |                         | 2   |     | 2   | 2   |
| C7-H9    | 7                       |     |     | 7.5 | 8   |
| C8-H8    | 163                     | 168 |     | 163 | 164 |
| C8-H9    |                         |     |     | 2   | 1.5 |
| C8-H10   | 8                       | 6.5 |     | 7.5 | 8   |
| C9-H9    | 163                     |     |     | 165 | 166 |
| C9-H7    | 8                       | 8   |     | 8   | 8   |
| C9-H8    |                         | 4.5 |     | 2   | 2   |
| C10-H10  | 164                     | 171 |     | 167 | 167 |
| C10-H9   |                         |     |     | 2   | 2   |
| C10-H8   | 7.5                     | 5   |     | 8   | 8   |
| C10a-H7  | 3                       | 5.5 |     | (b) | 2   |
| C10a-H9  | 7.5                     |     |     |     | 7.5 |
| C10b-H10 |                         | 5   |     | 12  | 5   |
| C10b-H4  | (b)                     | 4.5 |     |     | 4.5 |
| C10b-H1  |                         |     |     | 2   |     |
| C6a-H8   | 8                       | 8.5 |     | 8.5 | 8.5 |
| C6a-H10  | 3                       | 6   |     | 6.5 | 6.5 |

(a) Because of its low solubility, measures of J were not possible.  
 (b) Multiplet not resolved.

The triazino[4,5-*b*]indazole structure of **11** and **15** is ascertained by examination of the couplings of C10b; particularly, the doublet of doublets signal of C10b in **15** prove that carbon is coupled with two protons which are separated by three bonds. These are necessarily H10 and H4. This coupling supports the triazinoindazole structure **6**, because in the tetrazepine isomer such a coupling would be improbable since the two coupled nuclei would be separated by four non-coplanar bonds.

#### EXPERIMENTAL

<sup>13</sup>C Nmr spectra were recorded at 20° on a Varian CFT 20 spectrometer in Fourier Transform mode in DMSO-d<sub>6</sub>. Chemical shifts were referred to TMS as an internal reference and coupling was measured on expanded sections of the spectrum as 1 mm = 1.26 Hz.

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