111. *Absorption Spectra of Acridines. Part II. Monoaminoacridines.*

By N. H. Turnbull.

In Part I (Craig and Short, this vol., p. 419) were reported the visible absorption spectra, in aqueous solvents at three pH values, of acridine and the five isomeric monoaminoacridines, showing severally, where formed, the bivalent ion, the univalent ion, and the undissociated base. This work has now been extended to the ultraviolet under similar conditions, and the results are presented in Figs. 1—6. It is seen that those isomerides which have evinced the greatest biological activity (Rubbo, Albert, and Maxwell, *Brit. J. Exp. Path.*, 1942, **23**, 69) also exhibit the greatest spectrographic individuality.

Waterman and Harberts (*Bull. Soc. chim.*, 1936, **3**, 643) and de Borst, Heertjes, and Waterman (*ibid.*, 1938, **5**, 888) showed that aniline, *p*-toluidine, and benzidine, although absorbing at longer wave-lengths than the parent hydrocarbons, assume the spectra of these when made into hydrochlorides. This coincides with current knowledge that when an aromatic amino-nitrogen atom becomes quaternary, all structures involving a double bond between the nitrogen atom and the ring carbon atom cease to exist and their contribution to the resonance hybrid is lost. This change is evidently reflected in a reversion to the spectrum characteristic of the unsubstituted structure.

A similar effect may be seen in the aminoacridines in spite of the presence of two basic centres. From the electrometric studies of Albert and Goldacre (J., 1943, 454), it is evident that the curves marked " pH 11 " represent the free base in each case, those marked " pH 2·5 " depict mainly the univalent ions, and any major change between the latter curves and those obtained in 5N-hydrochloric acid is a result of the formation of bivalent ions.

It will be seen that the absorption maxima of the bivalent ions of 1-, 3-, and 4-aminoacridines coincide with those of acridine hydrochloride, whereas those of the univalent ions of these bases are displaced to longer wave-lengths. It is concluded that, in the shift from uni- to bi-valent ions, the amino-group in each substance accepts a proton and thereby ceases to affect the absorption spectrum. This confirms the conception (Part I) that these aminoacridines accept their first proton on the ring nitrogen atom. Supporting evidence is seen in the change from the spectra of the undissociated bases to those of the univalent ions, which is bathochromic, both in the visible and in the 2500—3100 A. region, just as is the case with the change from acridine to the acridinium ion.

2- and 5-Aminoacridines, which possess outstanding biological activity, depart from the above spectrographic pattern. 2-Aminoacridine absorbs very much as the 1-, 3-, and 4-isomerides but is seen to achieve only partial formation of the bivalent ion in 5N-hydrochloric acid (cf. also Part I), thus providing further

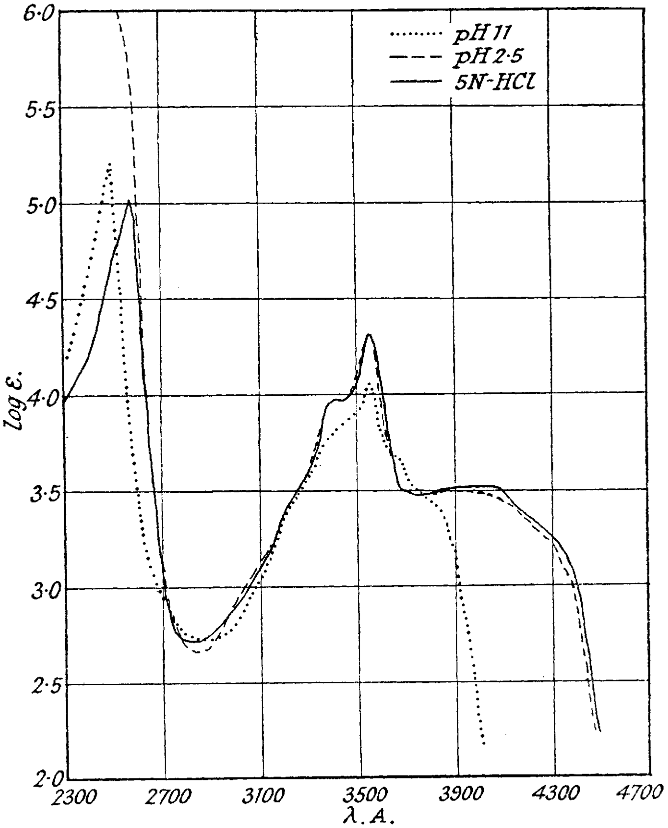


Fig. 1.
Acridine.

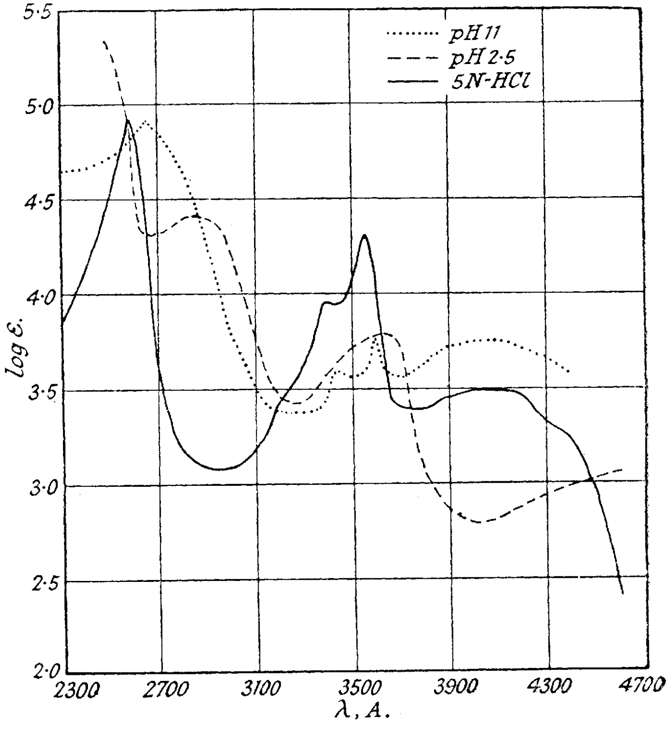


Fig. 2.
1-*Aminoacridine.*

evidence of the extra ionic resonance of the monoacid ion (cf. Albert and Goldacre, *loc. cit.*; Albert and Ritchie, J., 1943, 458). The spectra of 5-aminoacridine are, collectively, very different from those of the other isomerides, and this individuality may be connected with the suggested formulation of the base as 5-iminoacridane. The change in absorption on passing from the ion to the undissociated base is remarkably small and, in agreement with the postulate of a high degree of extra resonance for the univalent ion (Albert and Goldacre, *loc. cit.*), no spectroscopic evidence for the formation of a dihydrochloride could be found.

FIG. 3.

2-*Aminoacridine.*

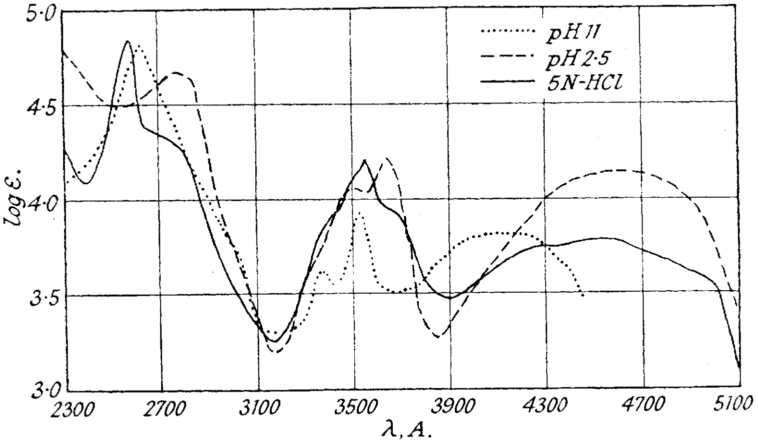
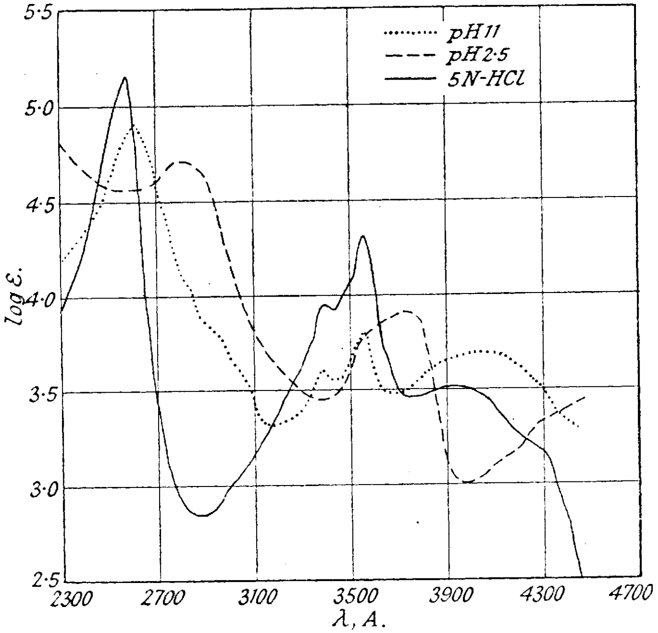


FIG. 4.

3-*Aminoacridine.*



EXPERIMENTAL.

A Hilger Medium Quartz Spectrograph (E 498) with Spekker photometer was used with a condensed tungsten-steel spark. The curves labelled "pH 2·5" were obtained in oxalic acid–potassium hydroxide buffer containing 66% v/v of methanol and adjusted to give a reading of pH 2·5 with a glass electrode (uncorrected for effect of alcohol). This buffer shows some absorption at wave-lengths less than 2600 A. The curves labelled "pH 11" were obtained in a sodium carbonate–borax buffer of pH 11, diluted with methanol to contain 34% v/v of the latter.

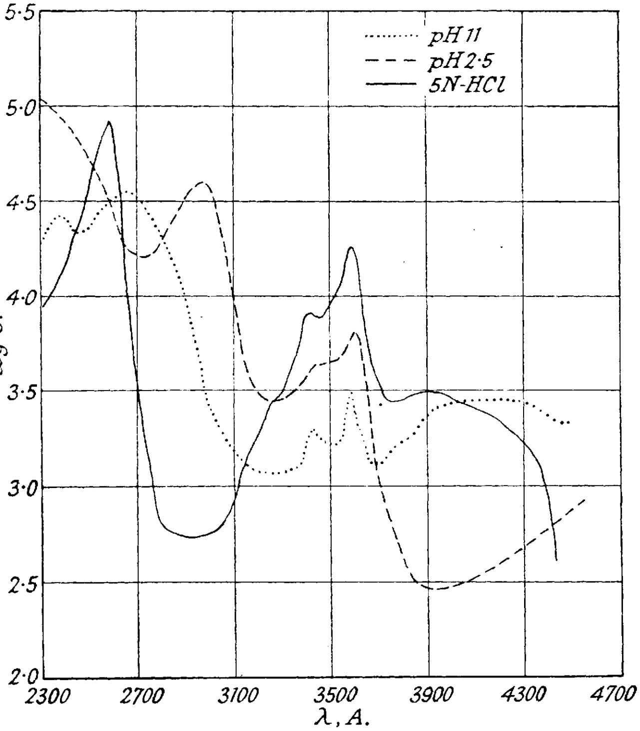


FIG. 5.
4-*Aminoacridine.*

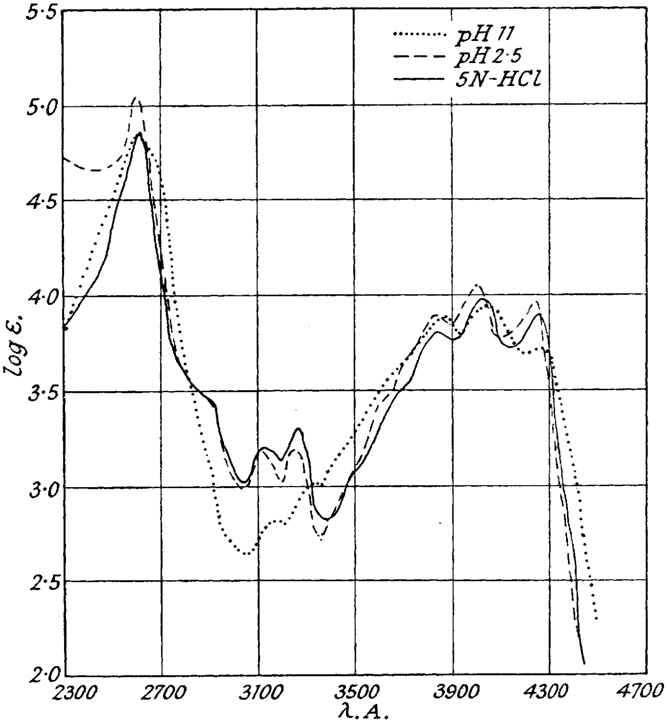


FIG. 6.
5-*Aminoacridine.*

The author is indebted to Dr. Adrien Albert who suggested this work, provided the samples used, and gave invaluable advice and assistance. Thanks are also due to the Directors of Nicholas Pty. Ltd. who have generously provided facilities and materials.

NICHOLAS PTY. LTD., MELBOURNE.

[*Received, December* 15*th*, 1944.]