# SYNTHESIS AND ANTIBACTERIAL ACTIVITY OF SOME 1-(2-PROPYNYL) AND 1-PROPADIENYL DERIVATIVES OF 1,4-DIHYDRO-4-OXOQUINOLINE-3-CARBOXYLIC ACIDS AND SIMILAR HETEROCYCLES

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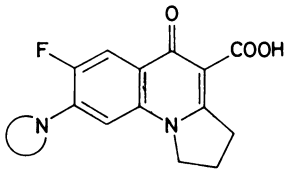
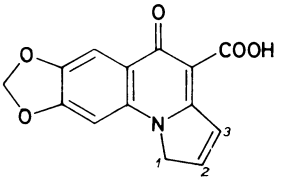
Received May 2, 1990
Accepted June 3, 1990

N-Alkylation of *IIIa*, *IIIb*, *IIId*—*IIIf*, and 9-acridanone with 3-bromopropyne in dimethyl sulfoxide in the presence of potassium carbonate yielded N-(2-propynyl) derivatives *IVa*—*IVe* and *VIa*, respectively. Ethyl esters *IVa*, *IVb*, and *IVe* were hydrolyzed to *IVf*—*IVh*, respectively. Compounds *IVf*, *IVg*, *IVc* treated with bases yielded N-propadienyl derivatives *Va*—*Vc*. On the other hand 2-substituted compounds *IVd* and *IVh* did not change under the same conditions. Compound *VIa* treated with powdered potassium hydroxide in dimethyl sulfoxide at room temperature yielded N-(1-propynyl) derivative *VII*.

Antibacterial quinolones[1-3] have attracted increasing attention as a source of new potent clinically important drugs. Recently some 1,2,3,4-tetrahydro-5-oxopyrrolo-[1,2-*a*]quinoline-4-carboxylic acids of a general formula *I* have proven to be highly active[4]. Smrž et al.[5] reported formation of a similar derivative *II* during attempts to synthesize *IVf* from *IIIa* by an alkylation with 3-bromopropyne followed by refluxing with an aqueous solution of sodium hydroxide. The reaction would be useful for the preparation of analogues of *I* having a double bond between the positions 2 and 3. Such analogues have not been prepared yet and would be of interest both as potential antibacterial agents and as possible intermediates for the alternate synthesis of *I*.




*I*

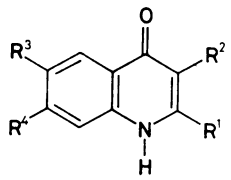



*II*

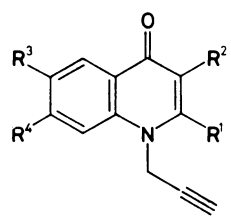
The structure assignment of *II* was based on the elemental analysis, IR, and $^1$H NMR spectra. Nevertheless, our analysis of the $^1$H NMR data revealed some

contradictions. The published interpretation was following: 6·00 d, 2 H (N—$CH_2$); 6·32 s, 2 H (O—$CH_2$—O); 7·62 s, 1 H (H-9); 7·68 bs, 1 H (H-3); 7·78 bt, 1 H (H-2); 8·36 bs, 1 H (COOH); 8·65 s, 1 H (H-6). There were two principal discrepancies in the interpretation. The shift for the position 6 (8·65) seemed to be too high with respect to the neighboring methylenedioxy group. The more serious question was why the signals of protons at the positions 2 and 3 were not mutually split. Both of these facts could be explained by our tentative interpretation of the published $^1$H NMR data which supposed structure *Va* instead of *II*. Our interpretation, which was in accordance with the data on both similar N-propadienyl compounds[6–8] and N-alkyl quinolone derivatives[9,10], was following: 6·00 d, 2 H ($CH_2$=C=); 6·32 s, 2 H (O—$CH_2$—O); 7·62 s, 1 H (H-8); 7·68 bs, 1 H (H-5); 7·78 bt, 1 H (N—CH=); 8·36 bs, 1 H (COOH); 8·65 s, 1 H (H-2).

Since similar N-propadienyl quinolone derivatives have not been reported yet we decided to reinvestigate this reaction. At first we repeated the reported synthesis without isolation of intermediates and we obtained the compound in question. Then we performed the same alkylation of *IIIa* with isolation of the intermediate *IVa* which after acidic hydrolysis yielded *IVb*. Compound *IVb* upon a treatment with aqueous solution of sodium hydroxide yielded the required compound. We found that weaker bases as potassium carbonate or sodium hydrogen carbonate were quite sufficient for the reaction and the material obtained by this way was purer. Our product was found identical with the sample provided by Dr Smrž (TLC, IR, UV, $^1$H NMR, MS). Our interpretation was confirmed by $^{13}$C NMR spectrum. For the N-propadienyl group we found shifts 100·09 (C-1), 204·29 (C-2), and 88·36 (C-3). Ref.[11] gave for similar propadienyl derivatives shifts 103·3–105·8, 200·7–203·2, and 92–93·7, respectively.



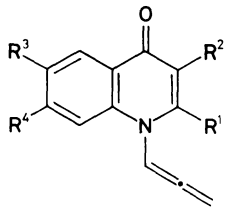
*IIIa*, $R^1$= H ; $R^2$= $COOC_2H_5$ ; $R^3$, $R^4$= O—$CH_2$—O
*IIIb*, $R^1$= H ; $R^2$= $COOC_2H_5$ ; $R^3$= F ; $R^4$= Cl
*IIIc*, $R^1$= H ; $R^2$= COOH ; $R^3$= F ; $R^4$= Cl
*IIId*, $R^1$= $R^2$= H ; $R^3$= F ; $R^4$= Cl
*IIIe*, $R^1$= $CH_3$ ; $R^2$= $R^3$= $R^4$= H
*IIIf*, $R^1$= $COOC_2H_5$ ; $R^2$= $R^3$= $R^4$= H



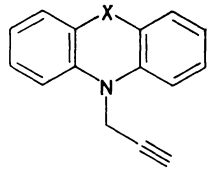
*IVa*, $R^1$= H ; $R^2$= $COOC_2H_5$ ; $R^3$, $R^4$= O—$CH_2$—O
*IVb*, $R^1$= H ; $R^2$= $COOC_2H_5$ ; $R^3$= F ; $R^4$= Cl
*IVc*, $R^1$= $R^2$= H ; $R^3$= F ; $R^4$= Cl
*IVd*, $R^1$= $CH_3$ ; $R^2$= $R^3$= $R^4$= H
*IVe*, $R^1$= $COOC_2H_5$ ; $R^2$= $R^3$= $R^4$= H
*IVf*, $R^1$= H ; $R^2$= COOH ; $R^3$, $R^4$= O—$CH_2$—O
*IVg*, $R^1$= H ; $R^2$= COOH ; $R^3$= F ; $R^4$= Cl
*IVh*, $R^1$= COOH ; $R^2$= $R^3$= $R^4$= H

In order to clarify the structural requirements for the isomerization, several types of similar N-(2-propynyl) derivatives were prepared by an alkylation of the respective N-unsubstituted derivatives *IIIa*, *IIIb*, *IIId*–*IIIf*, and 9-acridanone with 3-bromopropyne. The starting compounds *IIIa* (ref.[10]), *IIIb* (ref.[12]), *IIIe* (ref.[13]), *IIIf* (ref.[14]), and 9-acridanone[15] were prepared according to the literature. Compound *IIId* was prepared by thermal decarboxylation of acid *IIIc* which was obtained by an alkaline saponification of *IIIb*. Esters *IVa* and *IVb* were hydrolyzed to the appropriate acids *IVf* and *IVg* by refluxing with a mixture of hydrochloric and acetic acids. Acid *IVh* was prepared from *IVe* by an alkaline treatment with aqueous sodium hydroxide at room temperature.

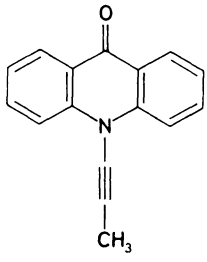
Compounds *IVf*, *IVg*, and *IVc* refluxed with aqueous or aqueous ethanolic solutions of sodium hydrogen carbonate provided N-propadienyl derivatives *Va*–*Vc*, respectively. The same products were obtained by a similar treatment with aqueous solutions of sodium hydroxide. On the other hand 2-substituted derivatives *IVd* and *IVh* did not isomerize under the conditions described above. Similarly 10-(2-propynyl)acridanone *VIa* (refs[7,16]) was not changed under these conditions. This fact could be explained either by some kind of participation of free CH at the position 2 during the isomerization of 1-(2-propynyl) derivatives to 1-propadienyl analogues, or by some specific steric demand of this reaction.




*Va*, $R^1$ = H ; $R^2$ = COOH ; $R^3$, $R^4$ = O—$CH_2$—O
*Vb*, $R^1$ = H ; $R^2$ = COOH ; $R^3$ = F ; $R^4$ = Cl
*Vc*, $R^1$ = $R^2$ = H ; $R^3$ = F ; $R^4$ = Cl




*VIa*, X = CO
*VIb*, X = single bond
*VIc*, X = S




*VII*

Compound *VIa* treated with powdered potassium hydroxide in dimethyl sulfoxide at room temperature yielded N-(1-propynyl) derivative *VII*. This fact is interesting since similar carbazole derivative *VIb* and phenothiazine derivative *VIc* have been reported to yield respective N-propadienyl derivatives under the same conditions[6,7]. Compound *IVd* did not change even under these conditions. Compounds *IVf* and *IVg* treated with potassium hydroxide in dimethyl sulfoxide at room temperature yielded primarily mixtures of the starting materials and the respective N-propadienyl derivatives which after prolonged treatment and/or at higher temperatures provide complex mixtures. Various attempts to induce further isomerizatin of N-propadienyl derivatives *Va* and *Vb* to the respective N-(1-propynyl) derivatives failed; potassium hydroxide in dimethyl sulfoxide and sodium hydride in N,N-dimethylformamide caused decomposition and tar product formation.

All the prepared compounds were tested for their antimicrobial activity in vitro at the Department of Microbiology of the Institute (Dr V. Holá, Head). Oxolinic acid[2] was used as a standard. The minimum inhibitory concentrations in mg/l are given unless they exceed 128 mg/l in Table I which summarizes the in vitro activity against gram-positive bacteria (*Staphylococcus aureus* 1/45, *Steptococcus pyogénes* 4/49, *Streptococcus faecalis* D 16/66) and gram-negative organisms (*Escherichia coli* 326/61, *Proteus vulgaris* 2/35, *Pseudomonas aeruginosa* 26/56). The organisms are from the State Collection of Strains, Prague.

It is evident that all compounds without 1-substituted 1,4-dihydro-4-oxoquinoline--3-carboxylic acid moiety lack antibacterial activity. Acids *IVf*, *IVg*, *Va*, and *Vb* are active against gram-negative bacteria with the exception of *P. aeruginosa* but inactive against gram-positives. N-Propadienyl derivatives *Va* and *Vb* are more active than the corresponding N-(2-propynyl) derivatives *IVf* and *IVg* but their activity is lower than the activity of oxolinic acid.

TABLE I

In vitro antibacterial activity (MIC given in mg/l)

| Organisms | OA | *IVf* | *IVg* | *Va* | *Vb* |
|---|---|---|---|---|---|
| *S. aureus* | 4 | 64 | >128 | 128 | 64 |
| *S. pyogenes* | 32 | >128 | >128 | >128 | >128 |
| *S. faecalis* | 32 | >128 | >128 | 128 | 128 |
| *E. coli* | 2 | 32 | >128 | 8 | 32 |
| *P. vulgaris* | <1 | 4 | 16 | 2 | 4 |
| *P. aeruginosa* | 32 | >128 | >128 | >128 | >128 |

OA oxolinic acid.

## EXPERIMENTAL

The melting points were determined on a Mettler FP 5 apparatus, those exceeding 300°C were determined on a Kofler block, and were not corrected. IR spectra were taken on a Unicam SP-2006 spectrometer in KBr pellets, unless otherwise stated; wavenumbers are given in $cm^{-1}$. UV spectra were taken on a Unicam PU 8800 spectrophotometer in ethanol, molar absorption coefficients ($\varepsilon$) are given in $m^2\ mol^{-1}$, wavelengths ($\lambda$) in nm. Mass spectra were measured on MCH 1 320 and MAT 44 S spectrometers. $^1H$ NMR spectra (100 MHz) and $^{13}C$ NMR spectra (25·14 MHz) were measured on an apparatus BS-487 (Tesla Brno) 100 MHz in hexadeuterated dimethylsulfoxide ($^{13}C$ NMR at 100°C). The standard for $^1H$ NMR spectra was 3-trimethylsilylpropionic acid, unless otherwise stated, the $^{13}C$ NMR spectra were calculated on tetramethylsilane. Chemical shifts are given in ppm ($\delta$-scale), coupling constants ($J$) in Hz. The assignments indicated by an asterisk may be interchanged.

Results of IR (Table II), UV (Table III). $^1H$ NMR (Table IV), and $^{13}C$ NMR spectra (Table V) of selected compounds were in accordance with the proposed structures.

### 7-Chloro-6-fluoro-1,4-dihydro-4-oxoquinoline-3-carboxylic Acid (*IIIc*)

A mixture of *IIIb* (5·4 g, 20 mmol), sodium hydroxide (4 g, 0·1 mol), and water (50 ml) was refluxed for 4 h, the cloudy solution was filtered and acidified with acetic acid. The precipitate was filtered off, washed with water and crystallized from N,N-dimethylformamide; yield 3·3 g (68%), m.p. 285—287 (decomp.). For $C_{10}H_5ClFNO_3$ (241·6) calculated: 49·71% C, 2·09% H, 14·67% Cl, 7·86% F, 5·80% N; found: 49·73% C, 2·02% H, 14·61% Cl, 8·04% F, 5·45% N.

### 7-Chloro-6-fluoro-1*H*-quinolin-4-one (*IIId*)

A mixture of *IIIc* (9·6 g, 40 mmol) and diphenyl ether (100 g) was refluxed for 6 h, at 30°C was added hexane (500 ml) and the mixture was left stand overnight, then the solid was filtered off and washed with hexane. Crystallization from methanol using charcoal provided 5·8 g (73%) of white crystals m.p. 283—298 (decomp.). For $C_9H_5ClFNO$ (197·6) calculated: 54·71% C, 2·55% H, 17·94% Cl, 9·61% F, 7·09% N; found: 54·68% C, 2·62% H, 17·88% Cl, 9·76% F, 7·12% N.

### General Procedure for Preparation of *IVa—IVe*

A mixture of the starting material (Table VI) (10 mmol), potassium carbonate (2·1 g, 15 mmol) and dimethyl sulfoxide (25 ml) was stirred at 70°C, then 3-bromopropyne (2·4 g, 20 mmol) was added over 1 h followed by stirring for additional 5 h at this temperature. The mixture was poured into water (100 ml), the separated solid was filtered off and crystallized from a suitable solvent using charcoal (Table VI).

### 1,4-Dihydro-6,7-methylenedioxy-4-oxo-1-(2-propynyl)quinoline-3-carboxylic acid (*IVf*)

A mixture of *IVa* (3·0 g, 10 mmol), acetic acid (15 ml), and concentrated hydrochloric acid (15 mmol) was refluxed for 8 h, the mixture was diluted by water (50 ml) and cooled down. The solid was filtered off and crystallized from acetic acid; yield 2·4 g (88%), m.p. 241—244°C. For $C_{14}H_9NO_5$ (271·2) calculated: 62·00% C, 3·34% H, 5·16% N; found: 61·78% C, 3·46% H, 5·25% N. Mass spectrum: ($m/z$): 271 ($M^+$).

TABLE II
IR spectra of prepared compounds

| Compound | ≡C—H | C≡C | COO | C=O | —O—$CH_2$—O— |
|---|---|---|---|---|---|
| *IIId* | — | — | — | 1 600 | — |
| *IVa* | 3 200 | 2 100 | 1 720 | 1 670 | 1 220, 1 050 |
| *IVb* | 3 200 | 2 120 | 1 720 | 1 680 | — |
| *IVc* | 3 290 | 2 220 | — | 1 620 | — |
| *IVd* | 3 260 | 2 110 | — | 1 600 | — |
| *IVe* | 3 180 | 2 118 | 1 712 | 1 589 | — |
| *IVf* | 3 250 | 2 130 | 1 700 | 1 625 | 1 210, 1 050 |
| *IVg* | 3 250 | 2 120 | 1 700 | 1 605 | — |
| *IVh* | 3 155 | 2 118 | 1 622 | 1 597 | — |
| *Va* | — | — | 1 695 | 1 625 | 1 220, 1 040 |
| *Vb* | — | — | 1 715 | 1 600 | — |
| *Vc* | — | — | — | 1 605 | — |
| *VIa* | 3 220 | 2 100 | — | 1 600 | — |
| *VII* | — | 2 240 | — | 1 640 | — |

TABLE III
UV spectra of prepared compounds

| Compound | $\lambda_{max}$ (log $\varepsilon$) |
|---|---|
| *IIId* | 338 (3·00), 324 (3·00), 289 (2·49), 277 (2·45), 247 (3·34), 240 (3·37), 208 (3·39) |
| *IVa* | 336 (3·10), 321 (3·07), 265 (3·49), 252 (3·52), 218 (3·28) |
| *IVb* | 332 (3·03), 320 (3·05), 304[a] (2·97), 260 (3·37), 250 (3·34), 213 (3·40) |
| *IVc* | 342 (3·10), 328 (3·06), 287 (2·33), 276 (2·39), 250 (3·34), 243 (3·37), 209 (3·40) |
| *IVd* | 309 (2·14), 273 (2·80), 224 (3·82) |
| *IVe* | 287 (3·02), 236 (3·64), 212 (3·39) |
| *IVf* | 334 (3·02), 320 (2·99), 262 (3·49), 255 (3·52), 218 (3·13) |
| *IVg* | 332 (2·93), 321[a] (2·89), 259 (3·32), 250 (3·28), 213 (3·26) |
| *IVh* | 295 (2·79), 243 (3·38), 234 (3·60) |
| *Va* | 337 (3·02), 328[a] (2·99), 259 (3·44), 225 (3·20) |
| *Vb* | 335 (2·99), 260 (3·37), 252 (3·35), 219 (3·40) |
| *Vc* | 344 (3·02), 330 (3·03), 243 (3·37), 208 (3·36) |
| *VIa* | 394 (3·00), 376 (2·93), 288 (2·37), 252 (3·73) |
| *VII* | 386 (2·69), 251 (3·39), 214 (3·05) |

[a] $\lambda_{infl.}$

7-Chloro-6-fluoro-1,4-dihydro-4-oxo-1-(2-propynyl)quinoline-3-carboxylic Acid (*IVg*)

A mixture of *IVb* (3·1 g, 10 mmol), acetic acid (20 ml), and concentrated hydrochloric acid (20 ml) was refluxed for 4 h, the mixture was cooled down and the solid was filtered off and washed with water. Crystallization from acetic acid yielded 2·4 g (86%), m.p. 225–229°C (decomp.). For $C_{13}H_7ClFNO_3$ (279·7) calculated: 55·83% C, 2·52% H, 12·68% Cl, 6·79% F, 5·01% N; found: 55·25% C, 2·57% H, 13·01% Cl, 6·95% F, 4·86% N. Mass spectrum (*m/z*): 279 ($M^+$).

TABLE IV

$^1$H NMR spectra of prepared compounds

| Compound | Data |
|---|---|
| *IVb* | 1·32 t, 3 H ($CH_3$, $J$ = 7·0); 3·58 t, 1 H (C≡CH, $J$ = 2·0); 4·28 q, 2 H ($CH_2$, $J$ = 7·0); 5·35 d, 1 H (N—$CH_2$, $J$ = 2·0); 8·08 d, 1 H (H-5, $J$(H, F) = 9·0); 8·12 d, 1 H (H-8, $J$(H, F) = 6·0); 8·80 s, 1 H (H-2) |
| *IVc* | 3·63 t, 1 H (C≡CH, $J$ = 1·5); 5·02 d, 2 H (N—$CH_2$, $J$ = 1·5); 6·15 d, 1 H (H-3, $J$ = 8·0); 7·90M8·20 m, 3 H (H-2, H-5, H-8) |
| *IVd* | 2·64 s, 3 H ($CH_3$); 3·75 (t, 1 H (C≡CH, $J$ = 1·5); 5·13 d, 2 H (N—$CH_2$, $J$ = 1·5); 7·03 s, 1 H (H-3); 7·51 t, 1 H (H-6); 7·74 t, 1 H (H-7); 7·90 d, 1 H (H-8); 8·10 d, 1 H (H-5) |
| *IVe* | 1·33 t, 3 H ($CH_3$, $J$ = 7·0); 3·80 t, 1 H (C≡CH, $J$ = 2·0); 4·48 q, 2 H ($CH_2$, $J$ = 7·0); 5·28 d, 2 H (N—$CH_2$, $J$ = 2·0); 7·70 s, 1 H (H-3); 7·80–8·30 m, 4 H (H-5, H-6, H-7, H-8) |
| *IVf* | 3·74 t, 1 H (C≡CH, $J$ = 2·0); 5·50 d, 2 H (N—$CH_2$, $J$ = 2·0); 6·36 s, 2 H (—O—$CH_2$—O—); 7·60 s, 1 H (H-8); 7·68 s, 1 H (H-5); 9·08 s, 1 H (H-2) |
| *IVg* | 3·80 t, 1 H (C≡CH, $J$ = 3·0); 5·55 d, 2 H (N—$CH_2$, $J$ = 3·0); 8·23 d, 1 H (H-5, $J$(H, F) = 9·0); 8·40 d, 1 H (H-8, $J$(H, F) = 6·0); 9·24 s, 1 H (H-2) |
| *IVh* | 3·80 t, 1 H (C≡CH, $J$ = 2·0); 5·28 d, 2 H (N—$CH_2$, $J$ = 2·0); 7·70 s, 1 H (H-3); 7·70–8·30 m, 4 H (H-5, H-6, H-7, H-8) |
| *Va* | 5·96 d, 2 H (C=$CH_2$, $J$ = 6·0); 6·30 s, 2 H (—O—$CH_2$—O—), 7·62 s, 1 H (H-8); 7·65 s, 1 H (H-5); 7·68 t, 1 H (N—CH, $J$ = 6·0); 8·67 s, 1 H (H-2) |
| *Vb* | 6·05 d, 2 H (C=$CH_2$, $J$ = 6·0); 7·90 t, 1 H (N—CH, $J$ = 6·0); 8·24 d, 1 H (H-5, $J$(H, F) = 9·0); 8·52 d, 1 H (H-8, $J$(H, F) = 6·0); 8·82 s, 1 H (H-2) |
| *Vc* | 5·88 d, 2 H (C=$CH_2$, $J$ = 6·0); 6·25 d, 1 H (H-3, $J$ = 7·0); 7·78 t, 1 H (N—CH, $J$ = 6·0); 7·98 d, 1 H (H-5, $J$(H, F) = 10·0); 8·00 d, 1 H (H-2, $J$ = 7·0); 8·15 d, 1 H (H-8, $J$((H, F) M 5·5) |
| *VIa* | 3·48 t, 2 H (C≡CH, $J$ = 1·5); 5·40 d, 2 H (N—$CH_2$, $J$ = 1·5); 7·40–7·90 m, 6 H (H-2, H-3, H-4, H-5, H-6, H-7); 8·40 d, 2 H (H-1, H-8) |
| *VII* | 2·32 s, 3 H ($CH_3$); 7·64–7·92 m, 6 H (H-2, H-3, H-4, H-5, H-6, H-7); 8·32 m, 2 H (H-1, H-8) |

TABLE V
$^{13}C$ NMR spectra of compounds *IVf*, *IVh*, *Va* and *Vb*

| Compound | Data |
|---|---|
| *IVf* | 43·40 t (N—$CH_2$), 76·26 d (—C≡), 78·50 d (≡C—H), 96·73 d (C-8)*, 101·59 d (C-5)*, 102·78 t (—O—$CH_2$—O—), 107·79 s (C-3), 121·08 s (C-4a), 136·54 s (C-8a), 146·33 d (C-2), 146·85 s (C-6), 153·05 s (C-7), 165·23 s (COOH), 175·98 s (C-4) |
| *IVh* | 56·47 t (N—$CH_2$), 77·46 s (—C≡), 78·73 d (≡C—H), 100·91 d (C-3), 121·08 d (C-6), 121·08 s (C-4a), 127·36 d (C-8)*, 128·85 d (C-5)*, 130·27 d (C-7), 147·23 s (C-2), 149·62 s (C-8a), 160·60 s (COOH), 165·53 (C-4) |
| *Va* | 88·36 t =$CH_2$), 96·73 d (C-8)*, 100·09 d (N—CH=), 101·44 d (C-5)*, 102·78 t (—O—$CH_2$—O—), 108·01 s (C-3), 120·56 s (C-4a), 136·69 s (C-8a), 144·46 d (C-2), 146·93 s (C-6), 153·20 s (C-7), 164·93 s (COOH), 175·91 s (C-4), 204·29 s (=C=) |
| *Vb* | 88·81 t (=$CH_2$), 99·87 d (N—CH=), 108·76 s (C-3), 111·56 d (C-5, $J$(C, F) = 22), 120·51 s (C-4a), 120·08 d (C-8), 125·26 s (C-8a), 127·31 s (C-7, $J$(C, F) = 20), 147·08 d (C-2), 154·85 s (C-6, $J$(C, F) = 240), 164·18 s (COOH), 176·28 s (C-4), 204·39 (=C=) |

TABLE VI
Characteristics of compounds *IVa*—*IVe*

| Product/Starting Yield, % | M.p., °C solvent | Formula (M.w.) | Calculated/Found | | | | |
|---|---|---|---|---|---|---|---|
| | | | % C | % H | % Cl | % F | % N |
| *IVa*/*IIIa* | 201—205[a] | $C_{16}H_{13}NO_5$ | 64·21 | 4·38 | — | — | 4·68 |
| 90 | acetic acid | (299·3) | 64·06 | 4·36 | — | — | 4·82 |
| *IVb*/*IIIb* | 216—220 | $C_{15}H_{11}ClFNO_3$ | 58·5 | 3·60 | 11·52 | 6·17 | 4·55 |
| 84 | ethanol | (307·7) | 58·46 | 3·51 | 11·34 | 6·48 | 4·42 |
| *IVc*/*IIId* | 198—201 | $C_{12}H_7ClFNO$ | 61·16 | 2·99 | 15·05 | 8·06 | 5·94 |
| 68 | methanol | (235·6) | 61·17 | 2·99 | 15·22 | 8·10 | 5·80 |
| *IVd*/*IIIe* | 72—74 | $C_{13}H_{11}NO$ | 79·17 | 5·62 | — | — | 7·10 |
| 53 | water | (197·2) | 78·76 | 5·53 | — | — | 6·83 |
| *IVe*/*IIIf* | 143—144 | $C_{15}H_{13}NO_3$ | 70·58 | 5·13 | — | — | 5·49 |
| 67 | DMF | (255·3) | 70·27 | 5·07 | — | — | 5·09 |

[a] Decomposition.

1,4-Dihydro-4-oxo-1-(2-propynyl)quinoline-2-carboxylic Acid (*IVh*)

Compound *IVe* (0·6 g, 2·4 mmol) was suspended in a solution of sodium hydroxide (2 g, 50 mmol) in water (10 ml) and ethanol (10 ml) and the mixture was stirred at room temperature for 4 h. Then the mixture was acidified with hydrochloric acid and evaporated to dryness, the residue was treated with water, the solid was filtered off, washed with water and crystallized from ethanol using charcoal; yield 0·35 g (65%), m.p. 165–171°C (decomp.). For $C_{13}H_9NO_3$ (227·2) calculated: 68·72% C, 3·99% H, 6·16% N; found: 68·99% C, 4·19% H, 5·90% N. Mass spectrum (*m/z*): 227 ($M^+$).

1,4-Dihydro-6,7-methylenedioxy-4-oxo-1-propadienylquinoline-3-carboxylic Acid (*Va*)

A solution of *IVa* (0·27 g, 1 mmol) in 10% aqueous solution of sodium hydrogen carbonate (5 ml) was refluxed for 1 h, the reaction mixture was cooled down, acidified with acetic acid and the formed precipitate was filtered off and crystallized from acetic acid; yield 0·21 g (78%). The crystals initially melted (225–232°C), then decomposed to a solid not melting up to 360°C. For $C_{14}H_9NO_5$ (271·2) calculated: 62·00% C, 3·34% H, 5·16% N; found: 61·32% C, 3·37% H, 5·35% N. Mass spectrum (*m/z*): 271 ($M^+$).

7-Chloro-6-fluoro-1,4-dihydro-4-oxo-1-propadienylquinoline-3-carboxylic Acid (*Vb*)

A mixture of *IVg* (1·4 g, 5 mmol), sodium hydrogen carbonate (2 g, 24 mmol), water (10 ml) and ethanol (10 ml) was stirred at room temperature for 1 h and then refluxed for 4 h. The mixture was cooled down, the precipitate was filtered off and crystallized from acetic acid; yield 1·2 g (86%), m.p. 248–251°C. For $C_{13}H_7ClFNO_3$ (279·7) calculated: 55·83% C, 2·52% H, 12·68% Cl, 6·79% F, 5·01% N; found: 55·56% C, 2·59% H, 12·41% Cl, 6·64% F, 4·75% N. Mass spectrum (*m/z*): 279 ($M^+$).

7-Chloro-6-fluoro-1-propadienyl-1*H*-quinolin-4-one (*Vc*)

A mixture of *IVc* (0·24 g, 1 mmol), sodium hydrogen carbonate (0·16 g, 2 mmol), water (1 ml) and ethanol (5 ml) was refluxed for 6 h, then cooled down, the formed precipitate was filtered off and crystallized from 50% aqueous ethanol; yield 0·2 g (83%), m.p. 225–227°C. For $C_{12}H_7$. .ClFNO (235·6) calculated: 61·16% C, 2·99% H, 15·05% Cl, 8·06% F, 5·94% N; found: 60·54% C, 3·15% H, 14·66% Cl, 7·92% F, 5·80% N.

10-(2-Propynyl)-9-acridanone (*VIa*)

To a stirred solution of 9-acridanone (1·95 g, 10 mmol), potassium carbonate (2·1 g, 15 mmol) and dimethyl sulfoxide (20 ml) at 70°C was during 1 h added dropwise 3-bromopropyne (2·4 g, 20 mmol) and the mixture was stirred at this temperature for additional 10 h, the mixture was poured into water (100 ml), the formed precipitate was filtered off, washed with water and crystallized from ethanol; yield 1·70 g (73%), m.p. 220–224°C. Ref.[16] gave m.p. 219°C. For $C_{16}H_{11}NO$ (233·3) calculated: 82·38% C, 4·75% H, 6·00% N; found: 82·03% C, 4·76% H, 5·67% N.

10-(1-Propynyl)-9-acridanone (*VII*)

A mixture of *VIa* (0·46 g, 2 mmol), powdered potassium hydroxide (0·02 g, 3·5 mmol), and dimethyl sulfoxide (10 ml) was stirred at room temperature for 1 h, then the mixture was poured into water (50 ml) and the precipitate was filtered off and washed with water. Crystallization

from ethanol provided 0·35 g (76%) of yellow needles, m.p. 211—213°C (Ref.[16] gave m.p. 213°C). For $C_{16}H_{11}NO$ (233·3) calculated: 82·38% C, 4·75% H, 6·00% N; found: 81·89% C, 4·85% H, 5·40% N.

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Translated by the author (S. R.)