

auf Grösse und Gitterordnung der Kristalle zu erkennen⁸⁻¹¹. Die Ergebnisse dieser Untersuchungen zeigen, dass formelechte Kristalle von Hydroxylapatit, Fluorapatit, Tricalciumphosphat (Whitlockit) und Oktacalciumphosphat gewonnen werden können. Die betreffenden Reaktionsbedingungen sind diffizil, so dass die Bildung einer formelechten Verbindung im biologischen Milieu nicht erfolgt.

Röntgenographische und elektronenmikroskopische Untersuchungen an Knochenkompakta zeigen, dass die Mineralsubstanz mikrokristallin vorliegt, ferner, dass der Gitteraufbau der Kristalle durch Gitterstörungen gekennzeichnet ist. Aus den Beugungsdiagrammen geht jedoch eindeutig hervor, dass dem Knochenmineral die Apatitstruktur zugrunde liegt. Die veränderten Löslichkeitseigenschaften, sowie eine von der idealen Formel des Apatits $\text{Ca}_{10}(\text{PO}_4)_6(\text{OH})_2$ abweichende Bruttozusammensetzung der Mineralsubstanz des Knochens sind durch eben jene Gitterstörungen bedingt.

Aus einem hierbei zufällig auftretenden Ca/P-Verhältnis von etwa 1,5 (anstelle $10:6=1,67$) bzw. dem entsprechenden Base-Calciumquotienten allein kann man nicht schliessen, dass $\text{Ca}_3(\text{PO}_4)_2$ vorliegt, welches in wässrigem Medium nur in der von Apatit vollkommen verschiedenen Struktur des Whitlockit existenzfähig ist.

Die Identifizierung des kristallinen Knochenminerals mit Carbonat-Apatit ist in diesem Zusammenhang insofern gerechtfertigt, als Carbonationen neben anderen Begleitungen als Substituenten des Phosphations in das Apa-

titgitter eintreten können; der Strukturtypus Apatit des Knochenminerals bleibt hiervon unbeeinflusst.

Eingehende Untersuchungen analoger Art an Zähnen werden an anderer Stelle veröffentlicht.

Summary. Interpretations regarding the structure of the bone mineral, based on quantitative data as to the basicity of calcium phosphate, have been complemented by X-ray and electron microscopic investigations. The chemical nature of the bone material is thereby thought to be substituted apatite.

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⁸ H. NEWESLY, Mh. Chemie 91, 1020 (1960).

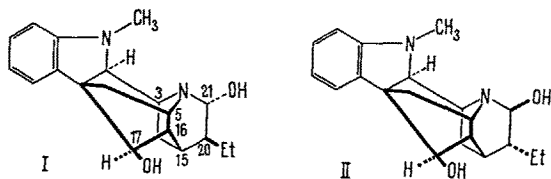
⁹ H. NEWESLY, Proceed. ORCA 8, 174 (1961) (Suppl. Arch. Oral Biol.).

¹⁰ H. NEWESLY, Angew. Chem. 73, 761 (1961).

¹¹ H. NEWESLY, Proceed. ORCA 9, 277 (1962) (Suppl. Arch. Oral Biol.); siehe auch Mh. Chemie 94, 270 (1963).

Rates of Ethiodide Formation and the Stereochemistry of Ajmaline at C-21¹

The stereochemistry of the alkaloid ajmaline and the derived base isoajmaline has been studied in detail by the CIBA Group, who concluded that ajmaline can be represented by expression I and isoajmaline by II².



The stereochemistry of the hydroxyl group at C-21 was assigned on the basis of conformational arguments. It was reasoned that since ajmaline and isoajmaline were in many cases in tautomeric equilibrium with their respective open chain aminoaldehydes, recyclization to the hydroxyquinuclidine form would result in a *trans* relationship between the C-21 hydroxyl and the C-20 ethyl substituent. Since the stereochemistry of the ethyl side chain was known with certainty in each case, stereostructures I and II were derived for ajmaline and isoajmaline respectively².

In order to verify these conclusions it was decided to measure the rates of quaternary iodide formation, as followed by conductivity measurements, for ajmaline, isoajmaline, and a number of their derivatives. Since the pseudo first-order rates of methiodide formation in acetonitrile were found to be much too fast to be followed in a number of cases, methyl iodide was replaced with the bulkier ethyl iodide, and the slower rates of ethiodide formation were determined.

From the Table it will be noticed that ajmaline and 17-acetyljmaline (Runs A and B) ethylate at a rate about twice that for the corresponding iso compounds. When the size of the C-21 substituent was increased by acetylation of the hydroxyl function (Runs C and D) the ajmaline derivatives ethylated about four times as quickly as the

Pseudo first-order rates of ethiodide formation for ajmaline, isoajmaline, and their derivatives

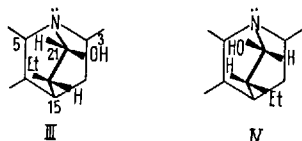
Runs	Compounds	Pseudo first-order rates $\times 10^4 \text{ sec}^{-1}$
A	Ajmaline (I)	117.6
	Isoajmaline (II)	60.7
B	17-Acetyljmaline	53.8
	17-Acetylisajmaline	27.9
C	21-Acetyljmaline	12.9
	21-Acetylisajmaline	3.2
D	17,21-Diacetyljmaline	6.1
	17,21-Diacetylisajmaline	1.5
E	21-Deoxyajmaline	694
	21-Deoxyisajmaline	648

¹ For previous papers on rates of quaternary iodide formation of alkaloids see (a) M. SHAMMA and J. B. MOSS, J. Amer. chem. Soc. 83, 5038 (1961) and (b) M. SHAMMA and E. F. WALKER JR., Chem. & Ind. 1962, 1866.

² M. F. BARTLETT, R. SKLAR, W. I. TAYLOR, E. SCHLITTLER, R. L. S. AMAL, P. BEAR, N. V. BRINGI, and E. WENKERT, J. Amer. chem. Soc. 84, 622 (1962).

iso series. Alternatively if the substituent at C-21 was replaced by hydrogen (deoxyajmaline and isodeoxyajmaline in Run E) the two rates were almost identical but with a very slight advantage in favor of deoxyajmaline.

A study of molecular models revealed that the quinclidine system in both ajmaline and isoajmaline is strained. If one looks at this system directly facing carbons 20 and 21, one observes a situation represented by expressions III or IV, where the hydrogen atom and the hydroxyl group on C-21 are not in a horizontal plane. Because of the bulk of the C-21 hydroxyl group in IV, it would be expected that the approach of the ethyl iodide molecule from the top would be slightly hindered, so that form IV should ethylate slower than III. This was indeed found to be the case since isoajmaline II or IV was half as slow as ajmaline I or III. As expected, this steric effect became more pronounced when the bulkier acetoxy derivatives were used (Runs C and D), and less important when the acetoxy group was replaced by the much smaller hydrogen atom (Run E).



These results are therefore in complete agreement with the earlier conclusions². The data also point out the usefulness of rate measurements to study relatively small steric differences in the structures of alkaloids and their derivatives.

Experimental. The apparatus used consisted of a conventional conductivity cell with black platinized electrodes purchased from the Fisher Scientific Co., a Hewlett Packard Model 200 AB audio-oscillator to furnish a 1000 cps current, a Leeds & Northrup Model 1553 shielded

ratio box, a Leeds & Northrup Model 4754 a-c decade resistance box in series with a fabricated 100 Kohm step type resistance box, a Leeds & Northrup air capacitor (nom. max. 0.001 M.F.) to balance the cell capacitance, and a Heath oscilloscope, Model 10-12, to act as a galvanometer in detecting the balance point. The equipment was assembled so that the resistance of the cell could be measured using the classical Wheatstone bridge arrangement.

The temperature was maintained at $25.0 \pm 0.1^\circ$ by suspending the cell in a constant temperature bath. The nitrogenous base (3 mg in each case) was dissolved in 10 ml of acetonitrile, and the solution introduced in the cell. 1 ml of ethyl iodide was then injected into the cell by using a graduated syringe, and a timer was started. The bridge was balanced at appropriate intervals, and the resistance and time were recorded until the reaction had gone practically to completion. The rates were calculated using the equations given in Ref.^{1a}.

Résumé. Les auteurs ont mesuré les vitesses de réaction entre l'ajmaline plus dérivés et l'iodure d'éthyle. Les conclusions stéréochimiques de TAYLOR au C-21 en ont été confirmées.

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Oxygen Isotope Paleotemperature Analyses of Lower and Middle Jurassic Fossils from Pliensbach, Württemberg (Germany)

I. Introduction. Utilizing the established techniques of O^{18}/O^{16} paleotemperature analysis¹, 22 Belemnoid specimens, 2 Pelecypod specimens and several Echinoid spines from the German Lias γ , δ and ζ and Dogger α and δ were examined. The analyses were made on an Atlas-Werke M86 mass-spectrometer using Carrara marble standard and the resultant data were corrected to refer directly to the PDB-1 Chicago standard². One of us (P. FRITZ) collected the material from the Pliensbach area near Stuttgart (Germany). The stratigraphy, lithology and thicknesses of the relevant strata are shown in Table I. The taxonomy of the specimen is included in the Table of Results (Table II).

II. Data obtained (see Tables II and III).

III. Interpretation of Data. From the Belemnoid results listed in Table II, it is evident that (assuming the mean ocean δ to have been zero in the Jurassic) the sea temperatures attained a maximum in the Upper Toarcian and Lower Bajocian from initially cooler conditions in the Pliensbachian. This maximum was followed by a decline in Upper Bajocian times. It is interesting to compare this picture with data obtained by one of us (R. BOWEN) else-

where in Germany³ and in some other countries of Western Europe⁴ (which were interconnected by seas during the part of the Jurassic under consideration). Lias ϵ (Lower Toarcian) Belemnoids from the Trimeusel locality on the Main River near Bamberg, Bavaria (Germany) gave three temperatures. These are 24.2°C , 27°C and 28.4°C . One of these is the same as an Upper Toarcian result listed in this paper, but the smallest figure is 2.8°C below the present minimum (which is derived from the Upper Toarcian). This is consistent with a gradual rising of temperature from Lower into Upper Toarcian times. From Switzerland, 3 previous determinations have been made—2 on *Belemnites tripartitus* from the Toarcian of Kanton Aargau and Canton de Vaud (readings of 27.3°C and 23.4°C respectively being obtained) and 2 on an unidentified Belemnoid from the Toarcian of Canton de Fribourg (giving 23.5°C). From France, from the Pliensbachian of the Vendée, 2 specimens of *Hastites umbilicatus* gave temperatures of 24.3°C and 24.6°C respectively. A

¹ S. EPSTEIN, R. BUCHSBAUM, H. A. LOWENSTAM, and H. C. UREY, Bull. Geol. Soc. Amer. 62, 417 (1951); 64, 1315 (1953). — H. C. UREY, H. A. LOWENSTAM, S. EPSTEIN, and C. R. MCKINNEY, Bull. Geol. Soc. Amer. 62, 399 (1951).

² The Carrara Standard has a value of -1.6‰ relative to PDB-1.

³ R. BOWEN, Experientia 19, 401 (1963).

⁴ R. BOWEN, J. Geol. 69, 309 (1961).