was found that the degree of the activities of XI toward Gram positive microorganisms was nearly the same to that of TA; with the synthetic medium, minimum concentrations of growth-inhibition for *Bacillus subtilis* are 5 μg/ml for XI and 8 μg/ml for TA, and that for *Staphylococcus aureus* are 10 μg/ml for XI and 8 μg/ml for TA. The results indicates that the L-tyrosine residue in TA can be replaced by L-phenylalanine without an influence for the activity.

Zusammenfassung. Die Synthese des dem Tyrocidin E entsprechenden, zyklischen Dekapeptids, eines bei der Zyklisierung des aktiven Esters linearen Dekapeptids, wird beschrieben.

N. MITSUYASU and N. IZUMIYA

Laboratory of Biochemistry, Faculty of Science, Kyushu University, Fukuoka (Japan), 17 November 1969.

Chemical Investigation of *Abroma augusta* Linn. Identity of Abromine with Betaine

Abroma augusta Linn. (*Ulatkambal*, N.O. Sterculiaceae), a small tree growing wild in India, is a popular medicine in the indigenous systems. The root and root-bark are reputed remedies as an emmenagogue for congestive and nervous dysmenorrhoea, and the leaves and stems are reported to be very efficacious in gonorrhoea. The root was reported to contain an alkaloid, abromine[1], $C_6H_{13}NO_2$, mp 283–285°; a sterol, $C_{30}H_{52}O_2$, mp 153–157°; friedelin[2] and abromasterol A, mp 125.5°. A recent short communication[3] reporting the isolation of taraxeryl acetate, taraxerol, β-sitosterol and a low melting neutral compound from the petroleum ether extract of the leaves, prompts us to report here the chemical work[13] we have been carrying out on the roots and leaves of this plant to explain its pharmacodynamic activity[4,5] and to characterize the alkaloid, abromine, and the sterols isolated previously.

The quaternary bases isolated as reineckates by the procedure followed in *Pluchea lanceolata*[6], were found to contain choline, betaine and a base yielding a picrate, mp 223–227°[7]. The method of isolation of abromine[1] and the reported mp of its derivatives indicate beyond doubt its identity with betaine in view of our isolation of the latter from the roots. The non-volatile, non-saponifiable fraction of the petroleum ether extract of the roots on chromatography over aluminium oxide yielded 2 sterols giving a violet to green colour (through blue) with Liebermann-Burchard reagent. These were identified as β-sitosterol (m/e 414 M^+) and stigmasterol (m/e 412 M^+).

The petroleum ether extract of the leaves of *A. augusta* on similar treatment yielded the following 5 compounds having different Rf values as revealed by thin-layer chromatography (SiO_2; C_6H_6:$CHCl_3$, 1:1; I_2 vapour or AC_2O–H_2SO_4–EtOH mixture as developer):

1. Compound A from petroleum ether eluant, granular solid, mp 84–85° (EtOAC), Rf 0.35 (I_2 vapour) identical spot with octacosanol, freely soluble in pet. ether, C_6H_6, and gave no colouration with Liebermann-Burchard reagent. Found[8]: C, 81.42, 81.30; H, 14.22, 14.10. $C_{28}H_{58}O$ requires: C, 81.87; H, 14.23. IR[9]-absorption peaks at 3220 (OH), 2860, 1465, 1400, 1380, 1125, 1075, 1065, 1020, 735 and 722 [$-(CH_2)_n$-rocking split] cm^{-1} in Nujol, which compared favourably well with those of octacosanol. NMR-spectrum in $CHCl_3$ showed a prominent peak at 1.25 δ due to methylene protons and small peaks at 0.9 δ and 3.65 δ. The mass spectrum exhibited prominent higher mass peaks at m/e 392 (M-18) and 422 (M'-28) with smaller mass peaks at m/e 450, 451, 436, 423, 408, 407, 394, 393, 378, etc. The general fragmentation pattern of the mass spectrum indicated[10] the compound A to be a mixture of octacosanol, $C_{28}H_{58}O$ (M-410) and the alkane, $C_{32}H_{66}$ (M'-450), the former predominating.

2. Compound B from pet. ether eluant, fine needles, mp 260–268° (pet. ether), Rf 0.95, soluble in pet. ether, C_6H_6, $CHCl_3$, gave a pink colour with Liebermann-Burchard reagent. IR-spectrum was very similar to that of compound C with additional absorptions at 3250 cm^{-1} (primary OH) and 722 and 735 cm^{-1} [$-(CH_2)_n$-rocking split]. NMR-spectrum in $CHCl_3$ showed a prominent methylene proton peak at 1.25 δ and methyl proton peaks at 0.82, 0.95, 1.1 and 1.6 δ. A comparative study of the IR-, NMR- and mass-spectra indicated the compound to be a mixture of taraxerol[11] [m/e 426 (M), 411 (M-CH_3), 302 (K), 287 (K'), 284 (K-H_2O), 204 (1), 189 (1-CH_3) and an aliphatic alcohol[10], $C_{32}H_{66}O$ [m/e 448 (M-18), 420 (M-18-28), 392 (M-18-2×28)].

3. Compound C from pet.ether:C_6H_6 (1:1) eluant, crystalline rods, mp 279–280° (C_6H_6), Rf 0.91, sparingly soluble in C_6H_6, $CHCl_3$, insoluble in pet. ether, soluble in acetone, ethyl acetate and alcohol and gave a pink colour with Liebermann-Burchard reagent. The mass-spectrum exhibited the usual fragmentation pattern of taraxerol[11]. The identity of the compound with taraxerol was confirmed by comparison of mp, mixed mp of the alcohol and its acetate and IR-spectrum with those of an authentic sample[12].

4. Compound D from C_6H_6 and $CHCl_3$ eluants, needles, mp 134–135° (alcohol), Rf 0.28, gave a violet to blue to green colour with Liebermann-Burchard reagent, formed an acetate, mp 127–128° which did not show any depression in mixed mp with the acetate of β-sitosterol.

[1] G. P. SRIVASTAVA and N. K. BASU, Ind. J. Pharmacy. *18*, 472 (1956).
[2] S. ALI, A. M. AHSAN and G. HANN, Pakist. J. scient. ind. Res. *1*, 305 (1958).
[3] N. ADITYACHAUDHURY and P. K. GUPTA, J. Ind. chem. Soc. *46*, 849 (1969).
[4] S. K. BHATTACHARYA, R. LAL and P. K. DAS, Ind. J. Pharmac. *1*, 7 (1969).
[5] S. K. BHATTACHARYA, R. LAL, K. BASU and P. K. DAS, J. Res. ind. Med., 4, 176 (1970).
[6] B. DASGUPTA, Experientia *23*, 989 (1967).
[7] B. DASGUPTA, K. BASU and S. DASGUPTA, Experientia *24*, 882 (1968).
[8] Microanalyses were done by Dr. F. B. STRAUSS, Microanalytical Laboratory, Oxford (England) and Central Drug Research Institute, Lucknow (India).
[9] All IR-, NMR- and mass-spectra were scanned by the National Chemical Laboratory, Poona (India).
[10] H. BUDZIKIEWICZ, C. DJERASSI and D. H. WILLIAMS, *Interpretation of Mass Spectra of Organic Compounds* (Holden-Day, San Francisco 1964), p. 32.
[11] H. BUDZIKIEWICZ, J. M. WILSON and C. DJERASSI, J. Am. chem. Soc. *85*, 3688 (1963).
[12] Grateful thanks are due to Prof. L. R. Row, Andra University, Waltair (India), for supply of authentic samples of taraxerol and its acetate with IR-absorption curves.

5. Compound E from alcohol eluant, needles, mp 102–104° (alcohol), Rf 0, insoluble in pet. ether, no colour with Liebermann-Burchard reagent. Found[8]: C, 78.92, 79.01; H, 13.69, 13.81. Calcd. for $C_{26}H_{54}O_2$: C, 78.32; H, 13.65; $C_{28}H_{58}O_2$: C, 78.80; H, 13.70. NMR-spectrum exhibited a strong methylene proton peak at 1.3 δ and a small peak at 1.55 δ. IR-spectrum showed the presence of 2 types of OH (3440 and 3200 cm^{-1}) and a $-(CH_2)_n$-group (722 cm^{-1} due to CH_2 rocking) besides other prominent peaks at 880, 1085, 1110, 1140, 1335 and a hump at 1550–1700 cm^{-1} in Nujol. Mass-spectrum showed a strong mass m/e 367 with other small mass fragments m/e 409, 396, 395, 390, 381, 368, 362, 353, 340, 339, 334, etc. and indicated that the compound was probably a mixture of long-chain fatty diols, $C_{26}H_{54}O_2$ and $C_{28}H_{58}O_2$.

Zusammenfassung. Isolierung und Charakterisierung verschiedener Stoffe aus der indischen Pflanze *Abroma augusta* Linn.

B. DASGUPTA and KRISHNA BASU

Department of Medicinal Chemistry,
Research and Post Graduate Institute of Indian Medicine,
Banaras Hindu University,
Varanasi-5 (India), 1 December 1969.

[13] This investigation forms a part of the work under the Composite Drug Research Scheme of Indian Council of Medical Research.

Transport of Oxygen through Membranes Containing Haemoglobin Solutions

Transport of oxygen through membranes containing haemoglobin has been studied experimentally by SCHOLANDER et al.[1,2]. It has been shown that, in the presence of haemoglobin, oxygen moves through the membrane several times faster than it would otherwise do. The results of SCHOLANDER et al. have been theoretically discussed by WANG[3], and FATT and LA FORCE[4]. It is only recently that a non-equilibrium thermodynamic analysis[5] of SCHOLANDER's results has been attempted; but while doing this, the cross coefficients, relating flows to non-conjugated forces, have been neglected. This is obviously not in keeping with the linear formalism of thermodynamic theory of irreversible processes and influences the analysis approximately.

The present communication, therefore, aims at giving a thermodynamic analysis of facilitated transport of oxygen, taking into account the cross-coefficients relating flows to the non-conjugated forces.

The system used by SCHOLANDER for his investigation can be schematically represented as in the Figure. The membrane is composed of a filter soaked in a solution of haemoglobin. Oxygen gas at different pressures p^{I} and p^{II}, p^{I} being greater than p^{II}, is placed in the compartments on the 2 sides of the membrane. When oxygen passes through the membrane, some of it combines with the haemoglobin in the membrane by the following reaction:

$$n\,O_2 + Hb \rightleftharpoons HbO_{2n}. \tag{1}$$

It can be seen that the oxygen within the membrane may move in the form of HbO_{2n} as well as in the form of dissolved free oxygen. If the rate of the chemical reaction (1) is sufficiently much more rapid than that of diffusion, the chemical reaction (1) can be taken to be at equilibrium at every point in the membrane, i.e. affinity A of the reaction (1) can be taken to be zero. Therefore, we can write:

$$n\,\mu_1 + \mu_2 = \mu_3 \tag{2}$$

where μ stands for the chemical potential and the subscripts 1, 2 and 3 represent oxygen, haemoglobin and oxyhaemoglobin, respectively.

The dissipation function ϕ for the system like the one described above, can be written as[5]

$$\phi = J_1\,grad(-\mu_1) + J_2\,grad(-\mu_2) + J_3\,grad(-\mu_3) \tag{3}$$

where J's represent the fluxes of the species denoted by the respective subscripts. The linear phenomenological relations can now be written as

$$\left.\begin{aligned} J_1 &= -L_{11}\,grad\,\mu_1 - L_{12}\,grad\,\mu_2 - L_{13}\,grad\,\mu_3 \\ J_2 &= -L_{21}\,grad\,\mu_1 - L_{22}\,grad\,\mu_2 - L_{23}\,grad\,\mu_3 \\ J_3 &= -L_{31}\,grad\,\mu_1 - L_{32}\,grad\,\mu_2 - L_{33}\,grad\,\mu_3 \end{aligned}\right\} \tag{4}$$

where L's are the Onsager's coefficients. We know that under steady state conditions, the externally measured overall flow of oxygen, J_1^T, is constant throughout the system. J_1^T must, therefore, be equal to the total transport within the membrane. Hence, we can write for the steady state

$$J_1^T = J_1 + nJ_3. \tag{5}$$

Since the dependence of chemical potential on position is due to the local changes in the concentrations of oxygen, haemoglobin and oxyhaemoglobin, we can write:

$$\left.\begin{aligned} grad\,\mu_1 &= \mu_{11}\,grad\,c_1 + \mu_{12}\,grad\,c_2 + \mu_{13}\,grad\,c_3 \\ grad\,\mu_2 &= \mu_{21}\,grad\,c_1 + \mu_{22}\,grad\,c_2 + \mu_{23}\,grad\,c_3 \\ grad\,\mu_3 &= \mu_{31}\,grad\,c_1 + \mu_{32}\,grad\,c_2 + \mu_{33}\,grad\,c_3 \end{aligned}\right\} \tag{6}$$

where $\mu_{ij} = \partial\mu_i/\partial C_j$ and C_1, C_2 and C_3 represent the concentrations of oxygen, haemoglobin and oxyhaemoglobin respectively. From equations (4), (5) and (6) we can now write:

$$\left.\begin{aligned} J_1^T = &-\{(L_{11}+nL_{31})\,\mu_{11} + (L_{12}+nL_{32})\,\mu_{21} \\ &+ (L_{13}+nL_{33})\,\mu_{31}\}\,grad\,C_1 \\ &-\{(L_{11}+nL_{31})\,\mu_{12} + (L_{12}+nL_{32})\,\mu_{22} \\ &+ (L_{13}+nL_{33})\,\mu_{32}\}\,grad\,C_2 \\ &-\{(L_{11}+nL_{31})\,\mu_{13} + (L_{12}+nL_{32})\,\mu_{23} \\ &+ (L_{13}+nL_{33})\,\mu_{33}\}\,grad\,C_3 \end{aligned}\right\} \tag{7}$$

[1] P. F. SCHOLANDER, Science *131*, 585 (1960).
[2] E. HEMMIGSEN and P. F. SCHOLANDER, Science *132*, 1379 (1960).
[3] J. H. WANG, Science *133*, 1770 (1961).
[4] I. FATT and R. C. LA FORCE, Science *133*, 1919 (1961).
[5] A. KATCHALSKY and P. F. CURRAN, in *Biophysics* (Harvard University Press, Cambridge 1967), p. 203.