Tetrahedron Letters No.47, pp. 4929-4932, 1968. Pergamon Press. Printed in Great Britain.

STRUCTURE OF CAPITASTERONE, A NOVEL C_{29} INSECT-MOULTING SUBSTANCE FROM *CYATHULA CAPITATA*

T. Takemoto, K. Nomoto, Y. Hikino, and H. Hikino

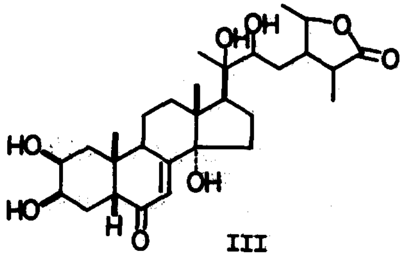
Pharmaceutical Institute, School of Medicine, Tohoku University, Sendai, Japan.

(Received in Japan 31 July 1968; received in UK for publication 20 August 1968)

The isolation of the first C_{29} insect-moulting substance cyasterone (III) from the roots of *Cyathula capitata* Moquin-Tandon (Amaranthaceae) has been recently reported.[1] Another C_{29} ecdysterol has now been isolated from the same material and named capitasterone. The present communication describes evidence leading to the expression I for capitasterone which, therefore, may be the immediate precursor of cyasterone (III).

Capitasterone, m.p. 234~235°, possesses the molecular formula $C_{29}H_{44}O_7$ (M at m/e 504) and shows positive color reactions for steroids. On acetylation, capitasterone gave the diacetate (II), m.p. 221~223°, which has no primary nor secondary free hydroxyl group.

The nucleus structure was deduced by the observations which follow. Capitasterone exhibits the following spectral properties: a UV maximum at 242 mμ, an IR band at 1644 cm^{-1}, and an NMR signal (1H) at 6.23 p.p.m.[*1] which indicate the presence of the 7-en-6-one system in the steroid skeleton. Treatment of capitasterone with hydrochloric acid in ethanol afforded a mixture of two products which showed maxima at 295 (7,14-dien-6-one) and 243 mμ (8,14-dien-6-one), respectively, the presence of the C-14 hydroxyl group being shown. In the mass spectrum of capitasterone, characteristic peaks occur at m/e 363, 345, and 327 which are due to the nucleus fragments formed by cleavage of the C-20:C-22 bond without rearrangement followed by successive dehydration. These peaks are also observed in the spectrum of cyasterone (III), indicating that the nucleus structure including the C-20 and 22 di-oxygenated system is similar to that of cyasterone. The C-2 and C-3 carbinyl hydrogen signals in the NMR spectrum of the diacetate (II) appear at 5.06 and 5.34 p.p.m. whose chemical shifts and splitting patterns are consistent with those of the acetates of the common phytoecdysones such as ecdysterone triacetate,[1] a fact which demonstrates that two hydroxyl groups are situated at C-2 and C-3 in the β-configurations. The ORD curve of capitasterone showing a positive Cotton effect (*a* +54, dioxan), which is similar to that of cya-



III

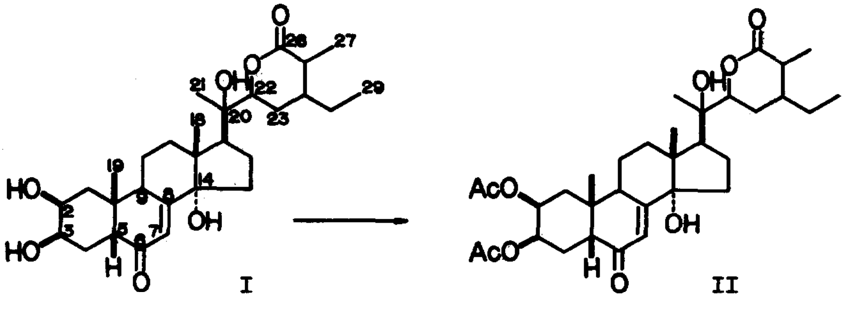
TABLE I. Methyl chemical shifts (pyridine).

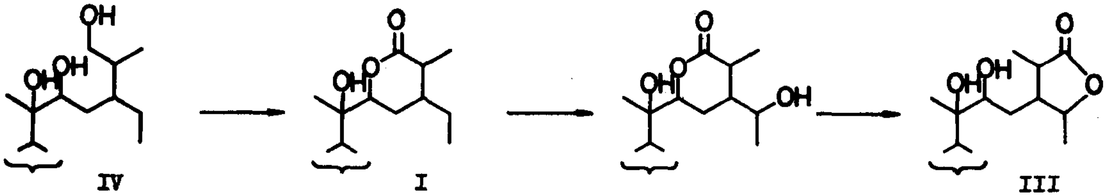
		C-18	C-19	C-21	C-26	C-27	C-29
Cyasterone	(III)[1]	1.19	1.06	1.51	--	1.33d	1.33d
Capitasterone	(I)	1.13	1.07	1.47	--	1.31d	0.72t

TABLE II. Proton signals ($CDCl_3$).

	C-2α	C-3α	C-7	C-9	C-18	C-19	C-21	C-22	C-26	C-27	C-28	C-29
Cyasterone 2,3,22-triacetate	~5.01 *	5.31 ddd	5.85 d	3.11 ddd	0.85 s	1.02 s	1.25 s	~4.98 *	--	1.28 d	4.10 dq	1.41 d
Capitasterone 2,3-diacetate	5.06 ddd	5.34 ddd	5.89 d	3.12 ddd	0.87 s	1.03 s	1.22 s	4.20 dd	--	1.32 d	--	0.94 t

* Splittings are unclear due to overlapping of the signals.





sterone (III), points to the 5β(H)-structure. These assignments were further confirmed by the chemical shifts of the C-19 methyl singlets in the NMR spectra of capitasterone and its diacetate (II) which are in agreement with those of the analogue (III) and its triacetate, respectively (Table I and II). The line positions of the C-18 methyl singlets in the NMR spectra of capitasterone and the diacetate (II) appear in the same regions to those of the congener (III) and its triacetate, respectively (Table I and II), indicating the C-14 hydroxyl to be α-oriented.

The most significant feature of capitasterone is that it contains a lactone system in a six or larger membered ring as evidenced by an IR band at 1730 cm^{-1}. Since the nucleus structure has no lactone as described above, the lactone system must be present in the side-chain. The mass spectrum of capitasterone shows a prominent peak at m/e 141 (M-363) which is corresponding to a $C_8H_{13}O_2^+$ ion and due to the side-chain fragment formed by fission of the C-20:C-22 bond. In the NMR spectrum of the diacetate (II), there is a 1H signal at 4.20 p.p.m. as a doublet of doublets ascribable to the carbinyl hydrogen at C-22, a methylene grouping being adjacent to it. Since the C-22 oxygen function is intact on acetylation, it is concluded that the oxygen participates in the lactone ring formation. The NMR spectra of capitasterone and its diacetate (II) exhibit deshielded methyl doublets at 1.31 and 1.32 p.p.m., respectively, which demonstrate the presence of a $-O-CO-CH-CH_3$ system. A methyl triplet at 0.72 p.p.m. in the NMR spectrum of capitasterone indicates the presence of a CH_3-CH_2- group. All the carbon and hydrogen atoms in the side-chain have already been accounted for by the above NMR data except for a missing methine group which consequently must connect the $-C_{(23)}H_2-$, the $-C_{(22)}H-O-CO-CH-CH_3$, and the $-CH_2-CH_3$, thus the side-chain structure being established.

The above evidence leads to the expression I for capitasterone, the first ecdysterol possessing a δ-lactone system.

Capitasterone may be most probably an intermediate in the biosynthesis of cyasterone (III) from amarasterone A (IV)[2] in the plant, Cyathula capitata.

Since the C-22 hydroxyl group, which seems to be quite essential for the biological activities, is masked in capitasterone, it was interesting to examine its moulting hormone activity. Tests with Sarcophaga peregrina show that capitasterone has high activity.

Thanks are due to Analytical Laboratory, Department of Chemistry, this University, for the NMR spectra, and to Naka Works, Hitachi Ltd., for the mass spectrum.

FOOTNOTE AND REFERENCES

*1 The NMR spectra of ecdysterols and their acetates were determined on a Varian HA-100 spectrometer in C_5D_5N and $CDCl_3$ solution, respectively. Chemical shifts are quoted in p.p.m. downfield from TMS as internal reference. Abbreviations: s=singlet, d=doublet, t=triplet, and q=quadruplet.

1) T. Takemoto, Y. Hikino, K. Nomoto, and H. Hikino, Tetrahedron Letters, 1967, 3191; H. Hikino, Y. Hikino, K. Nomoto, and T. Takemoto, Tetrahedron, 24, 4895 (1968).

2) T. Takemoto, K. Nomoto, and H. Hikino, Tetrahedron Letters, to be published.