change from 6.8 cm (3.4 Å) to approx. 11 cm (5.5 Å). This distance corresponds with the optimum freedom from tension in the model, which was determined manually[2].

In the cis-ladder conformation, separation of the two single strands after the hydrogen bonds have been broken is possible without untwisting. After separation, the bases are sterically in an optimum position for replication, transcription, renaturation, and hybrid formation.

The double-helix structure for DNA is a very rigid conformation. By contrast, the cis-ladder conformation is more flexible. It can be transformed, without the creation of any tension, into the following double-strand conformations:

1. the helical form (Fig. 1),
2. cis-ladder forms tilted out of the vertical (Fig. 4),
3. folded forms (Fig. 5), and
4. coiled forms (Fig. 6).

In contrast to the rigid double-helix conformation, the more flexible cis-ladder conformation makes the formation of sterically twisted superstructures more easily understood.

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[2] A model of the A form of the DNA double helix can likewise be moved tension-free to a cis-ladder position, in which the base pairs are also tilted 20° out of the horizontal

Die Polymorphie von Benzo[*a*]pyren

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Benzo[*a*]pyren, eines der stärksten Carcinogene aus der Gruppe der polycyclischen aromatischen Kohlenwasserstoffe, findet wegen seiner weiten Verbreitung (Industrieabgase, Zigarettenrauch etc.) großes Interesse bei den Krebsforschern. Der Wirkungsmechanismus dieser Substanz ist, wie der der anderen carcinogenen Kohlenwasserstoffe, noch weitgehend ungeklärt. Offensichtlich besteht jedoch ein Zusammenhang zwischen krebserzeugender Wirkung und spezifischen Merkmalen der Kristallstruktur [1]. Wir entdeckten eine weitere Modifikation des Benzo[*a*]pyrens: Die im Tierversuch verschiedentlich verwendete „kolloidale Form" ist nicht – wie bisher irrtümlich vermutet wurde [2, 3] – eine mikrokristalline Form der schon lange bekannten monoklinen Struktur, sondern eine selbständige Modifikation. Somit sind drei Kristallmodifikationen nachgewiesen.

Modifikation I

Darstellung
a) Kristallisation aus siedendem Essigsäureäthylester
b) Sublimation unter vermindertem Druck [2]
c) Schnelle Verdunstung einer Lösung in Amylacetat [4]

Eigenschaften
Sehr dünne blaßgelbe Plättchen nach (001)
Fluoreszenzfarbe blau

Orthorhombisch [4]
Q^4; $a_0=7{,}59$; $b_0=7{,}69$; $c_0=22{,}38$ Å;
$Z=4$; $D_x=1{,}27$

Modifikation II

Darstellung
Das „kolloidale Benzpyren" wird erhalten, wenn eine Lösung in Aceton mit Wasser verdünnt wird

Eigenschaften
Hellgelbes mikrokristallines Pulver (Fig. 1)
Fluoreszenzfarbe gelb

Orthorhombisch oder monoklin
$a_0=13{,}9$; $b_0=9{,}96$; $c_0=9{,}22$ Å;
$\beta=90°$; $Z=4$; $D_x=1{,}31$

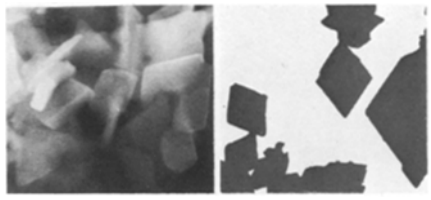

Fig. 1. REM- und TEM-Aufnahmen von „kolloidalem Benzpyren" (Mod. II). Kantenlänge der Kristalle 2 – 5 µm; Hauptfläche (001)

Diese Modifikation ist instabil. Bei Raumtemperatur erfolgt innerhalb von 6 Monaten eine vollständige Umwandlung in die Modifikation III. Die Gitterkonstanten konnten mit Hilfe indizierter Debye-Scherrer-Aufnahmen ermittelt werden (Tabelle 1). Die Indizierung wurde durch einen Vergleich der Aufnahmen mit denen des Dibenzo[*def,mno*]chrysens (Anthanthren) ermöglicht. Die große Ähnlichkeit der Debye-Scherrer-Aufnahmen beider Substanzen weist auf eine Isotypie ihrer Kristallstrukturen hin.

Modifikation III

Darstellung
Langsame Kristallisation aus Aceton oder Benzol

Eigenschaften
Bräunlichgelbe Nadeln; gestreckt nach [001]
Fluoreszenzfarbe gelbgrün

Monoklin [4, 5]
C_{2h}^5; $a_0=13{,}49$; $b_0=20.40$; $c_0=4{,}53$ Å;
$\beta=97°$; $Z=4$; $D_x=1{,}35$

Tabelle 1. Debye-Scherrer-Diagramme (CrK_α)

Modifikation I			Modifikation II			Modifikation III		
I	*d*	(*hkl*)	*I*	*d*	(*hkl*)	*I*	*d*	(*hkl*)
90	11,2	002	100	9,22	001	10	10,2	020
100	5,27	111	90	8,12	110	100	8,15	120
60	3,79	200	50	6,05	111	80	6,69	200
		020						
		021	5	4,66	300	5	5,60	220
50	3,73	201	80	4,06	220	20	4,78	140
70	3,39	210	20	3,85	311	50	4,10	320
		211	90	3,69	221			021
		121	60	3,18	321	65	3,76	031
5	2,41	310				5	3,71	330
						5	3,55	201

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1. Contag, B.: Naturwissenschaften *62*, 434 (1975)
2. Weigert, F., Mottram, J.C.: Nature *145*, 895 (1940)
3. Weigert, F.: ibid *150*, 56 (1942)
4. Iball, J.: Z. Krist. *94a*, 7 (1936)
5. Iball, J., Scrimgeour, S.N., Young, D.W.: Acta Cryst. *B32*, 328 (1976)

Evidence for the Anaerobic Release of Phosphorus from Lake Sediments as a Biological Process

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It is well known that eutrophic lake sediments release large amounts of phosphorus under anaerobic conditions (*b* in Fig. 1) and that this often causes heavy algal blooms. As originally described by Einsele in the late thirties [1, 2], the most general explanation for this outflow has been reduction processes in the sediment, especially of Fe^{3+} to Fe^{2+}, after O_2 depletion in the hypolimnion. This would result in soluble phosphate available for transport into the hypolimnion. However, data presented here indicate that P is made soluble by a biological rather than by a physical reduction process (*a* in Fig. 1).

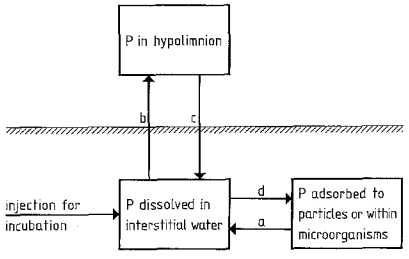

Fig. 1. The studied and discussed sediment-water system

Samples were taken in the highly eutrophic lake Södra Bergundasjön [3] and in the eutrophic lake Bönarpesjön, southern Sweden (Table 1). Undisturbed sediment-water system samples were taken with a Kajak-type corer [4] in Plexiglas tubes. ^{33}P phosphate was injected into the sediment at a depth of 1 cm through a 2.5-mm hole filled with silicon rubber. All experiments were run at 20 °C.

The overlying water (about 1 liter) in aerobic tubes was continuously aerated. Tubes for anaerobic experiments were flushed with N_2 for 15 min and closed for 5–26 days. Sterilized control systems were obtained by addition of 20 ml saturated $HgCl_2$ solution to the overlying water 2–4 days before incubation. In additional control experiments 50 mg tetracycline was used. Anaerobic cores to which $HgCl_2$ was added after incubation but before filtration were also used. After incubation, the overlying water and a 3-cm sediment layer were filtered separately (Whatman GF/C followed by 0.2-µm membrane filter). As a preservative, 96% ethanol (1:1) and 10 drops of saturated $HgCl_2$ were added to the filtrates. The filtrates were evaporated to dryness in vacuo below 40 °C, resuspended in 5 ml 70% ethanol, homogenized, and centrifuged. Aliquots were applied to Whatman No. 1 chromatography paper and separated in (A) propanol/water (7:3), (B) butanol/pyridine/water (6:4:3), and (C) the butanol phase of butanol/ethanol/water (45:5:50). Radioactivity of the separated compounds was measured in a radioactive chromatogram scanner (Actigraph III, Nuclear-Chicago).

The results can be summarized as follows:

1. Sediment taken during spring in Lake Södra Bergundasjön; anaerobic cores closed 6 days before incubation; ^{33}P phosphate incubated 180 min. In the interstitial water of the anaerobic sediment, a soluble organic ^{33}P compound was found with the following approx. R_f values in the solvent systems used: (A) 0.54, (B) 0.33, and (C) 0.05. Fractionation on Sephadex G10 indicated a molecular weight near 200 for this compound. No other soluble labeled compounds were found. Inorganic P (ortho- and pyrophosphate) remained at the starting point on the chromatograms. No soluble ^{33}P was found in the interstitial water in the aerobic cores or in the anaerobic cores poisoned before incubation.

2. Sediment taken during spring in Lake Södra Bergundasjön; anaerobic cores closed 10 days; incubation time 120 min. In the interstitial water of the anaerobic sediment 76% of the soluble ^{33}P showed the following R_f values: (A) 0.13, (B) 0, and (C) 0. 24% of the ^{33}P activity remained near the starting point. No soluble ^{33}P was found in aerobic or poisoned anaerobic sediment.

3. Sediment taken at beginning of summer in Lake Södra Bergundasjön; anaerobic cores closed 16 days; incubation time 10, 180, 240, and 915 min. No soluble ^{33}P found in interstitital water of any of the cores. The process (*a* in Fig. 1) might have already occurred in the lake or in an early phase of the experiment.

4. Sediment taken during summer (before O_2 depletion) in Lake Bönarpesjön; anaerobic cores closed 5, 12, 19, and 26 days; incubation time 360 min. The only soluble ^{33}P compound found had the same separation characteristics as the compound in experiment 1 and was isolated from the anaerobic core closed 19 days.

Earlier investigations of phosphorus exchange between water and sediment lack information about the chemical nature of the P compounds involved. This investigation showed that ^{33}P, added as phosphate, occurred as soluble organic phosphorus in the interstitial water of anaerobic sediment after incubation, indicating a biochemical conversion process. A definite verification of a biological process is that P release from the particulate material (*a* in Fig. 1) did not occur in anaerobic sediment poisoned before incubation.

To summarize: P was sorbed to the particulate material of both aerobic and anerobic sediments. In the nonpoisoned anaerobic sediment, phosphate was transformed into soluble organic form through a microbial process (*a* in Fig. 1).

Table 1. Selected characteristics of the sediments of lakes Södra Bergundasjön, central southern Sweden, and Bönarpesjön on the southern Swedish west coast. Sediment layer 0–10 cm

	Södra Bergundasjön	Bönarpesjön
Dry weight [mg/g fresh sediment]	31	209
Loss on ignition [mg/g dry weight]	515	252
Fe [mg/g dry weight]	41	64
Mn [mg/g dry weight]	3.1	2.5
Total P [mg/g dry weight]	10.3	1.4
General characteristics	Sapropel	Clay gyttja

