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Abnormalities Caused by Chloroform and Ether in the Spermatogenesis of Mammals.

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Abnormalities Caused by Chloroform and Ether in the Spermatogenesis of Mammals.

By

ANNA VEILANDS.

7 Text-figures.

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1. Introduction.

It is not seldom that in experimental investigations biological observations are made in the gonads of male animals which for a short time before some operation have been under the influence of the usual narcosis.

As the germ cells react very sensitively on the pathological state of the organism produced by the influence of various poisons, the question arises, whether the picture of microscopical investigation differing from the normal state is a consequence of the operation or whether it depends more on the influence of the narcosis.

The aim of this paper is to come to a conclusion based on the foregoing and on my observations of the effect of chloroform and of ether on spermatogenesis at its different stages.

There are many scientific observations in the pathological investigation of the germinal epithelium. I shall mention here only the recent publications which are more or less closely connected with the aim of my present work.

In 1922 A. KOSTITCH, a pupilof P. BOUIN, studied the influence of alcohol upon the gonads of white rats. He formulates the results obtained in the following postulates:

«1. L'épithélium séminal est particulièrement sensible à l'action de l'alcohol.

2. Les cellules séminales disparaissent dans l'ordre inverse de leur genèse. L'intoxication alcoolique produit d'abord la desquamation partielle ou massive de l'épithélium séminal, ce qui détermine la formation des bouchons cellulaires. Le ralentissement de la spermiogenèse provoque l'accumulation des spermatides arrêtées dans leur métamorphose. Dans les spermatocytes, l'intoxication alcoolique provoque de bonne heure les troubles dans les divisions maturatives.

3. L'accumulation des spermatides détermine la formation des tératocytes séminaux (tératospermatides).

4. L'arrêt de la spermiogenèse et l'élimination des tératocytes réduit l'épithélium à la couche génératrice, dont la persistance rend possible la régénération de l'épithélium.»

The destructive influence of alcohol upon the germ cells of man has recently been studied by C. WELLER (1922).

Investigating the germ cells of 5 individuals who had died in consequence of excessive use of alcohol he found that:

«The testes of these five cases all showed abnormal spermatogenesis. Vacuolar degeneration of the germinal epithelium, often showing a zonal distribution in the tubules: hyperchromatic spermatogonia, atypical division figures with hyperchromatic nuclei, retardation of spermatogenesis with relative increase in the number of spermatids and the formation of multinuclear forms attached to the wall or free in the tubular lumina, were noted in varying degrees in the different cases. These changes are not specific for alcohol, but resemble those experimentally produced in laboratory animals by alcohol and lead, and those described as resulting from certain acute infections in man (typhoid fever, influenza, and pneumonia).»

In 1923 R. HOFSTÄTTER, investigated the influence of nicotine upon the development of the gonads and upon propagation.

The experiments were made on dogs, rabbits, rats, and mice. The nicotine was added to the food; in some cases it was inhaled by the animals with the help of «Rauchkasten». All these experiments proved the harmful influence of nicotine on spermatogenesis.

ADLER (1914) has shown that similar degenerative processes in the testicle ca be caused by subcutaneous application of different compounds of iodine (Lipschütz 1924).

In conclusion to this short introduction I take the opportunity of expressing my deep gratitude to Prof. Dr. N. G. LEBEDINSKY for the problem he gave me to deal with and for his kind direction and advice during my work.

2. Material and Methods.

The work was done in 5 series, experiments being made on 25 mice in all. For each series 6 weeks old male white mice were taken from the same litter.

The mice of the first series were exposed to the influence of ether for 40 minutes to I hour and 50 minutes. The control animal was killed by a blow on the head without being narcotised. The next four mice were killed while still under the influence of the ether. The sixth mouse was killed after 12 hours, and the seventh after 24 hours.

For the second series 4 mice were made use of. The first as control animal, the other three were under the influence of chloroform: No. 2—1 minute and 30 seconds, No. 3—20 minutes, No. 4—20 minutes.

For the third series 4 mice were taken: the first as control animal; No. 2 was under the influence of chloroform for 15 minutes, No. 3 — for 30 minutes, No. 4—40 minutes.

The fourth series comprised 3 mice: No. I as control animal, No. 2 remained under the influence of chloroform for I hour and 30 minutes and was fixed after 12 hours; No. 3 was under the influence of chloroform for I hour and 30 minutes and was fixed after 24 hours.

This series yielded very distinct results.

The fifth series comprised 5 mice: No. 1 — the control animal; No. 2 remained under the influence of chloroform for 30 minutes and was fixed after 2 days, No. 3 — 45 minutes under chloroform and fixed after 3 days, No. 4 — 1 hour 30 minutes under chloroform and fixed after 2 days, No. 5—1 hour 30 minutes under chloroform and fixed after 3 days. In this series, too, the pathogenic influence of the narcosis was very markedly shown.

In order that the mice might more easily endure a prolonged influence of chloroform they were narcotised at intervals. They were allowed to come to, after which they were again exposed to chloroform.

The gonads were fixed in ZENKER's fluid. After rinsing in water, iodising, passing through spirit and xylol, they were embedded in 52°—56° paraffin. The sections are 6 μ thick.

In order to define the change in the size of the seminiferous tubules drawings of the preparations were made with the help of a WINKEL-ZEISS projector. The size of the tubules had not changed under the influence of chloroform.

Of the most characteristic preparations photographs were taken.

The following is a more detailed description of each separate series.

3. Observations.

The First Series.

The mice of this series were exposed to the influence of ether. Mouse No. 1 was the control animal. Mouse No. 2 was kept under the influence of ether for 40 minutes; mouse No. 3—1 hour; No. 4—1 hour 20 minutes; No. 5—1 hour 40 minutes.

All the mice from No. 2 to No. 4 inclusive died under the influence of the narcosis immediately after narcotisation, under the direct action of the ether. Mouse No. 6 was under the influence of ether for 1 hour 50 minutes and was fixed after 12 hours. Mouse No. 7 was under the influence of ether for 1 hour 50 minutes and was fixed after 24 hours.

The control animal was killed by a blow on the head and immediately fixed. The seminiferous tubules of this animal show 7 layers of cells. Along the walls of the tubules there are 2—3 layers of undeveloped germ cells — spermatogonia and spermatocytes, many of them in a state of division. Among the basal cells there are Sertoli cells of typical formation.

More towards the middle of the tubule there are praespermatids and spermatids. The spermatids are placed nearer to the centre and many of them are developed into spermatozoids.

In the greater part of the tubules spermatozoids with long threads are found; in other tubules spermatozoids with not yet formed plasm-like tails «spermatodesms» are to be seen. They are grouped in bunches.

In several tubules the tails of the spermatozoids have formed in the middle of the tubule a spirally twisted wreath.

In rare instances vacuolisation may be observed in some places. Between the tubules round, oval or polyhedral Leydig cells are encountered. These cells together with the connective tissue fill, but not entirely, the spaces between the tubules.

Sometimes pycnotic (hyperchromatic) nuclei of spermatocytes are met with.

All the mice from No. 2 to No. 7 inclusive were under the influence of ether. The cross sections of their seminiferous tubules do not show great changes. So-called «Zellklumpen» (cell clots described in detail by H. STIEVE in 1927.) are found in small numbers. Further a desquamation of the germ cells at various stages may be observed, germ cells detached from the germinal epithelium having migrated into the centre of the tubules. Pycno-

tic (hyperchromatic) nuclei of spermatocytes are also found. Such changes are met with in 2—3% of all the cross sections of the tubules.

The Second Series.

For this series 4 mice were taken. They were all 6 weeks old and from the same litter.

Mouse No. 1 was the control animal. Mouse No. 2 remained under the influence of chloroform for 1 minute and 30 seconds; mouse No. 3—20 minutes; mouse No. 4—20 minutes. All these mice were killed and fixed immediately after the narcosis.

The cross sections of the tubules of the control animal do not differ in any way from the cross sections of the same tubules of the control animal of the first series. No changes can be observed in the cross sections of the tubules of mouse No. 2 either as this mouse had been under the influence of chloroform only for I minute and 30 seconds.

Slight changes are seen in the tubules of mice No. 3 and No. 4. In these cases the walls of the tubules show in some places hyaline degeneration as described by A. MAXIMOV in 1899. Desquamation of the germinal epithelium is also met with. These changes are observed in 2—3% of the tubules.

The Third Series.

The 4 mice made use of in this series were also 6 weeks old and from the same litter.

Mouse No. 1 was the control animal. Mouse No. 2 remained under the influence of chloroform for 15 minutes, No. 3 — for 30 minutes, No. 4 — for 40 minutes. All these mice were fixed immediately after the experiment.

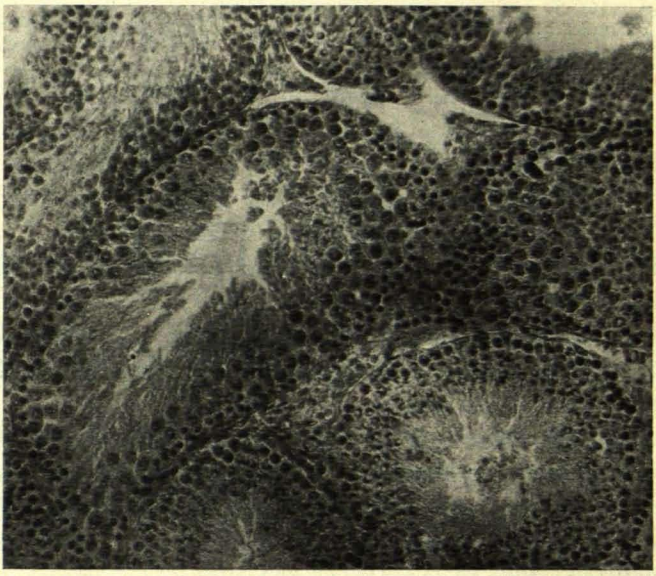
The cross sections of the seminiferous tubules of the control animal showed the usual structure.

The cross sections of the seminiferous tubules of mouse No. 2 as well as those of the control animal show along the walls 2—3 layers of spermatogonia and of spermatocytes at the stage of division, and typical cells of Sertoli. Nearer to the centre of the tubules there are praespermatids and spermatids.

In the tubules of mice No. 3 and No. 4 there are mostly 6—7 layers of epithelial cells. Yet in 5% of the total number of the tubules only 1 layer of spermatocytes is found.

Sometimes, as in the second series, hyaline degeneration of the walls of the tubules, desquamation of the germinal epithelium,

and pycnotic nuclei of spermatocytes may be observed. Some of these nuclei are entirely dark, in others the transformation has just begun.



No. 1. Sickle-shaped accumulation of chromatin. 4th series.

The Fourth Series.

For this series 3 mice, 6 weeks old and of the same litter were used. The experiment with the animals of this series differed from those of the other series inasmuch as the mice were not killed immediately after the narcosis, but after a certain interval of time.

Mouse No. 1 was the control animal. Mouse No. 2 remained under the influence of chloroform for I hour and 30 minutes and was fixed after 12 hours.

Mouse No. 3 was exposed to the influence of chloroform for I hour and 30 minutes and was fixed after 24 hours.

The cross sections of the tubules of the control animal show the usual structure, as in the first series.

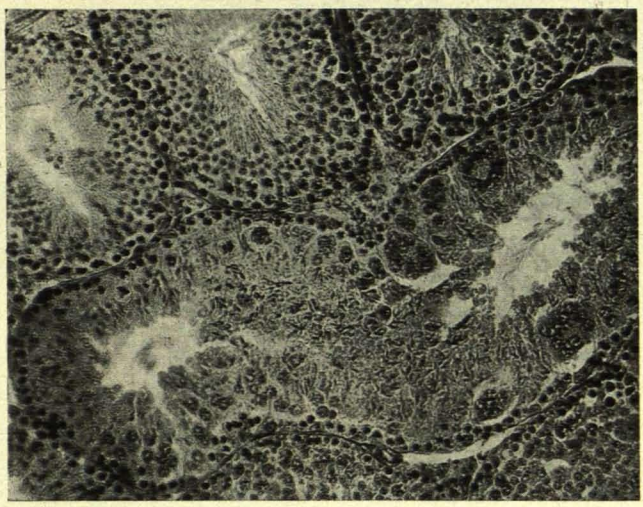
A much more pronounced transformation of the cells than in the former series is observed in the cross sections of the seminiferous tubules of mouse No. 2. This animal remained under the influence of chloroform for I hour and 30 minutes and was fixed after 12 hours. A transformation can be observed in 10% of the tubules.

Protoplasmic clots with 1—5 pycnotic nuclei are mostly found here. Besides these there is also a small number of cells with a sickle-shaped accumulation of chromation at one side of the nucleus (fig. 1).

In some instances the whole cross section of the tubule shows a transformation of the cells. Such tubules do not present the usual arrangement of the germinal epithelium; the latter appears only along the walls, while the tubule is filled with cell clots and protoplasmic thickenings; in the centre desquamation of the germinal epithelium and sometimes spermatozoids may be observed.

The strongest reaction can be established in the cross sections of the seminiferous tubules of mouse No. 3. This mouse remained under the influence of chloroform for I hour and 30 minutes and was fixed after 24 hours. The number of the epithelial cell layers varies from 2 to 6.

As in the control animal along the walls of the normally developed tubules 1—2 layers of spermatogonia and of typical Sertoli cells are seen. There are also spermatocytes at the stage of division, but in smaller number.



No. 2. «Giant cells». 4th series.

More towards the middle of the tubules praespermatids and spermatids are found. Such a normal condition is observed in 25% of all the tubules.

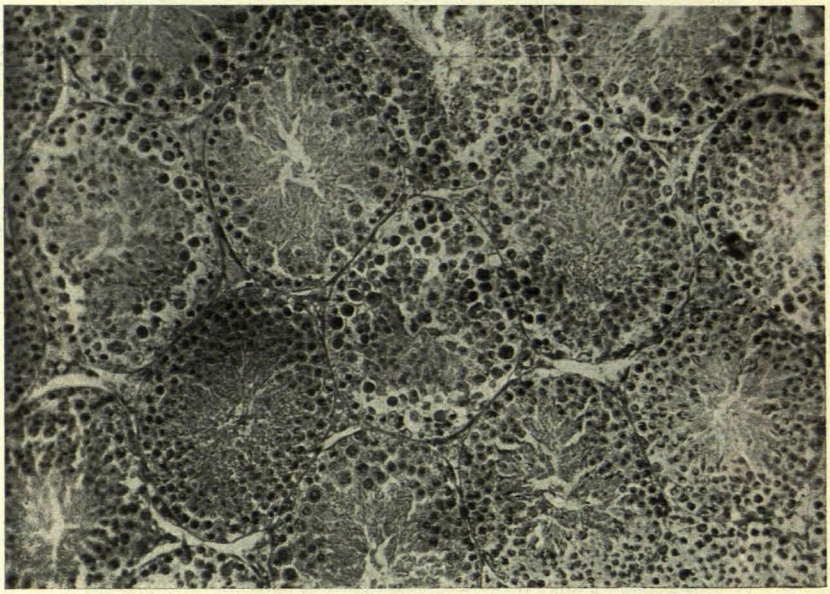
The greatest transformations are found in 75% of all the tubules. There are numerous «Riesenzellen» (giant cells) as descri-

bed by A. MAXIMOV in 1899. On the walls of some of the tubules 10—11 giant cells may be seen with 2—11 vesicular spermatocyte nuclei (fig. 2).

In the middle of the tubules there are germ cells of different age which have separated from the epithelium by way of desquamation.

Moreover, the walls of the tubules show much hyaline degeneration (fig. 3 and 4).

The size of the tubules is not changed. Leydig cells between the tubules are found in the same quantity as in the control animal.

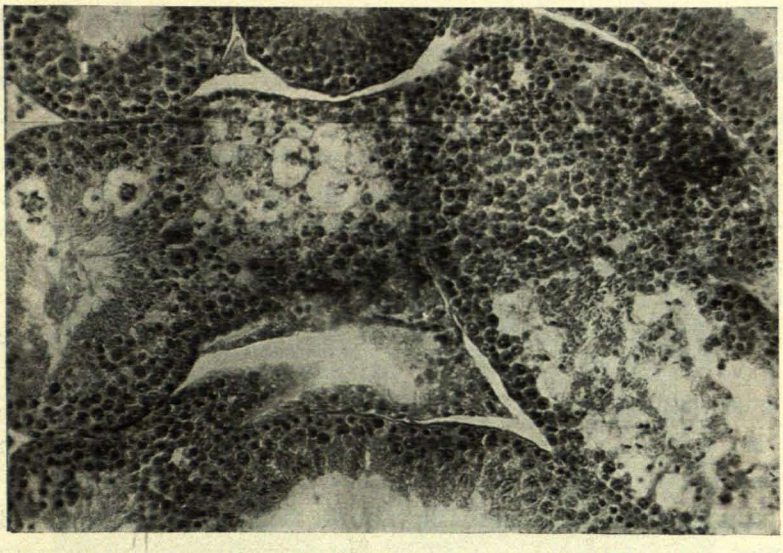


No. 3. Hyaline degeneration of the walls of the tubules. 4th series.

The Fifth Series.

This series consisted of 6 mice, all 6 weeks old and of the same litter.

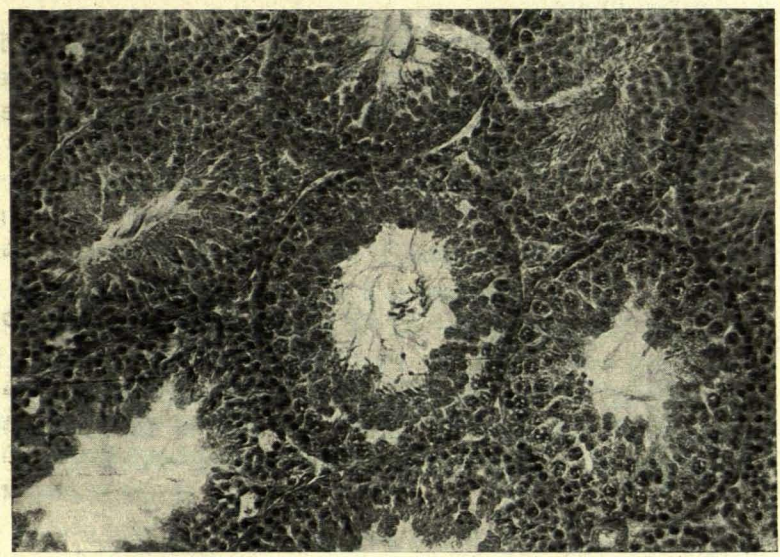
Mouse No. 1 was the control animal (fig. 5). Mice No. 2 and No. 3 remained under the influence of chloroform for 30 minutes and were fixed after 2 days. Mouse No. 4 was under the influence of chloroform for 45 minutes and was fixed after 3 days. Mouse No. 5 remained under the influence of chloroform for I hour and 30 minutes and was fixed after 2 days. Mouse No. 6 was under the influence of chloroform for 1 hour and 30 minutes and was fixed after 3 days.



No. 4. Vacuolisation. 4th series.

The cross sections of the seminiferous tubules of the control animal show the usual picture.

Mice No. 2 and No. 3 remained under the influence of chloroform for I hour and 30 minutes and were fixed after 2 days. The cross sections of their tubules show very slight changes.



No. 5. Control animal. 5th series.

The general aspect of the tubules is the same as in the control animal, i. e. 7 layers of germ cells in the usual order; also typical Sertoli cells are found. In the centre of the tubules typical spermatozoids with long threads or with spermatodesms are seen.

Sometimes vacuolisation can be established.

Between the tubules there are cells of Leydig in normal quantity and of typical shape. The transformation showed itself by the appearance of cell clots. These clots do not appear often, but one or two in each tubule.

In several tubules desquamation is observed: the spermatocytes have travelled to the centre of the tubule and are mixed with the spermatozoids (fig. 6).

Mouse No. 4 had been kept under chloroform for 45 minutes and fixed after 3 days.

In the cross sections of the tubules of this specimen, as in those of mice No. 2 and No. 3, we find but few changes when compared with those mice that had remained under the influence of chloroform for I hour and 30 minutes.

The general shape of the tubule is the same as in mice No. 2 and No. 3. A transformation of the cells can be established in 10% of the tubules.

In the cross sections tubules with 2 to 3 cell layers may be observed (fig. 7). These layers consist of spermatocytes with not clearly defined limits.

In some places the spermatocytes are at the stage of division. There are also Sertoli cells and spermatozoids with spermatodesms. From these tubules the praespermatids and spermatids have disappeared.

Of such tubules about 2 are found in one cross section. In a few tubules the spermatids travel towards the centre and cross over the inner limit of the spermatozoids. 1, 2 or 4 cell clots are found in the tubules.

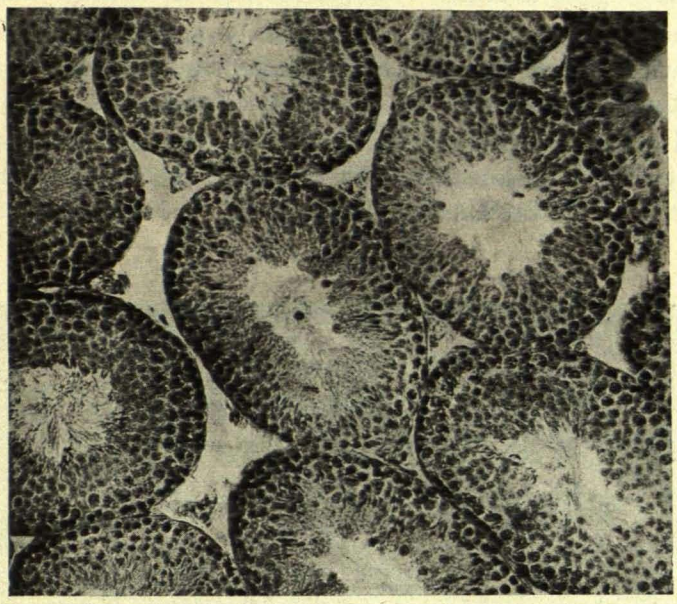
In one instance the clot consists of 9 spermatids, in another, of 6.

Very great changes are shown by the cross sections of the seminiferous tubules of the mouse that had been under the influence of chloroform for I hour 30 miuutes, and had been fixed after 2 2 days, i. e. of mouse No. 5. This mouse is of the same series and age as the control animal.

In this case the number of layers of the epithelial cells varies between 2 and 6. As in the control animal there are along the tu-

bules 1—2 layers of spermatogonia and typical cells of Sertoli. Also spermatocytes at the stage of division are found, yet not so numerous.

Transformation has also taken place in the praespermatids and the spermatids.



No. 6. Migration of spermatocytes into the centre of the tubule. 5th series.

The spermatids have formed cell clots. In these clots the protoplasm is sharply delimited and contains small nuclei. These nuclei are of round, oval or angular shape and stain dark. (H. STIEVE, 1927).

Aggregations of cells forming larger or smaller clots are often met with. Some clots are formed by 2 spermatids, but there are also clots consisting of 5 or 6 spermatids.

In some tubules the tails of the spermatozoids have assumed a spiral form. In the centre of the tubules where the control animal showed a lumen, sparse spermatocytes, spermatogonia, and accumulations of plasma are found. Such a desquamation may be observed in those layers where the spermatozoids with spermatodesms are placed in bundles.

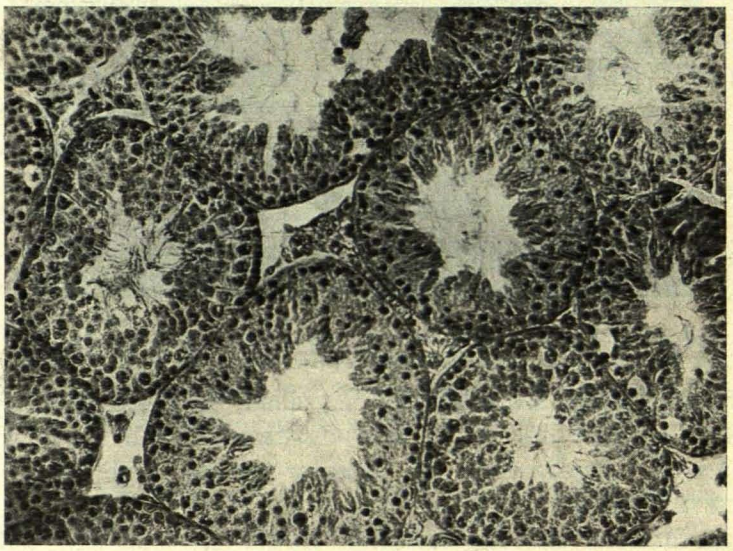
Often nuclei of prespermatids with a sickle-shaped mass of chromatin on one pole and a transparent zone everywhere else may be seen.

The indicated transformations are found in at least ⅔ of the tubules, ⅓ of the tubules remaining in a normal state. The size of the tubules is not changed. Cells of Leydig between the tubules are found in the same number as in the control animal.

A slight vacuolisation of the germinal epithelium can be observed.

A not quite normal state may also be observed in the gonads of mouse No. 6 that had been exposed to the influence of chloroform for 1 hour 30 minutes and fixed after 3 days.

The cross sections of this spermary show also a pronounced transformation of the cells. The number of the layers of germ cells varies. In some tubules there are 2 or 3 layers, in others 6 or 7.



No. 7. Tubules with 2—3 layers of cells.

In the last specimen, as in the control animal, along the walls of the tubules are to be seen 2 or 3 layers of spermatogonia and of spermatocytes at the stage of division and typical Sertoli cells. Nearer to the centre of the tubules are placed the praespermids and spermatids. Rarer than in the control animal mature spermatozoids are met with, instead there are more spermatozoids with spermatodesms.

Sometimes transformation occurs in the spermatids. They form dark-coloured protoplasmic masses consisting of one or two

cells. Such protoplasmic masses are not numerous, fewer than in the preceding experiment.

Desquamation is observed in 10% of the cross sections of the gonads. In the centre of the tubules clots of spermatids have formed. In some of these clots one can detect mixed germinal cells at different stages, as spermatocytes, praespermids, spermatids, and spermatozoids.

These transformations are found in not more than ⅓ of all the tubules. ⅔ show a normal structure. The size of the tubules is not changed, the walls are not thickened. Cells of Leydig between the tubules are met with in the same number as in the control animal. Vacuolisation of the germinal epithelium can also be observed.

4. Summary.

Our investigations prove that ether has a weaker influence on the germinal epithelium than chloroform. The action of the ether produces but a slight transformation of the epithelium.

If the animal was killed directly after having been exposed to the influence of chloroform the signs of transformation were less considerable.

Quite different results were obtained if a certain period of time had elapsed between the influence of the chloroform and the fixation.

The pathological influence showed in the cases where the mouse had been under the influence of chloroform for 1 hour 30 minutes with intervals and had been fixed after 24 hours. Then the change in the germinal epithelium was most obvious. But if 3 days had passed between the narcosis and the fixation only slight changes could be observed, the tubules having regained their normal shape.

It is evident that in these cases a regeneration of the germinal epithelium had been possible.

Chloroform as well as X-rays, radium, alcohol (W. HARMS, 1926), blue light (L. FALIN, 1929), nicotine (R. HOFSTÄTTER, 1923) low temperature (N. GRONSKY, 1930), work strongly into the male gonads destroying the epithelium and transforming the cells.

Under the influence of chloroform there appear in the seminiferous tubules:

1. «Giant cells» — multicellular formations containing vesicular nuclei of spermatocytes or of spermatids.

2. Protoplasmic clots with pycnotic (hyperchromatic) nuclei of spermatocytes.

3. Cells with sickle-shaped deposits of chromatin on one side of the nucleus.

4. Vacuolisation of the protoplasm.

5. Cell clots of spermatids.

6. Desquamation of the germinal cells at different stages.

7. Hyaline degeneration of the walls of the seminiferous tubules.

When chloroform is used at various operations, an examination of the germinal epithelium of the male gonads may give a false idea of its condition before narcotisation. These appearances must be taken into account when making experiments and appraising the results thereof.

Literature.

Bilski, F. Über Blastophthorie durch Alkohol. Mit Versuchen am Frosch. Arch. f. Entwicklungsmech. d. Organismen, 50, 1921.

Falin, L. Beobachtungen über die Wirkung der Weiss- und Blaulichtbestrahlung auf die Geschlechtsdrüsen der weissen Ratten. Anat. Anz. 67, 1929.

Gronsky, N. Über die Wirkung der niedrigen Temperatur auf die Hohen der weissen Ratten bei deren Lokalanwendungen. Anat. Anz. 69, 1930.

Harms, J. W. Experimentelle Untersuchungen über die innere Sekretion der Keimdrüsen und deren Beziehung zum Gesamtorganismus. Jena 1914.

Harms, J. W. Körper und Keimzellen 2. Teile. Monografien a. d. Gesamtgebiet d. Physiol. d. Pflanzen u. d. Tiere. 1926.

Hofstätter, R. Experimentelle Studie über die Einwirkung des Nikotins auf die Keimdrüsen und auf die Fortpflanzung. Virchows Arch. f. pathol. Anat. u. Physiol. 244, 1923.

Kostitch, A. Action de l'alcool sur la glande interstitielle du testicule. Internat. Zeitschr. gegen den Alkoholismus. Jg. 30, 1922.

Lipschütz, A. The Internal Secretions of the Sex Glands. 1924.

Maximov, A. Die histologischen Vorgänge bei der Heilung von Hodenverletzungen und die Regenerationsfähigkeit des Hodengewebes. Beitr. path. Anat. 26, 1899.

Stieve, H. Entwicklung, Bau und Bedeutung der Keimdrüsenzwischenzellen. Erg. Anat. 23, 1921.

Stieve, H. Samenzellenverklumpung als Grund für die Unfruchtbarkeit gesunder Tiere. Zeitschr. für mikr. anat. Forschung. 12, 1927.

Sand, K. Die Physiologie des Hodens 1933. Leipzig. (Verlag von Curt Kabirsch.)

SCHINZ, R. u. B. SLATOPOLSKY, Beiträge zur experimentellen Pathologie des Hodens (und zur Histologie und Histogenese des normalen Hodens, der Hodenatrophie und der Hodennekrose). Denkschriften der Schweizerischen Naturforschenden Gesellschaft. Band 61, Abh. 2. 1924.

WELLER, C. Testicular changes in acute alcoholism in man and their relationship to blastophthoria. (Dep. of Pathol. Univ. of Michigan Ann. Arbor) Proc. of the Society for Biology and Medecine 19, 1922.

(No L. Ū. Salīdzināmās anatomijas un eksperimentālās zooloģijas institūta.)

Chloroforma un ēteŗa radītie traucējumi zīdītāju spermatogenezē.

(Kopsavilkums.)

ANNA VEILANDS.

Minētam darbam izlietotas albinotiskas mājas peles. Pētījumi rāda, ka ēteris darbojas vājāk uz dzimumepitēliju, nekā chloroforms.

Ja dzīvnieku nonāvēja tūlīt pēc chloroforma iedarbības, min. audu pārveidošanās pazīmes bija vājākas nekā tad, kad no chloroforma iedarbības līdz iefiksēšanai pagāja zināms laiks. Patoloģiskais iespaids visspēcīgāk izpaudās tad, kad pele atradās zem chloroforma iespaida 1 st. 30 min. ar pārtraukumiem un iefiksēta pēc 24 stundām, jo dzimumepitēlijā bija notikusi vislielākā pārveidošanās. Bet ja pēc chloroforma iedarbības līdz iefiksēšanai pagāja 3 dienas, tad bija sastopamas tikai mazas pārmaiņas, jo kanālīši bija atguvuši savu normālo veidu. Te tā tad bija paspējusi notikt dzimumepitēlija reģenerācija.

Chloroforms, tāpat kā Rentgena stari, radijs, alkohols (HARMS, 1926.), zilā gaisma (FALIN, 1929.), nikotīns (HOFSTÄTTER, 1923.), zema temperātūra (GRONSKY, 1930.) spēcīgi iedarbojas uz vīrišķiem dzimumdziedzeŗiem, izārdot viņu epitēliju un pārveidojot šūnas.

Zem chloroforma iespaida sēklas kanālīšos veidojas:

1. «Milzu šūnas» — daudzšūnu veidojumi, kas satur pūšļveidīgus spermatocitu vai spermatīdu kodolus.
2. Protoplazmatiskas masas ar piknotiskiem spermatocitu kodoliem.
3. Šūnas ar spirālveidīgu chromatīna novietojumu vienā kodola malā.
4. Protoplazmas vakuolizācija.
5. Kopā saplūdušu spermatīdu grupas («Zellklumpen»).
6. Dažādu stādiju dzimumšūnu deskvamācija.
7. Sēklas kanālīšu sieniņu hialinā deģenerācija.

No šī darba rezultātiem jāsecina, ka pētot pēc dažāda veida eksperimentiem notikušās pārmaiņas vīrišķā dzimumepitēlijā, var (ja bijusi pielietota vispārēja narkoze) iegūt par attiecīgo audu uzbūvi nepareizu priekšstatu, kas neatbilst pirms narkozes iespaida bijušai ainai. Tādēļ visas minētās parādības jāņem vērā, uzstādot daudzus mēģinājumus un apsveŗot viņu iznākumus.