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A STUDY OF MOLDS IN BUTTER

By

YUJI SASAKI

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INTRODUCTION

The production of butter is one of the important industries in Hokkaido. It supply the demand of Japan, and, what is stillmore, enlarging the market in foreign countries. It is an urgent question to elevate the quality of products from the point of view of national nutrition.

The market value of butter is determined, in a large measure, by flavor and aroma, but the general appearance also have considerable influence upon the consumers. One of the most disturbing defects of market butter is due to the growth of molds. The presence of mold in butter is objectionable both from the standpoint of the close relation between mold and keeping quality and because of the unsightly appearance of butter showing mold speck or spots. The mold depreciate the keeping quality of butter is well known. The greatest objection to moldy butter, however, does not lie in its objectionable flavor, but rather in the appearance of the surface of butters with the mold speck and spots which render it unsightly and cause much loss to the creamery and the dealer. Therefore the elimination of the mold-injuries is the most important question relating to the improvement of the qualities of butter.

In the western countries a number of investigators have studied the molds of butter, but in Japan no one has investigated the mold problem of butter, except Prof. em. Dr. JUN HANZAWA. The want of the thorough investigation of the problem is keenly felt in this country. Now the author studied the fungous flora of butter manufacturing in Hokkaido, some of the factors influencing the growth of molds, some of the physiological activities of them, etc.

The studies reported here were undertaken in an attempt to provide data from which future research may be directed toward a more complete solution of the problem.

REVIEW OF LITERATURE

Since DUCLAUX⁵⁰ (1883) mentioned the fact that *Penicillium glaucum* were found in butter, many species of molds have been isolated by many investigators in the foreign countries from butter and equipment or material used in its manufacture or packaging. These species of molds and investigators may be summarized as follows:

Name of mold	Authority
<i>Acremoniella brevia</i>	MACY, H. and G. H. STEEL ⁶⁰ (1934)
<i>Acrostalagmus cinnabarinus</i>	" , " . " " . " " (")
<i>Alternaria</i> sp.	THOM, C. and R. W. SHAW ⁶⁸ (1915)
	CLINTON, G. P. ¹¹ (1920)
<i>Alternaria humicola</i>	MACY, H. and G. H. STEEL (1934)
<i>Alternaria fusciculata</i>	" , " . " " . " " (")
<i>Aspergillus</i> sp.	CRAMPTON, C. A. ¹³ (1902)
	BURR, A. ⁹ (1909)
	STOKOE, W. N. ^{92, 93} (1921)
	STÄRKLE, M. ⁹⁰ (1924)
	PARASCHTSCHUK, S. ^{67, 68} (1928)
<i>Aspergillus candidus</i>	MACY, H. and G. H. STEEL (1934)
<i>Aspergillus flavus</i>	BATTEN, L. and H. W. BYWATERS ⁵ (1918)
	MACY, H. and G. H. STEEL (1934)
<i>Aspergillus fumigatus</i>	" , " . " " . " " (")
<i>Aspergillus glaucus</i>	SAYER, W. S., V. RAHN, and B. FARRAND ⁵ (1908)
	STOKOE, W. N. (1921)
<i>Aspergillus luteo-niger</i>	MACY, H. and G. H. STEEL (1934)
<i>Aspergillus micro-virido-</i>	
<i>citrinus</i>	" , " . " " . " " (")
<i>Aspergillus nidulans</i>	" , " . " " . " " (")
<i>Aspergillus niger</i>	BURR, A. (1910)
	JACOBSON, H. C. ⁴¹ (1919)
	MACY, H. and G. H. STEEL (1934)
<i>Aspergillus Oryzae</i>	BATTEN, L. and H. W. BYWATERS (1918)
<i>Aspergillus Sydowi</i>	MACY, H. and G. H. STEEL (1934)
<i>Aspergillus terreus</i>	" , " . " " . " " (")
<i>Aspergillus ustus</i>	" , " . " " . " " (")
<i>Aspergillus versicolor</i>	" , " . " " . " " (")
<i>Botricanus scostan</i>	PARASCHTSCHUK, S. (1928)
<i>B. trytis</i> sp.	HAPPICH, C. ³³ (1901)
<i>Chaetomium</i> sp.	DUCLAUX, E. (1901)
<i>Cladosporium</i> sp.	THOM, C. and R. W. SHAW (1915)
	STOKOE, W. N. (1921)
	PARASCHTSCHUK, S. (1928)
<i>Cladosporium butyri</i>	ORLA-JENSEN, S. ⁴³ (1902)
	JACOBSON, H. C. (1919)

- | | |
|----------------------------|--|
| <i>Mucor petrinsularis</i> | BURR, A. (1910) |
| <i>Mucor plumbeus</i> | FETTICK, O. ¹⁰ (1912) |
| <i>Mucor racemosus</i> | DUCLAUX, E. (1901) |
| | MACY, H. and G. H. STEEL (1934) |
| | PARASCHTSCHUK, S. (1928) |
| | MACY, H. and G. H. STEEL (1934) |
| <i>Mucor spinosus</i> | DUCLAUX, E. (1901) |
| <i>Mucor sylvaticus</i> | PARASCHTSCHUK, S. (1928) |
| | MACY, H. and G. H. STEEL (1934) |
| <i>Oidium lactis</i> | HAPPICH, C. (1901) |
| | EICHHOLZ, W. ¹⁶ (1901) |
| | ORLA-JENSEN, S. (1902) |
| | TEICHERT, L. (1904) |
| | ARTHAND-BERTHET, J. ⁷ (1905) |
| | REITZ, A. (1906) |
| | O'CALLAGHAN, M. A. ⁶⁴ (1907) |
| | FETTICK, O. ¹⁸ (1908) |
| | SAYER, W. S., V. RAHN and B. FARRAND (1908) |
| | RAHN, O. ⁷² (1910) |
| | PRIKRYL, V. (1914) |
| | THOM, C. and R. W. SHAW (1915) |
| | COMBS, W. B. and C. M. ECKLES ¹² (1917) |
| | NICHOLLS, H. M. ⁶³ (1919) |
| | CLINTON, G. P. (1920) |
| | MEUBRINK, H. (1928) |
| | PARASCHTSCHUK, S. (1928) |
| | MACY, H. and G. H. STEEL (1934) |
| | SORENSEN, C. M. ⁸⁶ (1935) |
| <i>Oidium varicolor</i> | PROKS, J. ⁷² (1924) |
| <i>Oospora ruberrima</i> | SACCARDO, P. A. ⁸¹ (1926) |
| <i>Penicillium</i> sp. | GRIPENBERG, R. (1899) |
| | DUCLAUX, E. ¹⁵ (1899) |
| | HAPPICH, C. (1901) |
| | CRAMPTON, C. A. (1902) |
| | REITZ, A. (1906) |
| | BURR, A. (1908, 1910) |
| | STÄRKLE, M. (1924) |
| | PARASCHTSCHUK, S. (1928) |

	STOKOE, W. N. (1928)
<i>Penicillium Adametzi</i>	MACY, H. and G. H. STEEL (1934)
<i>Penicillium baiiolum</i>	" , " " " " " (")
<i>Penicillium bialowiczense</i>	" , " " " " " (")
<i>Penicillium biforme</i>	" , " " " " " (")
<i>Penicillium biourgeianum</i>	" , " " " " " (")
<i>Penicillium Blakesleei</i>	" , " " " " " (")
<i>Penicillium brevicaulis</i>	WEIGMANN, H. ¹⁰⁴ (1908)
	WEIGMANN, H. and A. WOLFF ¹⁰⁵ (1909)
<i>Penicillium brevi-compactum</i>	MACY, H. and G. H. STEEL (1934)
<i>Penicillium brunneo-violaceum</i>	" , " " " " " (")
<i>Penicillium Camemberti</i>	" , " " " " " (")
<i>Penicillium chermasium</i>	" , " " " " " (")
<i>Penicillium chrysogenum</i>	" , " " " " " (")
<i>Penicillium crustosum</i>	GRIPENBERG, R. (1899)
<i>Penicillium cyclopium</i>	MACY, H. and G. H. STEEL (1934)
<i>Penicillium expansum</i>	THOM, C. and R. W. SHAW (1915)
<i>Penicillium fellutanum</i>	MACY, H. and G. H. STEEL (1934)
<i>Penicillium frequentans</i>	" , " " " " " (")
<i>Penicillium Gilmanii</i>	" , " " " " " (")
<i>Penicillium glaucum</i>	DUCLAUX, E. (1901)
	EICHHOLZ, W. (1901, 1902)
	ORLA-JENSEN, S. (1902)
	TEICHERT, L. (1904)
	FETTICK, O. (1908, 1912)
	SAYER, W. S., V. RAHN and B. FARRAND (1908)
	BURR, A. (1910)
	KÜHL, H. (1910)
	BATTEN, L. and H. W. BYWATERS (1918)
	JACOBSON, H. C. (1919)
	STOKOE, W. N. (1921)
	PARASCHTSCHUK, S. (1928)
<i>Penicillium griseo-brunneum</i>	MACY, H. and G. H. STEEL (1934)
<i>Penicillium griseo-fulvum</i>	" , " " " " " (")
<i>Penicillium Howardii</i>	" , " " " " " (")
<i>Penicillium italicum</i>	" , " " " " " (")
<i>Penicillium Johannisoli</i>	" , " " " " " (")
<i>Penicillium Martensii</i>	" , " " " " " (")

<i>Penicillium notatum</i>	MACY, H. and G. H. STEEL (1934)
<i>Penicillium olivaceum</i>	McWEENEY, E. G. (1894)
<i>Penicillium politans</i>	MACY, H. and G. H. STEEL (1934)
<i>Penicillium psittacinum</i>	" , " " " " " (")
<i>Penicillium puberulum</i>	" , " " " " " (")
<i>Penicillium Roqueforti</i>	KÜHL, H. (1910)
	THOM, C. and R. W. SHAW (1915)
	CLINTON, G. P. (1920)
	MACY, H. and G. H. STEEL (1934)
<i>Penicillium solitum</i>	" , " " " " " (")
<i>Penicillium spinulosum</i>	" , " " " " " (")
<i>Penicillium stoloniferum</i>	" , " " " " " (")
<i>Penicillium suaveolens</i>	" , " " " " " (")
<i>Penicillium tabacinum</i>	" , " " " " " (")
<i>Penicillium terrestre</i>	" , " " " " " (")
<i>Penicillium Trzebinskii</i>	" , " " " " " (")
<i>Penicillium urticae</i>	" , " " " " " (")
<i>Penicillium viridicatum</i>	" , " " " " " (")
<i>Rhizopus arrhizus</i>	PARASCHITSCHUK, S. (1928)
<i>Rhizopus nigricans</i>	MACY, H. and G. H. STEEL (1934)
<i>Rhizopus speciosus</i>	" , " " " " " (")
<i>Spicaria divaricata</i>	" , " " " " " (")
<i>Stemphylium butyri</i>	SHAW, G. W. ⁸⁷ (1896)
	PATTERSON, F. W. ⁷⁰ (1900)
	THOM, C. and R. W. SHAW (1915)
<i>Sterigmatocystis</i> sp.	DUCLAUX, E. (1901)
<i>Stilbaciae graphium</i>	PARASCHITSCHUK, S. (1928)
<i>Trichoderma lignorum</i>	MACY, H. and G. H. STEEL (1934)
<i>Trichosporium collae</i>	GRIPENBERG, R. (1899)
<i>Trichothecium roseum</i>	MACY, H. and G. H. STEEL (1934)
<i>Verticillium</i> sp.	DUCLAUX, E. (1901)

In this country, HANZAWA⁸⁷ first reported (1932) that eighty three cultures of molds isolating from butter in Hokkaido had been identified to seventeen kinds of *Penicillia*, two kinds of *Aspergilli* (*Sterigmatocystis*), an *Alternaria* sp., a *Botrytis* sp., a *Fusarium* sp., an *Oidium* sp., a *Catenularia* sp., a *Rhizopus* sp., and some undetermined molds.

According to THOM and SHAW⁸⁸, mold in butter usually takes three forms:

- "1. Orange-yellow (red) areas with a submerged growth of mycelium, which are produced by *Oidium lactis*.
2. Smudged or dirty-green areas, either entirely submerged or with some surface growth. These are produced by species *Alternaria* and *Cladosporium*.
3. Green surface colonies, which are produced by *Penicillium*, or more rarely, *Aspergillus*, either upon the butter, causing decomposition, or upon the container or wrapping, injuring the appearance of the sample in the market."

GRIPENBERG³² who examined storage butter, found that most of the molds in butter belonged to the genera *Penicillium* and *Trichosporium*, and that of these, *Penicillium crustaceum* and *Trichosporium collae* were the most common species.

MACY and STEEL⁶⁰ stated that most of the mold cultures studied were found to cause a noticeable change in the aroma of the butter, and that the appearance of the butter was marred appreciably by many of the cultures but most seriously by species of *Alternaria*, *Hormodendrum*, *Phoma* and *Stemphylium*.

The relation between molds and the keeping quality of butter have been studied by SHUTT³⁸, MACY and RICHIE⁵¹, PARFITT⁶⁹, THOMSON¹⁰², AUSE and MACY⁵, MACY and STEEL⁶⁰, and the others.

That the churn is one of the greatest sources of contamination of butter made from pasteurized cream has been shown early by many investigators. MACY and COMBS⁵³ discovered that the churn was the source of molds in 65 per cent of the creameries studied, salt in 33 per cent, the starter in 40 per cent, the water in 44 per cent and pipes and pumps in nearly 75 per cent of the creameries. MACY, COULTER and COMBS⁵¹, and the author^{82, 83} found the churn to be the most prolific of all sources of yeast and mold infection. Various procedures for cleaning and sterilizing the churn have been advocated by HUNZIKER³⁹, GREGORY²¹, HOOD and WHITE³⁸, JAMES⁴², OLSON and HAMMER⁶⁵, MORRISON, MACY and COMBS^{68, 62}, BENDIXEN⁷, the author⁸³ and the others.

The air in a creamery was considered by GRIMES, KENNELLY and CUMMINS³⁷ and the author⁸² as a possible source of mold contamination of butter. Their results indicated that considerable numbers of molds were falling from the air in the creamery studied. OLSON and HAMMER observed that considerable numbers of bacteria, yeasts and molds were falling from the air inside the churn and that larger

numbers were falling near a churn. Commonly, the numbers of bacteria falling were larger than the numbers of yeasts or molds, and the numbers of molds were larger than the numbers of yeasts⁵. They reported that there was no distinct seasonal variation in the numbers of bacteria, yeasts or molds falling from the air at the various locations studied, and that a muslin cover reduced the number of organisms falling on a surface from the air⁶.

The importance of parchment paper as a source of mold infection has been emphasized by ARUP⁴, GREGER²⁰, HANSEN²⁴, MACY and PULKRABEK⁵¹.

In respect of the growth of molds in butter at different temperatures, the reports are largely in generalities. A report from the United States Department of Agriculture² recommended that butter be stored below 2°F. (−16.67°C.) to prevent mold development. HOOD and WHITE³⁸ pointed out that molds grew in butter over a wide range of temperatures but were checked at temperatures near the freezing point of water. This was in agreement with the views of ROGERS⁷⁹ expressed several years before. MACY^{55, 57} and PULKRABEK⁵¹ observed that temperature was a factor which influenced the development of mold on experimental butters.

In a general way it appears evident that low temperatures impede the development of molds in butter but experimental evidence for different species and specific temperatures is lacking. Butter has been found to be moldy even at relatively low temperatures when stored for sufficient periods of time.

Proper pasteurization when accompanied by effective precautions to prevent recontamination between pasteurizer and churn, materially assists in minimizing the appearance of molds on butter. THOM and AYERS⁹ showed that most species of molds, that may be found in cream are easily destroyed by pasteurizing heat. HUNZIKER¹⁰ found that vat pasteurization at 145°F. (62.8°C.) for 30 minutes and flash pasteurization at 185°F. (85°C.) was 99.9% efficient in destroying yeasts and molds in cream, while flash pasteurization at 165°F. (73.9°C.) showed a yeast and mold destruction of only 78%. STIRITZ⁹¹ demonstrated that pasteurization at 185°F. (85°C.) for 30 seconds (flash) was 99.9% efficient in killing yeasts and molds. HOOD and WHITE³⁸ showed that cream pasteurized at 180°F. (82.2°C.) contained no mold cells.

Observations have been made in a general way upon the effect

of salt on the appearance of mold in butter. BURR and WOLF¹¹ reported that salted butter with a normal curd content was not an exceptionally good substrate for molds and that mold spores could not germinate well when 2 per cent salt was present in the butter. RAHN, BROWN and SMITH⁷⁴ found that *Oidium lactis* increased in unsalted but not in salted butter. HASTING³¹ held the opinion that mold spores could not germinate in salted butter. GRIPENBERG³², COMBS and ECKLES¹², and MACY⁵⁵ also concluded that the salt content of butter had a considerable influence upon the development of mold. FERTIK¹⁸ observed the development of *Oidium lactis*, *Mucor mucedo* and *Penicillium glaucum* in unsalted and salted butters. All three species decreased in proportion to the increased percentage of salt. No growth appeared in samples containing 4 per cent or more of salt. THOM and SHAW⁷⁸ investigated that three cultures of *Alternaria*, four of *Mucor*, two of *Penicillium roqueforti*, and individual cultures of the following, *Cunninghamella* sp., *Fusarium* sp., *Oidium lactis*, *Penicillium* sp., *Penicillium expansum*, *Penicillium stoloniferum*, *Penicillium chrysogenum*, *Penicillium purpurogenum*, *Rhizopus nigricans*, *Trichoderma* sp., and a red mold grew on CZAJEK's agar containing 6.5 per cent of salt. In 14.4 per cent of salt, *Alternaria* and *Penicillium* alone developed. In an 18 per cent salt, three species of *Penicillium* and *Aspergillus repens* grew; in 21 per cent the spores of *Penicillium chrysogenum* were the only ones to germinate.

SCHIAFFER⁸¹ stated that the growth of molds was rather favored by the low acidity of butter made from pasteurized cream. According to LAXA⁴⁸ the presence of lactic acid did not hinder markedly the peptonization of casein by molds. In studies carried on by BOEKHOUT and DE VRIES⁸ two cultures of *Hormodendrum cladosporioides* were grown on a medium containing lactic acid. One culture was checked by 0.75 per cent lactic acid; the other not until the percentage of acid reached 1.0 per cent. Many papers dealing with the effect of hydrogen-ion concentration upon the development of molds have been presented in recent years. These investigations indicate that most molds grow over a wide range of hydrogen-ion concentrations. Most species are favored by an acid medium.

EXPERIMENTALS

A. Taxonomic consideration of the molds found in butter.

I. Isolation of molds from butter.

The molds investigated here, were isolated from monthly butter samples manufacturing at important thirteen creameries in Hokkaido extending over 3 years since 1935. After the butter had been worked and was ready to be removed from the churn. The samples for microbiological analysis were taken aseptically as cubes about two pounds by means of a sterile spatula. The butter samples were placed and packed in sterile parchment papers. All samples were placed for twenty four hours, immediately after sampling, in a refrigerator where the temperature were held at -10°C . The samples were cold and packed for transport carefully so as to prevent breakage and retain a low temperature. Upon receipt of the samples at the laboratory they were plated as soon as possible by means of the following methods.

A clot of butter, at least 10 g., were removed aseptically from the center of the butter sample with a sterile trier. The butter was transferred from the trier to the sterile sample jar with a sterile spatula or spoon. Then the sample jar containing the butter to be tested was placed in a water bath between 40 and 45°C ., and shaken until the butter was of thin creamy consistency. The time required for the sample to reach a creamy consistency did not allow to exceed 15 minutes. After depositing one c.c. of the melted butter in the Petri dishes by means of a sterile pippette, about 10 c.c. of the liquefied agar was introduced at 40 to 42°C . into each plate. The medium used "Koji" extract-agar. Just prior to pouring, the reaction was adjusted to pH 3.5-4.0 with 1 per cent lactic acid solution to avoid growth of bacteria. The agar and the sample was mixed thoroughly and spread it evenly over the bottom of the dish by rotating. After solidification of the medium, the plates were inverted and placed in the incubator at once. The plates were incubated for 5 or 7 days at 27°C . If the colonies of molds were developing on the plates, they were isolated on the agar slant.

Five hundreds and eighteen cultures of molds were obtained by this method. They were classified into 15 genera—48 species and 5 varieties as follows:

Phycomycetes

Order Spirogyrales

Family Mucoraceae

Subfamily Mucorae

Genus *Rhizopus* *Rh. nigricans* EHRENBERG

Deuteromycetes

Order Moniliales

Family Moniliaceae

Hyalosporae

Micronemeae

Genus *Oospora* *Oo. lactis* (FRES.) SACCARDO.*Oo. sutaveolens* (LINDNER) LINDAU.*Oo. lupuli* (MATTEWS et LOFT) SACCARDO.

Macronemeae

Aspergillae

Genus *Aspergillus* ... *Asp. clavatus* DESMAZIERS.*Asp. Chevalieri* (MANGIN) THOM et CHURCH.*Asp. Chevalieri* var. *ruber* n. v.*Asp. repens* (CORDA) SACCARDO.*Asp. ruber* (SPIEKERMAN et BREMER)

THOM et CHURCH.

Asp. fumigatus FRESENIUS.*Asp. nidulans* (FIDAM) WINTER.*Asp. Scleroti* (BAINIER et SARTORY)

THOM et CHURCH.

Asp. versicolor (VUILLEMIN) TIRABOSCHI.*Asp. versicolor* var. *magnus* n. v.*Asp. flavus* LINK.*Asp. flavus* var. *asper* n. v.*Asp. terreus* THOM.*Asp. yezoensis* nov. sp.Genus *Penicillium* ... *Pen. yezoensum* HANZAWA.*Pen. spinulosum* THOM.*Citromyces Pfefferianus* WEHMER.*Pen. parallelorum* nov. sp.*Pen. carmino-violaceum* DIERCKX.*Pen. fellutanum* BIOURGE.*Pen. citreo-viride* BIOURGE.*Pen. Paczoskii* ZALESKI.

- Pen. Terlikowskii* ZALESKI.
Pen. columnare THOM.
Pen. ellipticum nov. sp.
Pen. Waksmani ZALESKI.
Pen. Sartoryi THOM.
Pen. spinulo-ramigenum nov. sp.
Pen. digitatum SACCARDO.
Pen. citreo-roseum DIERCKX.
Pen. Roqueforti THOM.
Pen. Janczewskii ZALESKI.
Pen. solitum WESTLING.
Pen. flavo-glaucum BOURGUE.
Pen. patitans WESTLING.
Pen. crustosum THOM.
Pen. crustosum var. *spinulosporum* n. v.
Pen. expansum THOM.

Genus *Scopulariopsis* · *Scop. brevicaulis* (SACCARDO) BAINIER.

Genus *Paecilomyces* · *Paec. varioti* BAINIER.

Cephalosporiae

Genus *Trichoderma* · *Trichoderma Koningi* OUDEMANS.

Botrytidae

Genus *Botrytis* ······ *Botrytis cinerea* PERSOON.

Hyalodidymae

Genus *Trichothecium* · *Trichothecium roseum* LINK.

Family Dematiaceae

Amerosporae

Macronemeae

Genus *Dematium* ······ *Dematium pullulans* DE BARY.

Didymosporae

Macronemeae

Genus *Cladosporium* ··· *Cl. herbarum* (FRES.) LINK.

Dictyosporae

Macronemeae

Genus *Stemphylium* ··· *St. botryosum* WALLR. var. *botrytis*
 (FREUSS) LINDAU.

Genus *Alternaria* ······ *Al. tenuis* NEES.

Family Tuberculariaceae

Mucedineae

Phragmosporae

Genus *Fusarium* *Fusarium* sp.

Dematiaceae

Amerosporae

Genus *Epicoccum* *Ep. purpurascens* EHRENBERG.

The descriptions of these molds are as follows. (The colony colors of molds were described according to RIDGWAY's color standards⁷⁷.)

II. Description of molds.

Rhizopus nigricans EHRENBERG.¹⁰³

(Pl. 1—1)

Colonies on Czapek's solution-agar poor, colorless, wooly. Colonies on Koji extract-agar abundant, heavily cobwebbed, dark grayish; reverse deep olive-buff (Rdg., XL, 21''').

The mycelium at first white, later becomes brown with stolons and rhizoids. Sporangioophores generally occur in clusters of three or more unbranched sporangioophores, which arise from the place where the rhizoids are formed, 500 to 2,000 μ long by 15 to 30 μ in diameter; sporangia black, large, hemispherical 100 to 300 μ in diameter, in which containing columella and spores; columella large and oval, 60 to 120 μ long by 55 to 100 μ in diameter; spores irregular form, globose or oval, angular, 9 to 12 by 6 to 10 μ , having parallel wales on the surface.

Growth on Koji extract-gelatin abundant, up to 15 mm. high, wooly, dark gray; gelatin liquefied slowly, uncolored.

Growth on potato not abundant, white, then chestnut-brown (Rdg., XIV, 11').

Litmus milk slightly changed to bluish.

Oospora lactis (FRES.). SACCARDO.^{35, 41, 51, 51}

Syn. *Oidium lactis* FRESSENIUS.^{45, 91, 103}

(Pl. 1—2)

Colonies on Koji extract-agar abundant, raised, somewhat restricted, moist, white; reverse white to cream-buff (Rdg., XXX, 19''). Mycelium consists of irregularly branching, septate hyphae; conidia are formed by the separation of the oidial bodies by partition walls. The whole hyphae may break down into single cells. Chains of oidia often form a zigzag line, because the individual spores still stick

to one another; oidia 5 to 12 μ by 3.2 to 5 μ .

Colonies on Czapek's solution agar poor, white.

Growth on Koji extract-gelatin abundant, thin, white to pale yellowish gray; gelatin not liquefied.

Growth on potato not good, white.

Milk unchanged; litmus not discolored.

Oospora suaveolens (LINDNER) LINDAU.⁴¹

Syn. *Sachsia suaveolens* LINDNER.^{35, 51, 91}

(Pl. 2-3)

Colonies on Czapek's solution-agar poor, white powdery.

Colonies on Koji extract-agar spreading, dense, white cream-buff (Rdg., XXX, 19''), moist appearance in age; reverse white; an agreeable odour resembling amyl acetate is developed. Hyphae branched, septate, break up to form oidia in chains; oidia cylindrical or ovoid, 4 to 12 μ long by 2.5 to 4.5 μ in diameter, sometimes occur as globose or irregular yeast-like cells.

Growth on Koji extract-gelatin abundant, white; reverse white; an agreeable ester-like odour developed; gelatin not liquefied; slightly brownish pigment formed.

Growth on potato not good, velvety, white.

Milk peptonized; litmus reduced.

Oospora lupuli (MATTHEWS et LOTT) SACCARDO.^{41, 91}

Syn. *Oidium lupuli* MATTHEWS et LOTT.⁵¹

(Pl. 3-5)

Colonies on Czapek's solution-agar poor, white, spreading; salmon-colored masses of conidia appearing on the margin, usually at the rim of the Petri dish; surface mycelium carrying short branches, from which the numerous conidia are formed; conidia ovoid to cylindrical, 5 to 12 μ in long axis, formed by the rounding off the cell separated by partitions from straight and branched hyphae; conidia give rise to new ones by budding.

Colonies on Koji extract-agar abundant, moist at first, grayish white, then changed to ochraceous-salmon (Rdg., XV, 13') with conidia production.

Growth on Koji extract-gelatin abundant, wooly, pinkish buff

(Rdg., XXIX, 17''); reverse chestnutbrown (Rdg., XIV, 11'); gelatin liquefied slowly, colored dark brownish.

Growth on potato abundant, floccose, shell pink (Rdg., XXVIII, 11'') to ochraceous-salmon (Rdg., XV, 13').

Milk peptonized; litmus slowly reduced.

Aspergillus clavatus DESMAZIERS.¹⁰⁰

(Pl. 3—4)

Colonies on Czapek's solution-agar gray green to dark green (mytho green; Rdg., XLI, 29'''), heavy, rapidly growing and spreading with radiate wrinkles, reverse white to deep olive-buff (Rdg., XL, 21'''); conidiophores short up to 1,000 μ long by up to 20 μ diameter, walls smooth, colorless, gradually enlarged at apex in to a clavate vesicle which is fertile over an area up to 120 μ long by 25 to 55 μ in longest diameter; sterigmata in a single series closely covering the vesicle, 7.5 to 9 μ by 2.5 to 3 μ ; conidia elliptical or oval, green, 3.8 to 4.5 μ by 3 to 4 μ , thinwalled, smooth; perithecia and sclerotia not found.

Growth on Koji extract-gelatin abundant, olive-buff (Rdg., XL, 21''') or dark olive-buff (Rdg., XL, 21'''), reverse dark olive-buff (Rdg., XL, 21''') to olive-brown (Rdg., XL, 17'''); gelatin liquefied to 5 mm. deep in 40 days at 15°C., change to brownish red.

Growth on potato raised, floccose, vetiver green (Rdg., XLVII, 25''') or deep grayish olive (Rdg., XLVI, 21'''), substratum uncolored.

Milk peptonized strongly, litmus change to red.

Aspergillus Chevalieri (MANGIN) THOM et CHURCH.¹⁰⁰

(Pl. 4—6)

Colonies on Czapek's solution-agar at first glaucous green (Rdg., XXXIII, 39''), then dusky green (Rdg., XXXIII, 37''), grape green (Rdg., XLI, 25''') to olive yellow (Rdg., XXX, 23'') or pyrite yellow (Rdg., IV, 23), reverse lemon yellow to pyrite yellow; conidiophores arise from substrate, mostly short 80 to 180 μ long by 4 to 7 μ diameter, rarely large up to 350 μ long by 5 to 7.5 μ diameter, walls smooth, colorless, gradually enlarged at apex in to a flask-shaped vesicle which is fertile over almost all of the surface, 8 to 21 μ in diameter; sterigmata in a single series closely covering the vesicle with axis roughly parallel to axis of the stalk, 6 to 10 μ long by 3.5

to 4.5μ diameter; conidia verrucose, oval or globoid, 4.5 to 5.8μ by 4.0 to 5.5μ large, conidial chains divergent; perithecia are formed abundantly, yellow, globose 50 to 120μ diameter, in which asci abundantly produced; ascus include 8 ascospores; ascospores disc-shape, 4.5 to 6μ diameter 4 to 5μ thickness, with distinct furrow and ridges.

Growth on Koji extract-agar slant glaucous green (Rdg., XXXIII, 39'') to deep grayish blue-green, yellow perithecia produced at central area, powdery, reverse and agar yellowish brown.

On Koji extract-gelatin deep slate-olive (Rdg., XLVI, 29'''), andover green (Rdg., XLVII, 25''') to citron-yellow (Rdg., XVI, 23') or lemon yellow (Rdg., IV, 23), reverse yellow-ocher (Rdg., XV, 17') to buffy citrine (Rdg., XVI, 19'), substrate change to pale brownish red, gelatin not liquefied.

Growth on potato good, slightly raised and floccose, light brownish olive (Rdg., XXX, 19'') or Sepia (Rdg., XXIX, 17''); perithecia abundantly produced.

Milk coagulated but not peptonized in 20 days at 27°C .; litmus change to deep blue.

Aspergillus Chevalieri var. *ruber* nov. var.

(Pl. 4—7)

Colonies on Czapek's solution-agar at first glaucous green (Rdg., XXXIII, 39''), then buffy citrine (Rdg., XVI, 19') or light brownish olive (Rdg., XXX, 19''), margin lemon chrome (Rdg., IV, 21) by perithecia, reverse primuline yellow (Rdg., XVI, 19') to ochraceous-buff (Rdg., XV, 15') at margin, chocolate (Rdg., XXVIII, 7'') at central area, brownish soluble pigment produced; conidiophores short, 50 to 150μ long by 4 to 7μ rarely up to 12μ diameter, walls smooth, gradually enlarged upward, with apical flask-shaped vesicles up to 11 to 21μ rarely 28μ in diameter, fertile mostly on the upper half, bearing sterigmata in one series, usually 6.5 to 10μ by 2.5 to 3.5μ crowded, closely packed with axis roughly parallel to axis of the stalk, chains of conidia divergent; conidia oval or globoid, slightly rough or smooth, 4 to 7μ by 3 to 5.5μ , rarely 9 by 6μ ; perithecia globoid, 65 to 170μ in diameter; ascus contains 8 ascospores; ascospores 4.5 to 5.5μ by 3.5 to 4.5μ , with distinct furrow and crests.

Growth on Koji extract-agar slant at first glaucous green, then

grayish green with solid powderlike appearance, yellowish brown in central area, reverse and agar dark reddish brown.

Koji extract-gelatin not liquefied in 40 days at 15°C., surface of growth dark olive-gray (Rdg., LI, 23''') to mineral gray (Rdg., XLVII, 25'''), reverse yellow ocher (Rdg., XV, 17'), substratum change to brownish red.

Growth on potato good, floccose, deep grayish olive (Rdg., XLVI, 21''') to deep olive (Rdg., XL, 21'''), yellowish perithecia produced, substratum change to brown.

Milk unchanged in 20 days at 27°C., but litmus change to deep bluish color.

This mold resembles *Aspergillus Chevalieri* (MANGIN) THOM et CHURCH in ascospores, but is different in color of colony and of substratum which change to brown or reddish brown. The author regard this as a variety of *Aspergillus Chevalieri*, and named *Aspergillus Chevalieri* var. *ruber*.

Aspergillus repens (CORDA) SACCARDO.^{100, 28}

(Pl. 5—8)

Colonies on Czapek's solution-agar glaucous green when young, then oil green (Rdg., V, 27), central area change to citron green (Rdg., XXXI, 25'') to sulphur yellow (Rdg., V, 25) with perithecia formation, marginal area glaucous green, reverse lemon yellow (Rdg., IV, 23) or buffy citrine (Rdg., XVI, 19') to sayal brown (Rdg., XXIX, 15''), substratum change to pale yellowish brown; conidiophores large up to 400 μ long by 8 to 11 μ diameter, walls smooth; vesicle flask-shaped, 13 to 19 μ in diameter; sterigmata in a single series closely covering the vesicle, 8 to 11 μ long by 3 to 5 μ diameter, chains of conidia divergent; conidia oval to globose, 5 to 7.5 μ by 4.5 to 7 μ , verruculose; perithecia globoid, 65 to 120 μ in diameter; ascus contains 8 ascospores, which from 4.7 to 6 μ in long axis with shallow and smooth furrow, no frill or ridge.

Growth on Koji extract-agar slant glaucous green to dirty grayish green, central area and reverse yellowish brown, substratum change to brownish; in old cultures surface change to deep dirty grayish green, yellowish gray-brown in center, reverse and substratum change to dark yellowish gray-brown.

Koji extract-gelatin not liquefied, surface growth light yellowish

olive (Rdg., XXX, 29'') to deep grayish olive (Rdg., XVI, 19'), substratum change to brownish red.

Growth on potato poor, light brownish olive (Rdg., XXX, 19'') to buffy olive (Rdg., XXX, 21'') potato change to brown color.

Milk unchanged in 20 days at 27°C., but limus change to blue then reduced, grayish yellow-green soluble pigment produced.

Aspergillus ruber (SPECKERMANN et BREMER)

THOM et CHURCH.^{100, 28}

(Pl. 5—9)

Colonies on Czapek's solution-agar at first glaucous green then towniy-olive (Rdg., XXIX, 17'') to orange citrine (Rdg., IV, 19) or lemon chrome (Rdg., IV, 21) at central area with production of perithecia, marginal area glaucous green (Rdg., XXXIII, 39''), reverse rau sienna (Rdg., III, 17) or brownish black, substratum change to yellowish brown to reddish brown color; conidiophores mostly arising from substratum, 250 to 300 μ long by 8 to 10 μ diameter, walls smooth; vesicle clavate to subglobose, 15 to 19 μ in diameter; sterigmata radiating in single series, 9 to 15 μ long by 3.5 to 5.5 μ diameter, conidial chains divergent; conidia elliptical to globose 6.5 to 9.5 μ long by 3.2 to 6 μ diameter, verruculose; perithecia globose, yellow, 40 to 140 μ in diameter; ascus contains 8 ascospores; ascospore thick disc-like, 6 to 6.5 μ in long axis, with shallow furrow, no frill or ridges.

Growth no Koji extract-agar abundant, at first glaucous green then dirty grayish green, central area change to reddish brown, reverse dark reddish brown, substratum change to reddish brown; old culutures powder-like, reddish brown, reverse and substratum change to brownish black.

Growth on Koji extract-gelatin abundant, deep grayish olive (Rdg., XLVI, 21'''), reverse brownish black, substratum red-brownish black and fluorescent, gelatin not liquefied in 40 days at 15°C.

Growth on potato flat and floccose, perithecia abundant, light brownish olive (Rdg., XXX, 19''), substratum change to brown.

Milk unchanged in 20 days at 27°C., but litmus change to pale blue then reduced, grayish yellow-green soluble pigment produced.

Aspergillus fumigatus FRESENIUS.¹⁰⁰

(Pl. 6—10)

Colonies on Czapek's solution-agar raised and spreading, floccose and funiculose, glaucous green (Rdg., XXXIII, 39'') to artemisia green (Rdg., XLVII, 33'''), reverse and substratum uncolored; conidiophores walls smooth, densely crowded, up to 300μ long by 7 to 8μ in diameter, arising directly from submerged hyphae or as branches from aerial hyphae, gradually enlarged upward, with apical flask-shaped vesicles up to 16 to 30μ in diameter, fertile mostly only on the upper half, bearing sterigmata in simple series, about 6 to 9μ long by 2.5 to 3μ in diameter, crowded closely packed with axis roughly parallel to axis of the stalk, conidial chains from solid columns up to 200μ by 50 to 60μ ; conidia ovate to globose, 2.5 to 3.5μ in diameter, smooth.

Growth on Koji extract-gelatin heavy, white to glaucous green, reverse zinc orange (Rdg., XV, 13'), rugose, substratum uncolored but liquefied to 2 mm. deep in 40 days at 15°C .

Growth on potato abundant, raised, floccose, artemisia green (Rdg., XLVII, 33''') to andover green (Rdg., XLVII, 25'''), substratum uncolored.

Milk strongly peptonized, litmus change to deep blue.

Aspergillus nidulans (EIDAM) WINTER.¹⁰⁹

(Pl. 6—11)

Colonies on Czapek's solution-agar spreading, floccose to funiculose, Lincoln green (Rdg., XLI, 25''') to deep grape green (Rdg., XLI, 25'''), reverse and substratum ocher red (Rdg., XXVII, 5'), abundant colorless drops formed; conidiophores commonly 40 to 80μ long by 3.5 to 4.5μ in diameter, increasing gradually to a domelike vesicle 8 to 11μ in diameter, walls smooth, thick; sterigmata in two series, crowded closely, primary sterigmata 4 to 6.5μ by 2 to 3μ , secondary sterigmata 5.5 to 8μ by 2 to 3μ ; conidia globose, 3 to 4μ in diameter, rough, conidial chains adherent into a solid column 120 to 130μ long, by 30 to 50μ in diameter; perithecia not produced.

Growth on Koji extract-gelatin abundant, vinaceous-buff to dark olive-buff (Rdg., XL, 17'''–21'''), reverse olive-green (Rdg., XL 17'''), substratum change to pale brown, then gradually to black, gelatin liquefied about 10 mm. deep in 40 days at 15°C .

Growth on potato heavy, raised, velvety to floccose, Lincoln-green (Rdg., XLI, 25''), substratum change to brown.

Milk strongly peptonized, litmus at first weak bluish then change to red.

Aspergillus Sydowi (BAINIER et SARTORY) THOM et CHURCH.¹⁰⁰

(Pl. 6—12)

Colonies on Czapek's solution-agar spreading, somewhat raised, velvety, with some trailing hyphae, marginal area glaucous-blue (Rdg., XXXIV, 43'') to artemisia green (Rdg., XLVII, 33'''), central area deep olive-buff (Rdg., XL, 21'') to smoke gray (Rdg., XLVI, 21'''), reddish brown drops appeared, reverse and substratum cacao brown (Rdg., XXVIII, 9'') to vandyke red (Rdg., XIII, 1'); conidiophores mostly arising from submerged hyphae, commonly 100 to 350 μ long by 2.5 to 3.5 μ in diameter, walls colorless, smooth and thick, heads radiate; vesicles 9 to 18 μ in diameter; sterigmata in two series, primary sterigmata 4.3 to 5.2 μ by 3 to 3.7 μ , secondary sterigmata 4.5 to 7.2 μ by 2.7 to 3.7 μ ; conidia globose, 2.8 to 3.5 μ in diameter, spinulose; reduced conidial apparatus frequent as small heads, penicillate clusters of branched sterigmata on short conidiophores or single branched sterigmata sessile on trailing hyphae; perithecia or sclerotia are not formed.

Growth on Koji extract-gelatin good, andover green (Rdg., XLVII, 25'''), reverse olive-buff (Rdg., XL, 21'') to dark olive-buff (Rdg., XL, 21'''), substratum change to brownish red, gelatin liquefied to 23 mm. deep in 40 days at 15°C.

Growth on potato good slightly raised, floccose, deep grayish olive (Rdg., XLVI, 21'''), substratum change to brown.

Milk peptonized very strongly, litmus reduced.

Aspergillus versicolor (VUILLEMIN) TIRABOSCHI.¹⁰⁰

(Pl. 7—13)

Colonies on Czapek's solution-agar at first white, passing through shades of yellow, to deep olive-buff (Rdg., XL, 21'') or vetiver green (Rdg., XLVII, 25'''), margin white, reverse colorless to pale grayish or seashell pink (Rdg., XIV, 11'), raised, velvety to funiculose; conidiophores directly arising from submerged hyphae, 300 to 360 μ long by 3.5 to 4 μ in diameter, or branching as short branches, penicillate

clusters of branched sterigmata or single branched sterigmata from trailing aerial hyphae, wall smooth, thick; vesicles 7.5 to $10\ \mu$ in diameter, commonly flask-shaped, fertile on the upper two-thirds with radiating sterigmata in two series, primary sterigmata 4 to $6\ \mu$ long by 2 to $2.5\ \mu$ in diameter, secondary sterigmata 6 to $7\ \mu$ long by 1.5 to $2.2\ \mu$ in diameter; conidia oval to globose 2.5 to $3.5\ \mu$ in diameter, delicately roughened, in loosely radiating chains.

Growth on Koji extract-gelatin heavy, distinct rugose, deep olive-buff (Rdg., XL, 21'''), reverse colorless, gelatin liquefied to 25 mm. deep, change to brownish red.

Growth on potato abundant, raised, floccose, conyidalis green (Rdg., XLI, 29''') to vetiver green (Rdg., XLVII, 25'''), substratum uncolored.

Milk strongly peptonized, at first litmus change to pale blue then reduced.

Aspergillus versicolor var. *magnus* nov. var.

(Pl. 7-14)

Colonies on Czapek's solution-agar at first white, passing through shades of yellow, to vetiver green (Rdg., XLVII, 25''') or deep grape green (Rdg., XLI, 25'''), reverse colorless to sulphur yellow (Rdg., V, 25); conidiophores mostly arising from the substratum, larger than *Aspergillus versicolor*, up to $600\ \mu$ long by 5 to $7\ \mu$ in diameter, walls smooth, thick; vesicle flask-shaped, 11 to $14.5\ \mu$ in diameter; conidia oval to globose, 2.5 to $3.5\ \mu$ in diameter, delicately spinulose, in radiating chains.

Growth on Koji extract-gelatin good, at first deep olive-buff (Rdg., XL, 21'''), then covered with white hyphae, reverse buffy citrine (Rdg., XVI, 19'), gelatin liquefied to 25 mm. deep in 40 days at 15°C ., slightly change to brown.

Growth on potato heavy, raised, floccose, andover green (Rdg., XLVII, 25''') to deep grayish olive (Rdg., XLVI, 21''') or vinaceous-buff (Rdg., XL, 17''').

Milk strongly peptonized, litmus reduced. This molds resembles *Aspergillus versicolor* (VUILLEMIN) TIRABOSCHI¹⁰⁰, but is different in conidiophores which almost arising from submerged hyphae and distinct large. The author regard this as a variety of *Aspergillus versicolor*, and named *Aspergillus versicolor* var. *magnus*.

Aspergillus flavus LINK¹⁰⁹

(Pl. 8—15)

Colonies on Czapek's solution-agar, spreading, buffy citrine (Rdg., XVI, 19), reverse white to olive buff (Rdg., XL, 21'''), dark brownish pigment formed in old cultures; conidiophores arising directly from substratum, or branching from aerial hyphae, 200 to 400 μ long by 6 to 8 μ in diameter, broadening upward, with walls colorless, pitted or spiny, gradually enlarging to form a vesicle 15 to 20 μ in diameter; sterigmata in one series, compactly produced at a half upper part of vesicle, 7 to 8 μ by 3.5 to 4 μ in diameter, conidial chains adherent to columnar mass; conidia subglobose or globose, smooth, 4.5 μ to 6 μ in diameter; perithecia or sclerotia not produced.

Growth on Koji extract-gelatin heavy, white, reverse deep colonial buff (Rdg., XXX, 21''), gelatin liquefied to 20 mm. deep, uncolored.

Growth on potato good, velvety or floccose, buffy citrine (Rdg., XVI, 19') with abundant conidia, substratum uncolored.

Milk peptonized strongly, litmus change to blue.

Aspergillus flavus var. *asper* nov. var.

(Pl. 8—16)

Colonies on Czapek's solution-agar spreading, buff citrine (Rdg., XXX, 21'') to yellowish olive (Rdg., XXX, 23''), reverse Isabella color (Rdg., XXX, 19'') to ecru-olive (Rdg., XXX, 21''); conidiophore arising from substratum, 120 to 300 μ long by 6.5 to 8.5 μ in diameter, walls slightly pitted, enlarging upward to form a vesicle 13 to 18.5 μ in diameter; sterigmata in one series, compactly produced at a half upper part of vesicle, 8 to 10 μ long by 3 to 4 μ in diameter; conidial chains adherent into a columnar mass; conidia globose or subglobose, asperated, 4 to 7 μ in diameter; perithecia or sclerotia not produced.

Growth on Koji extract-gelatin heavy, olive yellow (Rdg., XXX, 23''), reverse deep colonial buff (Rdg., XXX, 21'') to buffy citrine (Rdg., XVI, 19'), gelatin liquefied to 15 mm. deep, uncolored in 40 days at 15°C.

Growth on potato good, velvety, buffy citrine (Rdg., XVI, 19'), substratum uncolored.

Milk peptonized strongly, litmus change to blue.

This mold resembles to *Aspergillus flavus* LINK,¹⁰⁰ but is different in conidia which asperated. The author regard this as a variety of *Aspergillus flavus*, and named *Aspergillus flavus* var. *asper*.

Aspergillus terreus THOM.¹⁰⁰

(Pl. 9—17)

Colonies on Czapek's solution-agar spreading, velvety, from light ochraceous-buff (Rdg., XV, 15') through cinnamon-buff (Rdg., XXIX, 17'') to sayal brown (Rdg., XXIX, 15''), colorless drops found, reverse lemon chrome (Rdg., IV, 21) to citron yellow (Rdg., XVI, 23'), agar lemon yellow (Rdg., IV, 23); conidiophores 70 to 100 μ long by 5.5 to 8 μ in diameter, with walls smooth, colorless, up to 1 μ thick, unseptate, with apex enlarged to form a vesicle commonly 15 to 19 μ in diameter, bearing close packed sterigmata in two series upon its domelike upper surface; primary sterigmata 6 to 7 μ long by 1.5 to 2 μ in diameter, secondary sterigmata 6.5 to 7.5 μ long by 1.5 to 1.8 μ in diameter; conidial chains adherent to solid columnar mass; conidia globose, 1.7 to 3 μ in diameter, smooth.

Growth on Koji extract-gelatin abundant, light pinkish cinnamon (Rdg., XXXIX, 15'') to sulphur yellow (Rdg., V, 25) or pinard yellow (Rdg., IV, 21), reverse deep colonial buff (Rdg., XXX, 21'') or black, gelatin liquefied to 10 mm. deep, change to brownish red.

Growth on potato abundant, flat, velvety or floccose, cinnamon-buff (Rdg., XXIX, 17'') to tawny olive (Rdg., XXIX, 17'), substratum uncolored.

Milk peptonized strongly, litmus change to blue.

Aspergillus yezoensis nov. sp.

(Pl. 9—18)

Colonies on Czapek's solution-agar spreading, velvety, black, reverse white to olive buff (Rdg., XL, 21'''); conidiophores commonly 400 to 600 μ long, sometimes up to 1,000 μ , by 8 to 10 μ in diameter, walls heavy, 1 to 1.5 μ in thickness, smooth hyaline; vesicles large spherical, 25 to 35 μ in diameter, covering with compact sterigmata; sterigmata in one series, 6 to 9 μ long by 3 to 5 μ in diameter; conidial chains adherent into diverging columnar masses; conidia globose, 3 to 4 μ in diameter, with spiny points.

Growth on Koji extract-gelatin distinct rugose, brownish black,

reverse colonial buff (Rdg., XXX, 21''), gelatin liquefied to 13 mm. deep, but uncolored.

Growth on potato velvety, vandyke brown (Rdg., XXVIII, 11'') or brownish black, substratum uncolored.

Milk peptonized strongly, litmus change to red.

This species resembles to *Aspergillus luchuensis* INUI¹⁰⁰ in one series sterigmata, but is different in conidial chains which adherent into diverging columnar masses, in larger conidia, and in strong peptonizing power. The author regard this as a new species, and named *Aspergillus yezoensis*.

Penicillium yezoensum HANZAWA.²⁷

(Pl. 10—19)

Colonies on Czapek's solution-agar spreading, velvety or funiculose, gnaphalium green or pea green (Rdg., XLVII, 29'''), then change to light pinkish cinnamon (Rdg., XXIX, 15'') with sclerotia-production from central area, droplets abundant, reverse cream-buff or chamois (Rdg., XXX, 19'') to light mineral gray (Rdg., XLVII, 25'''), gradually tinged with pink, zonate in age; conidiophores 120 to 200 $\mu \times 2.5$ to 3 μ unbranched, dilated to 4.5 to 6 μ at the apex and bearing a verticil of 7 to 9 sterigmata 10 to 12 by 3 to 3.5 μ ; conidia in chains parallel to loosely columnar in arrangement, 2.5 to 3.5 by 2 to 2.5 μ , ellipsoid, thin walled, faintly spinulose; sclerotia salmon, subglobose, 100 to 300 μ in diameter.

Growth on Koji extract-gelatin abundant, rugose, vinaceous cinnamon to light congo pink (Rdg., XXVIII, 7'') with sclerotia, reverse naples yellow to bister (Rdg., XXIX, 15''), substratum change to brownish, gelatin not liquefied.

Growth on potato poor, flat and velvety, white, substratum colored.

Milk peptonized, change to reddish brown then yellow-brown, litmus change to blue.

Penicillium spinulosum THOM.¹⁰¹

(Pl. 10—20)

Colonies on Czapek's solution-agar spreading, 700 to 800 μ in depth, floccose, andover green to slate olive (Rdg., XLVII, 25'''-29'''), reverse colorless to deep olive-buff (Rdg., XL, 21'') to chamois (Rdg.,

XXX, 19''), center and margin mineral gray (Rdg., XLVII, 25'''); drop not produced; sclerotia and perithecia are not found; zonation appeared in age. Conidiophores arising from submerged or creeping hyphae, walls smooth, 30 to 150 μ long by 2 to 3 μ in diameter with apex enlarged to 4.5 to 5 μ in diameter, bearing a single verticil of sterigmata 9.5 to 10.5 by 3 to 3.5 μ ; penicillus a loose column of conidial chains up to 100 to 200 μ in length by 10 to 20 μ ; conidia globose, 2.7 to 3.2 μ in diameter, spinulose.

Growth on Koji extract-gelatin abundant, rugose, mineral gray (Rdg., XLVII, 25''') to deep grayish olive (Rdg., XLVI, 21'''); reverse olive buff (Rdg., XL, 21''') to naples yellow (Rdg., XVI, 19'); liquefying gelatin slowly, changing to red.

Growth on potato abundant, rugose, andover green (Rdg., XLVII, 25''') to Lincoln green (Rdg., XLI, 25'''), substratum uncolored.

Milk alkaline and peptonized.

Citromyces Pfefferianus WEHMER.¹⁰¹

(Pl. 11-21)

Colonies on Czapek's solution-agar spreading, flat, 1 to 1.8 mm. in depth, velvety or funiculose, mostly azonate, with margin broad, white, sage green to slate olive (Rdg., XLVII, 29'''); reverse of colonies pale ochraceous-buff to light ochraceous-buff (Rdg., XV, 15') at central, light mineral gray (Rdg., XLVII, 25''') at marginal area. Conidiophores arising from submerged or creeping hyphae, sometimes branched, rarely septate, 50 to 120 μ long by 1.2 to 2.5 μ with apex enlarged to 4 to 6 μ in diameter, walls smooth, branches 19 to 20 μ long; sterigmata 9 to 14 by 3.5 to 4.5 μ , 4 to 6 in number, compact, single; conidial chains parallel; conidia globose or subglobose, smooth, 2.2 to 4 by 2.2 to 3.3 μ ; sclerotia or perithecia are not found.

Growth on Koji extract-gelatin abundant, andover green (Rdg., XLVII, 25'''), later covered with abundant aerial hypae, colorless or pale pinkish cinnamon (Rdg., XXIX, 15''); reverse rugose, olive buff (Rdg., XL, 21'''), blakish olive at center, dark citrine (Rdg., IV, 21) at margin; gelatin liquefied to 5 mm. in depth in 40 days at 15°C.

Growth on potato abundant, raised, rugose, felted, andover green to kronbergs green (Rdg., XXXI, 25'') or olive green (Rdg., IV, 23); substratum uncolored.

Milk alkaline, but not peptonized.

Penicillium parallelosporum nov. sp.

(Pl. 11—22)

Colonies on Czapek's solution-agar spreading, tea green (Rdg., XLVII, 25) to storm gray (Rdg., LII, 35'''), floccose, 1.6 to 2.2 mm. in depth; reverse pinkish buff or cinnamon-buff (Rdg., XXIX, 17''), mineral gray (Rdg., XLVII, 25''') at margin. Conidiophores 150 to 250 μ long by about 2.5 μ with apex enlarged to 6.5 to 7 μ in diameter, walls distinct spinulose, unbranched, sterigmata 10 to 15 by 3 to 3.5 μ , 7 to 9 in numbers, single; conidial chains parallel to 300 to 400 μ long; conidia elliptic, smooth, 2.5 to 3.5 by 1.5 to 2.3 μ ; perithecia or sclerotia are not found.

Growth on Koji extract-gelatin abundant, distinctly rugose, mineral gray (Rdg., XLVII, 25'''); reverse Isabella color (Rdg., XXX, 19''); gelatin liquefied slowly, changing to brownish.

Growth on potato abundant, rugose felted; conidial area poor, colorless to olive buff (Rdg., XL, 21'''), substratum uncolored.

Milk slightly peptonized; litmus reduced slowly.

This species resembles *Penicillium Trzebinskii* ZALESKI,¹⁰¹ but different in conidiophores which markedly spinulose, in conidial chains parallel, and reverse of colonies which not changed to dark reddish brown. The author regard this as a new species of genus *Penicillium*, and named *Penicillium parallelosporum*.

Penicillium carmino-violaceum DIERCKX.¹⁰¹

(Pl. 12—23)

Colonies on Czapek's solution-agar floccose or funiculose, restricted, at center raised, markedly rugose, 2.1 to 2.2 mm. in depth, artemisia green (Rdg., XLVII, 33''') to deep grayish olive (Rdg., XLVI, 21'''), colorless droplets formed; reverse of colonies primuline yellow (Rdg., XVI, 19') or Dresden brown (Rdg., XV, 17') to buffy-pink (Rdg., XXVIII, 11'') to light russet-vinaceous (Rdg., XXXIX, 9'''); substratum changed to pale purple-brown. Conidiophores arising mostly from trailing or anastomosing hyphae, 80 to 230 μ long by 2 to 2.5 μ in diameter, walls smooth; sterigmata elongated, 14 to 18 by 2 to 3 μ , 4 to 5 in number, single; conidia elliptical, 3.5 to 4.3 by 2.4 to 3 μ , smooth, in chains parallel; perithecia or sclertia not found.

Growth on Koji extract-gelatin abundant, distinctly rugose, an-

dover green (Rdg., XLVII, 25'''); reverse madder brown (Rdg., XIII, 53'') to Victoria lake (Rdg., I, 1); substratum becoming pale brownish, liquefied to 5 mm. in depth in 40 days at 15°C.

Growth on potato poor, flat, andover green (Rdg., XLVII, 25'''); substratum uncolored.

Milk alkaline, but not peptonized.

Penicillium fellutanum BOURGE.¹⁰¹

(Pl. 12—24)

Colonies on Czapek's solution-agar narrowly growing, with margin radiating, with central areas wrinkled and raised to 1.7 to 2 mm. high, azonate, funiculose, court gray or gnaphalium green (Rdg., XLVII, 29'''); reverse cream-buff (Rdg., XXX, 19'') or deep olive-buff (Rdg., XL, 21''). Conidiophores arising from submerged or trailing or ropy hyphae, 20 to 90 μ long by 2.5 to 4.5 μ in diameter with apex enlarged, walls smooth; penicillus monoverticillate with conidial chains adherent into a column or divergent; sterigmata 10 to 12 μ long by 2 to 3 μ in diameter, 6 to 8 in number; conidia at first elliptical or oval later subglobose, 2.5 to 3 by 2 to 2.8 μ , smooth; sclerotia or perithecia not found.

Growth on Koji extract-gelatin abundant, covering with colorless or pale yellowish aerial hyphae; reverse olive-yellow (Rdg., XXX, 23''); liquefied gelatin to 6 mm. in depth in 40 days at 15°C., and change to reddish brown.

Growth on potato poor, raised, colorless.

Milk distinct alkaline, but not peptonized.

Penicillium citreo-viride BOURGE.¹⁰¹

(Pl. 13—25)

Colonies on Czapek's solution-agar spreading, raised and rugose at center, funiculose, 1.8 to 1.9 mm. high, zonate in old culture; margin broadly submerged; surface of colonies slate-olive (Rdg., XLVII, 29'''); reverse yellow ocher (Rdg., XV, 17') or cinnamon-rufous (Rdg., XIV, 11'); substratum becoming yellow or yellowish brown. Conidiophores arising mostly from trailing or ropy hyphae, walls smooth, 60 to 100 μ long by 2 to 3 μ in diameter with apex enlarged; penicillus monoverticillate with conidial chains adherent into colum; sterigmata 10 by 2.5 to 3 μ , 8 to 10 in number; conidia

oval, later globose, 2 to 2.7μ in diameter, smooth; sclerotia or perithecia not found.

Growth on Koji extract-gelatin abundant, distinctly rugose, blackish olive, soon covered with colorless or pale yellowish mycelium; reverse buffy citrine (Rdg., XVI, 19'); gelatin changed to reddish brown, liquefied to 7 mm. in depth in 40 days at 15°C .

Growth on potato abundant, raised, rugose, felted, Lincoln green (Rdg., XLI, 25''').

Milk peptonized, alkaline; litmus reduced.

Penicillium Paczoskii ZALESKI.¹⁰¹

(Pl. 13—26)

Colonies on Czapek's solution-agar spreading, convex, about 2 mm. high at center, floccose or funiculose, slightly zonate, sage green to slate olive (Rdg., XLVII, 29'''); reverse of colonies mostly colorless, central area tilleul-buff (Rdg., XL, 17''), to grayish olive (Rdg., XLVI, 21'''), marginal area light mineral gray (Rdg., XLVII, 25'''). Conidiophores arising from submerged hyphae or from trailing or anastomosing hyphae, mostly short, 25 to 160μ long by 2.5 to 3μ in diameter with apex enlarged, walls smooth, later slightly rough; penicillus monoverticillate with conidial chains parallel or forming a loose column; sterigmata somewhat elongated, 12 to 14 by 3 to 3.5μ , 4 to 5 in number, compact; conidia elliptical or oval, 2 to 3 by 1.8 to 2.5μ , smooth as seen with low magnification, very delicately punctate as seen under oil immersion; perithecia or sclerotia not found.

Growth on Koji extract-gelatin abundant, distinctly rugose, light brownish olive (Rdg., XXX, 19'') to sepia (Rdg., XXIX, 17''); reverse mineral gray (Rdg., XLVII, 25''') to deep grayish olive (Rdg., XLVI, 21''') at center, cream buff (Rdg., XXX, 19'') at margin; gelatin uncolored, liquefied to 4 mm. in depth in 40 days at 15°C .

Growth on potato poor, somewhat raised, buffy citrine (Rdg., XVI, 19'); potato change to brown.

Milk strongly alkaline, but not peptonized.

Penicillium Tertikowskii ZALESKI.¹⁰¹

(Pl. 14—27)

Colonies on Czapek's solution-agar spreading, convex 700 to 800μ

high, wrinkled, zonate, with fairly wide submerged margin, slate-olive (Rdg., XLVII, 29'''); characterized by a mixture of conidiophores rising from submerged hyphae and as branches from a loose fibrous net work of hyphae and ropes of hyphae, with colorless droplets; reverse cream-buff (Rdg., XXX, 19''); conidiophores 2.5 to 3.5 μ in diameter, and 100 to 180 μ long when arising from submerged hyphae, up to 50 to 70 μ long as branches of aerial hyphae, with walls pitted or roughened; penicilli consisting of a single verticil of sterigmata producing a loose column of conidial chains 100 to 150 μ long; sterigmata 8 to 10 μ long by 3 to 4 μ in diameter; conidia globose 2.5 to 3.5 μ in diameter, roughened; sclerotia or perithecia not formed.

Growth on Koji extract-gelatin abundant, rugose, deep grayish olive (Rdg., XLVI, 21''); reverse a central area pale lemon yellow (Rdg., IV, 23), light grayish olive (Rdg., XLVI, 21''') to vandyke brown (Rdg., XXVIII, 11'') at margin; gelatin liquefied and change to brown.

Growth on potato abundant, raised, felted, rainette green (Rdg., XXXI, 27''), substratum uncolored.

Milk strongly alkaline, peptonized.

Penicillium columnare THOM.¹⁰¹

(Pl. 14—28)

Colonies on Czapek's solution-agar poor, velvety in appearance, with scattered trailing hyphae bearing some conidiophores at center and very thinly growing, andover green (Rdg., XLVII, 25'''); reverse and substratum colorless in young pale reddish brown in age; sclerotia or perithecia not found; no drops seen; penicillus a solid column about 15 to 20 μ in diameter and up to 200 μ long; conidiophores 30 to 90 μ long by 2.5 to 3 μ arising from submerged or trailing hyphae; apex vesiclelike up to 4 to 6.5 μ in diameter, with a single verticil of sterigmata; sterigmata 5 to 9 μ by 2.5 to 3 μ with chains long and adherent into a column; conidia 2.5 μ , spinulose; sclerotia or perithecia not found.

Growth on Koji extract-gelatin abundant, rugose, andover green (Rdg., XLVII, 25'''); reverse olive buff (Rdg., XL, 21'') to pale lemon yellow (Rdg., IV, 23); gelatin liquefied and colored to pale brown.

Growth on potato abundant, raised somewhat, velvety or floccose, rainette green (Rdg., XXXI, 27'') to Kronberg's green (Rdg., XXXI,

25").

Milk slightly basic, peptonized.

Penicillium ellipticum nov. sp.

(Pl. 15—29)

Colonies on Czapek's solution-agar restricted, center raised to 1.5 to 3 mm. high, rugose, funiculose, margin white about 1 mm. in width, conidial area tea green (Rdg., XLVII, 25'''), azonate; large colorless drops seen abundantly; reverse of colonies olive-buff (Rdg., XL, 21'') to olive-gray or dark olive-gray (Rdg., LI, 23'''); substrate uncolored. Conidiophores mostly arising from trailing or anastomosing hyphae, simple or sparingly branched with sterigmata monoverticillate, walls smooth, 2 to 2.5 μ in diameter, and to 200 μ long when arising from submerged hyphae, up to 10 to 40 μ long as branches of aerial hyphae; sterigmata 10 to 16 $\times$ 2.5 to 4 μ , 2 to 3 in number; conidia elliptical, faintly spinulose, 3 to 4.5 $\times$ 1.7 to 2.8 μ ; conidial chains parallel or divergent, sclerotia or perithecia not produced.

Growth on Koji extract-gelatin abundant, rugose, mineral gray (Rdg., XLVII, 25''') to deep grayish olive (Rdg., XLVI, 21'''); reverse dull citrine (Rdg., XVI, 21') to Kronberg's green (Rdg., XXXI, 25''); gelatin liquefied, uncolored.

Growth on potato abundant, rugose, felted, white with aerial hyphae.

Milk alkaline but not peptonized.

The known species in *Penicillium* Monoverticillata-Ramigena section, having the elliptical conidia, are *Penicillium cyaneum* (BAINIER et SARTORY) BOURGE¹⁰¹ and *Citromyces musae* BAINIER et SARTORY. The species is different from this species in the color of colonies, and the latter different in the shape of conidia; the author named this species *Penicillium ellipticum*.

Penicillium Waksmani ZALESKI.¹⁰¹

(Pl. 15—30)

Colonies on Czapek's solution-agar spreading, radiately wrinkled, occasionally showing zonation, with central area somewhat elevated 1.5 mm. high, marginal area velvety, central area funiculose, abundant colorless large drops seen, conidial area sage green (Rdg.,

XLVII, 29''') to deep olive-gray (Rdg., LI, 29'''), margin white 2 mm. in width; reverse primrose yellow or olive-ocher (Rdg., XXX, 23''-21''), marginal area tea green or pea green (Rdg., XLVII, 25'''-29'''). Conidiophores arising from trailing or anastomosing hyphae, very short 10 to 70 μ long by 2 to 3 μ in diam.; penicilli partly single verticils of sterigmata, partly showing one or more branches with secondary penicilli; sterigmata 8 to 10 μ by 2.5 to 3.5 μ , 2 to 5 in number; conidia globose, 2.5 to 3 μ in diameter, with walls faintly pitted; conidial chains forming a short column; sclerotia or perithecia not found.

Growth on Koji extract-gelatin abundant, mineral gray (Rdg., XLVII, 25'''), covered with white aerial hyphae; reverse Naples yellow or buffy citrine (Rdg., XVI, 19'), rugose; gelatin slowly liquefied and change slightly reddish.

Growth on potato poor, raised, at first colorless, then deep slate-olive (Rdg., XLVI, 29''') to Lincoln green (Rdg., XLI, 25''').

Milk alkaline and peptonized; litmus reduced; yellowish green soluble pigment produced.

Penicillium Sartoryi THOM.¹⁰¹

(Pl. 16-31)

Colonies on Czapek's solution-agar spreading, convex, 1.5 to 2 mm. high, sometimes slightly zonate, margin velvety, central area floccose, and over green to slate-olive (Rdg., XLVII, 25'''-29'''); reverse lily green or deep slate-green (Rdg., XLVII, 33'''), at center light drab (Rdg., XLVI, 17'''). Conidiophores mostly arising from submerged hyphae, sometimes long trailing hyphae, 80 to 250 μ long by 1.7 to 2.8 μ in diameter, variously branching with the secondary branches often longer than the main axis, each terminating in a monoverticillate penicillus, walls smooth; sterigmata 8 to 11 μ long by 2.5 to 3 μ , 4 to 6 in number, conidia elliptic when young, oval or globose when ripened, smooth, 2.5 to 3.7 by 2 to 3.5 μ ; conidial chains parallel or forming a loose column; perithecia or sclerotia not found.

Growth on Koji extract-gelatin abundant, rugose, deep grayish olive (Rdg., XLVI, 21''') to blackish olive; reverse Isabella color (Rdg., XXX, 19'') at center, blackish olive or black in margin; gelatin slowly softened, changed reddish.

Growth on potato poor, somewhat raised, white.

Milk alkaline, but not peptonized.

Penicillium spinulo-ramigenum nov. sp.

(Pl. 16—32)

Colonies on Czapek's solution-agar spreading, raised at center to 2.1 to 2.2 mm. high, margin broadly submerged, velvety at marginal area, funiculose at central area, azonate, slate-olive (Rdg., XLVII, 29'''), later covered with white aerial hyphae; reverse center cream buff or honey yellow (Rdg., XXX, 19''), margin olive-gray (Rdg., LI, 23'''). Conidiophores arising from submerged hyphae or branches of aerial or ropy hyphae, simple or branching with the secondary branches, each terminating in a monoverticillate penicillus, walls distinctly spinulose, 90 to 350 μ long by 2.5 to 4.5 μ in diameter, at apex enlarged to 5 to 6 μ in diameter; sterigmata 10 to 12 by 3 to 4 μ , 8 to 9 in number; conidia globose or subglobose, 2.2 to 3.5 μ in diameter, faintly roughened; conidial chains parallel; sclerotia or perithecia not found.

Growth on Koji extract-gelatin abundant, andover green (Rdg., XLVII, 25'''), covered with white aerial hyphae; reverse light brownish olive (Rdg., XXX, 19'') to vandyke brown (Rdg., XXVIII, 11'') at center, Victoria lake (Rdg., I, 1) to black at margin; gelatin liquefied and colored to brownish red.

Growth on potato abundant, raised and rugose, felted, Kronberg's green (Rdg., XXXI, 25'').

Milk alkaline and peptonized at first, then changed to neutral; litmus reduced in 20 days.

There is no species, which seen the pitted or spinulose walls on conidiophore and conidia, in the *Penicillium Monoverticillata-Ramigena* series.¹⁰¹ The author recommended this as a new species, and named *Penicillium spinulo-ramigenum*.

Penicillium digitatum SACCARDO.¹⁰¹

(Pl. 17—33)

Colonies on Czapek's solution-agar very poor, thin, spreading, 1.8 to 1.9 mm. high at center, velvety to funiculose, white powdery then change to pale yellowish olive-green; reverse colorless or pale grayish brown. Conidiophores arising from submerged hyphae or as branches of trailing or anastomosing hyphae, 30 to 100 μ long by

3.5 to 5 μ in diameter, all walls smooth; branched irregularly, monoverticillate penicillus often seen; typical metulae not found; sterigmata varying greatly in size and appearance 8 to 10 μ long or even to 70 μ long, markedly divaricate; conidia varying cylindrical to almost globose, often uneven in size and shape in the same chain, 4.5 to 13.5 μ long by 3.7 to 8 μ , smooth; conidial chains divergent and tangled; sclerotia or perithecia not found.

Growth on Koji extract-gelatin abundant, wrinkled and buckled, mineral gray (Rdg., XLVII, 25''') to deep grayish olive (Rdg., XLVI, 21'''); reverse olive-buff (Rdg., XL, 21'') to deep grayish olive (Rdg., XLVI, 21'''); gelatin faintly softened, changing brownish in color.

Growth on potato poor, somewhat raised, olive-buff (Rdg., XL, 21'').

Milk slowly peptonized and acid, litmus reduced in age.

Penicillium citreo-roseum DIERCKX.¹⁰¹

(Pl. 18-34)

Colonies on Czapek's solution-agar spreading broadly, velvety, dark olive-gray (Rdg., LI, 23'''), margin narrow white, tomentose to 1.6-1.7 mm. in depth, rarely zonate; reverse dragon's-blood red to jasper red or pompeian red (Rdg., XIII, 5'-3'); substratum pale red. Conidiophores arising from submerged hyphae, smooth, 100 to 150 μ long by 3 to 3.5 μ in diameter, sometimes branched, bearing closely packed metulae and sterigmata; branches about 20 μ long, smooth; metulae 10 to 15 μ long, in threes or fours; sterigmata 10 to 13 μ by 3 to 3.5 μ , in threes or fours; conidia elliptical to subglobose, 2.3 to 3.7 by 2 to 2.8 μ , smooth; conidial chains parallel to 100 μ long; perithecia or sclerotia not found.

Growth on Koji extract-gelatin abundant, at first andover green (Rdg., XLVII, 25''') then pinkish cinnamon (Rdg., XXIX, 15'') to apricot orange (Rdg., XIV, 11') by growth of aerial hyphae; reverse buffy citrine (Rdg., XVI, 19') to reddish black; substratum strong red, liquefied quickly.

Growth on potato abundant, raised, felted, andover green (Rdg., XLVII, 25'''), then pale pinkish by growth of aerial hyphae; substratum changed to Eugenia red (Rdg., XIII, 1') to carmine (Rdg., I, 1) or reddish black.

Milk slowly alkaline, not peptonized.

Penicillium Roqueforti THOM.^{31, 101}

(Pl. 18—35)

Colonies on Czapek's solution-agar velvety with surface fairly smooth or plane, spreading broadly, with margin broad, white, thin, cobwebby or veil-like, with hyphae radiating partly on the surface partly just below the surface of the substratum, and green conidial areas following the hyphae in unevenly radiating lines, at margin white then leaf green (Rdg., XLI, 29'') or American green (Rdg., XLI, 33''); reverse dusky olive-green (Rdg., XLI, 25'') to mineral gray or gnaphalium green (Rdg., XLVII, 25'''-29'''), at center cream-buff (Rdg., XXX, 19'') to citrindrab (Rdg., XL, 21''). Conidiophores mostly 80 to 150 μ long or often to 250 μ by 4 to 6 μ in diameter, mostly arising from submerged hyphae, branched with walls roughly granular and pitted; penicilli variously simple monoverticillate masses, verticils of metulae and sterigmata, compact branching systems, or with one or more long appressed or diverging branches with asperulate walls; metulae 12 to 20 μ long, with walls asperulate; sterigmata 7 to 12 μ long by 2.5 to 4 μ in diameter, smooth; conidia globose or subglobose 2.8 to 4 μ in diameter, smooth, in long chains forming loose columns; sclerotia or perithecia not found.

Growth on Koji extract-gelatin abundant, rugose, andover green (Rdg., XLVII, 25'''); reverse buffy citrine (Rdg., XVI, 19') at center, deep grayish olive (Rdg., XLVI, 21''') at margin; gelatin slowly and partly liquefied, colored slightly reddish brown.

Growth on potato poor, floccose, light brownish olive (Rdg., XXX, 19'') to olive (Rdg., XXX, 21'').

Milk alkaline, peptonized; litmus reduced.

Penicillium Janczewskii ZALESKI.¹⁰¹

(Pl. 19—36)

Colonies on Czapek's solution-agar spreading, convex, velvety in appearance, composed of a close meshed felt, with margin white, center rugose, 1 to 1.1 mm. high, rarely zonate, sometimes colorless drops appeared, andover green slate-olive (Rdg., XLVII, 25'''-29'''); reverse chamois (Rdg., XXX, 19'') to cinnamon-buff or clay color (Rdg., XXIX, 17''), margin pea green (Rdg., XLVII, 29'''); substratum colored to pale yellow. Conidiophores arising from sub-

merged or aerial hyphae, 90 to 100 μ long by 2 to 3 μ in diameter, walls smooth, frequently with short branches 10 to 20 μ with secondary penicilli, with walls smooth; metulae unequal and asymmetrically arranged, 10 to 16 μ , in divaricate verticils of 2 to 5; sterigmata 10 to 12 by 3 to 4 μ , in verticils of 3 to 7; chains of conidia arranged in twisting or coiling columns up to 50 to 100 μ long; conidia globose, 1.7 to 2.5 μ in diameter, faintly roughened; sclerotia or perithecia not found.

Growth on Koji extract-gelatin abundant, wrinkled, and buckled, artemisia green (Rdg., XLVII, 33''') to mineral gray (Rdg., XLVII, 25'''); reverse yellow ocher (Rdg., XV, 17') or ochraceous-buff (Rdg., XV, 15') to sudan brown (Rdg., III, 15); gelatin liquefied slowly and colored slightly to red.

Growth on potato abundant, raised rugose, floccose, and over green (Rdg., XLVII, 25''') to olive (Rdg., XXX, 21'').

Milk strongly peptonized, alkaline; later litmus reduced.

Penicillium solitum WESTLING.¹⁰¹

(Pl. 19—37)

Colonies on Czapek's solution-agar spreading broadly, funiculose, raised to 2 mm. high, zonate broadly, artemisia green (Rdg., XLVII, 33'''), slightly tinged vinaceous in age, colorless or yellow drops seen; reverse chalcedony yellow (Rdg., XVII, 25'), margin pea green (Rdg., XLVII, 29''); substratum colored yellowish. Conidiophores smooth, arising from submerged or creeping hyphae, 110 to 200 μ long by 2.5 μ in diameter, asymmetrically branched, with branches appressed; metulae 8 to 12 μ long; sterigmata 8 to 10 μ by 2 to 3.5 μ ; conidia smooth, globose or subglobose 2.2 to 4 μ by 2 to 3.7 μ ; conidial chains adherent into columns, 100 to 200 μ long by 7 to 10 μ in diameter; sclerotia or perithecia not formed.

Growth on Koji extract-gelatin abundant, covering with white aerial hyphae; reverse rugose, light grayish olive (Rdg., XLVI, 21'''); gelatin slowly and partly liquefied, uncolored.

Growth on potato abundant, raised, tufted, artemisia green (Rdg., XLVII, 33''') to Lincoln green (Rdg., XLI, 25''') or deep grayish olive (Rdg., XLVI, 21'''), substratum colored to yellow.

Milk peptonized and colored to brownish yellow then slowly to greenish yellow; litmus partly reduced.

Penicillium flavo-glaucum BOURGE.¹⁰¹

(Pl. 20—38)

Colonies on Czapek's solution-agar velvety or fasciculate, spreading, central area rugose, pea green to sage green (Rdg., XLVII, 29''') with white margin, zonate broadly, sometimes colorless drops appeared, later covered with white aerial hyphae from central area; reverses cartridge buff or cream buff (Rdg., XXX, 19''). Conidiophores rough, pitted, 150 to 300 μ long by 4 to 5 μ in diameter, arising from submerged hyphae singly or aggregate to a coremiform masses; penicillus with walls rough, about 50 μ long, consisting of branches, metulae and sterigmata; branches in twos, about 20 μ long, granulate; metulae 7 to 15 by 2.5 to 3.5 μ , in twos or threes or rarely fours; sterigmata cylindrical, 10 to 15 by 2.5 to 4 μ , in twos or fours rarely sevens; conidia elliptical or oval 3 to 4.5 by 2.3 to 3.5 μ , smooth, closely packed parallel chains, often adherent to a loose column; perithecia or sclerotia not found.

Growth on Koji extract-gelatin abundant, white aerial hyphae covering the surface; reverse Naples yellow (Rdg., XVI, 19'); gelatin slowly liquefied, changed slightly reddish.

Growth on potato abundant, raised, rugose, felted, Kronberg's green (Rdg., XXXI, 25'') to olive green (Rdg., IV, 23).

Milk at first acid and coagulated, then peptonized and litmus reduced.

Penicillium palitans WESTLING.¹⁰¹

(Pl. 20—39)

Colonies on Czapek's solution-agar spreading, raised at center up to 2.5 mm. high, margin velvety to fasciculate, central area floccose to funiculose, then covered with white areial hyphae, slightly zonate, Russian green (Rdg., XLII, 37'''); reverse colorless to grayish white, margin court gray or gnaphalium green (Rdg., XLVII, 29'''); odor moldy or fruity; substratum uncolored. Conidiophores single or fasciculate to a loose coremiform masses, 150 to 350 μ in length by 3.5 to 4 μ in diameter, with walls verrucose, branched asymmetrically; branches appressed, verrucose, 15 to 20 μ long; metulae 10 to 13 μ by 4 to 4.5 μ , with walls smooth when young, verrucose at the lower part in old culture; sterigmata 8 to 12 by 3 to 5 μ , in threes or fours with parallel chains of conidia; conidia globose 3 to 4 μ in

diameter, smooth; sclerotia or perithecia not found.

Growth on Koji extract-gelatin abundant, mineral gray (Rdg., XLVII, 25'''); reverse olive ocher (Rdg., XXX, 21'') to burnt sienna (Rdg., II, 9); gelatin slowly or partly liquefied, uncolored.

Growth on potato abundant, raised, wrinkled, felted, Lincoln green (Rdg., XLI, 25''').

Milk peptonized strongly; litmus change to blue partly, then to red, reduced in age.

Penicillium crustosum THOM.¹⁰¹

(Pl. 21—40)

Colonies on Czapek's solution-agar spreading, velvety or fasciculate, indistinctly zonate in age, about 100 to 250 μ deep in velvety appearing areas with the development of continuous crusts of conidial chains, which break off as irregular masses when struck or tapped; drops colorless; odor slightly fruity; conidial area pistachio green (Rdg., XLI, 33''') to sage green (Rdg., XLVII, 33'''); margin white; reverse light mineral gray (Rdg., XLVII, 25''') to colonial buff (Rdg., XXX, 21''); substratum uncolored. Conidiophores 80 to 100 μ long by 3 to 4 μ in diameter, with walls rough pitted; penicillus consisting usually of the main axis and one branch variously up to 30 μ long appressed with few metulae 10 to 18 μ long and groups of sterigmata 8 to 13 μ long by 2.5 to 3.5 μ , branches and metulae pitted; conidia globose 2.5 to 3.7 μ in diameter, smooth; conidial chains parallel; sclerotia or perithecia not found.

Growth on Koji extract-gelatin abundant, andover green (Rdg., XLVII, 25'''); reverse radiately wrinkled, olive ocher (Rdg., XXX, 21''); gelatin liquefied and changed to slightly yellowish brown.

Growth on potato abundant, raised, felted, andover green (Rdg., XLVII, 25''') to Rainette green (Rdg., XXXI, 27'').

Milk strongly peptonized; litmus reduced or slightly acid.

Penicillium crustosum var. *spinosporum* nov. var.

(Pl. 21—41)

Colonies on Czapek's solution-agar spreading, fasciculate or velvety, zonate broadly, with the development of continuous crusts of conidial chains, which break off as irregular masses when struck or tapped; drops colorless; odor slightly fruity; conidial area elm

green or varley's green (Rdg., XVII, 27'-XVIII, 31') when young, olive-brown (Rdg., XL, 17''') in old cultures; reverse colorless or cream color to naples yellow (Rdg., XVI, 19'), margin gnaphalium green (Rdg., XLVII, 29'''); substratum uncolored. Conidiophores 60 to 300 μ long by 4 to 5 μ in diameter, with walls rough pitted, single or coremiform; penicillus consisting usually of the main axis and one branch variously up to 40 μ long appressed with few metulae 10 to 18 μ long and groups of sterigmata 10 to 11 by 3 to 4 μ ; conidia globose 3 to 4.5 μ in diameter, markedly spinulose; conidial chains parallel; sclerotia or perithecia not found.

Growth on Koji extract-gelatin abundant, andover green (Rdg., XLVII, 25'''); reverse radiately wrinkled, light grayish olive (Rdg., XLVI, 21'''), margin olive ocher (Rdg., XXX, 21''); gelatin liquefied partly, becoming slightly brownish.

Growth on potato abundant, velvety, Lincoln green (Rdg., XLI, 25''').

Milk strongly peptonized; litmus changed to blue at first, then neutral, through faint red, reduced at last.

This strain resembles *Penicillium crustosum* THOM¹⁰¹, but different in the surface of conidia which markedly spinulose. The author regard this as a new variety of *Penicillium crustosum*, and named var. *spinulosporum*.

Penicillium expansum THOM.¹⁰¹

(Pl. 22-42)

Colonies on Czapek's solution-agar spreading, zonate, fasciculate; drops colorless; pistachio green or American green (Rdg., XLI, 33'''), sometimes covering with conidial crusts, margin white; reverse colorless or rarely yellowish in margin; substratum uncolored. Conidiophores 150 to 270 μ long by 2.7 to 3 μ in diameter, single or coremiform, with walls smooth; penicillus to 50 μ long, consisting of the main axis and one branch with few metulae and sterigmata; branches 15 to 35 μ long; metulae 9 to 16 μ by 2 to 3.5 μ , in groups of 2 to 4; sterigmata 10 to 15 by 2.8 to 3 μ in groups of 2 to 5; conidia elliptical or oval, 3 to 4 by 2.5 to 3.2 μ , smooth; conidial chains parallel; sclerotia or perithecia not found.

Growth on Koji extract-gelatin abundant, rugose, andover green (Rdg., XLVII, 25'''); reverse olive ocher (Rdg., XXX, 21''); gelatin liquefied and changed slightly brownish.

Growth on potato abundant, raised, wrinkled, felted, and over green (Rdg., XLVII, 25''') to rainette green (Rdg., XXXI, 27'').

Milk peptonized; litmus reduced and slightly red.

Scopulariopsis brevicaulis (SACCARDO) BAINIER.^{39, 101}

(Pl. 22—43)

Colonies on Czapek's solution-agar abundant, broadly spreading, thin, funiculose, powdery in appearance, white then sayal brown (Rdg., XXIX, 15'') to light brownish olive (Rdg., XXX, 19'') with the development of conidia; reverse Isabella color to light brownish olive (Rdg., XXX, 19''); conidial apparatus irregular upon very short stalks developing a complex penicillus with branches in several superposed series, and usually three to four in the verticil, or frequently reduced to single sterigmata or groups of sterigmata sessile or nearly so on the hyphae; sterigmata tapering gradually to the conidia bearing apex, 8 to 20 μ long by 3 to 4.5 μ in diameter, conidia 5.5 to 7 μ , in diameter and almost spherical, truncate at the base, walls smooth at first, rough in age.

Colonies on Koji extract-agar abundant, raised, wrinkled and buckled, margin somewhat restricted, white to cream-buff (Rdg., XXX, 19''), funiculose; reverse white to Naples yellow (Rdg., XVI, 19').

Growth on Koji extract-gelatin abundant, wrinkled, vinaceous-buff (Rdg., XL, 17''') to chamois (Rdg., XXX, 19''); reverse light grayish olive (Rdg., XLVI, 21''') at center, Isabella color to light brownish olive (Rdg., XXX, 19''); gelatin liquefied quickly with ammoniacal odor, uncolored.

Growth on potato abundant, white to cream-buff (Rdg., XXX, 19'').

Milk peptonized strongly; litmus reduced.

Paecilomyces varioti BAINIER.¹⁰¹

(Pl. 23—44)

Colonies on Czapek's solution-agar broadly spreading, deep olive-buff to dark olive-buff (Rdg., XL, 21'''); surface growth consisting mostly of trailing fertile hyphae, becoming powdery in appearance; reverse of colony vinaceous-buff (Rdg., XL, 17''') to light brownish olive (Rdg., XXX, 19''); fertile hyphae septate, mostly creeping;

conidial fructifications either terminal or on short branches of creeping or partially erect hyphae, consisting of separate sterigmatic cells, of verticills, or of series of verticils of branchlets and sterigmata irregularly distributed along the fertile hyphae; sterigmata 12 to 30 μ long by 3 to 5 μ in diameter, with long acuminate tubes usually bent from the axis of the cell and broadly divergent at the apices, bearing long chains of conidia; conidia elliptical or fusiform, 4.5 to 8 μ by 2 to 3.5 μ , smooth.

Growth on Koji extract-agar abundant, spreading broadly, deep olive-buff to dark olive-buff (Rdg., XL, 21'''); reverse Isabella color to light brownish olive (Rdg., XXX, 19'').

Growth on Koji extract-gelatin abundant, white to vinaceous-buff (Rdg., XL, 17'''), brownish drops appeared; reverse deep olive-buff (Rdg., XL, 21'''); gelatin liquefied, uncolored.

Growth on potato abundant, flat, yellow ocher (Rdg., XV, 17') to light brownish olive (Rdg., XXX, 19'').

Milk alkaline, but not peptonized.

Trichoderma Koningi OUDEMANS.^{51, 78, 103}

(Pl. 24—45)

Colonies on Czapek's solution-agar abundant, spreading, floccose, white at first, then change to strontian yellow (Rdg., XVI, 23') to deep dull yellow-green (1) (Rdg., XXXII, 31''), azonate; reverse olive gray (Rdg., LI, 23''') to olive lake (Rdg., XVI, 21') or dark olive-buff (Rdg., XL, 21''').

Colonies on Koji extract-agar abundant, spreading, white, floccose to funiculose; dark green masses begin to appear only when culture is 7 to 10 days old, azonate; reverse Naples yellow (Rdg., XVI, 19'). Vegetative hyphae hyaline, septate, branched, 2.5 to 10 μ in diameter; conidiophores mostly arising as side branches on the trailing hyphae, septate and branched mostly opposite, each branch carrying a spherical conidial head, 4 to 7 μ in diameter; conidia elliptical, 3 to 3.5 by 2 to 2.5 μ , smooth, branches 5 to 8.5 μ long by 3 to 4 μ in diameter.

Growth on Koji extract-gelatin abundant, rainette green (Rdg., XXXI, 27'') to olive-green (Rdg., IV, 23), white to pale lemon yellow or lemon yellow (Rdg., IV, 23) at center; reverse center olive yellow (Rdg., XXX, 23''), margin lemon yellow (Rdg., IV, 23); gelatin liquefied, uncolored.

Growth on potato poor, white mealy.

Milk coagulated and digested; litmus change to red and reduced.

Botrytis cinerea PERSOON.^{50, 41}

Syn. *Sclerotinia Fuckeliana* DE BARY.⁴⁵

(Pl. 24—46)

Colonies on Czapek's solution-agar abundant, spreading and floccose, at first white then from margin kronbergs green (Rdg., XXXI, 25'') to smoke gray (Rdg., XLVI, 21''') in age; reverse cream-buff (Rdg., XXX, 19'') to olive-buff (Rdg., XL, 21''').

Colonies on Koji extract-agar abundant, spreading and floccose, smoke gray (Rdg., XLVI, 21''') to deep olive (Rdg., XL, 21'''); reverse vinaceous-buff (Rdg., XL, 17''') to chestnut-brown (Rdg., XIV, 11') or deep olive (Rdg., XL, 21'''), black spots appeared by sclerotia-production. Mycelium hyaline, branched, septate; conidiophores erect, septate, 1 to 1.2 mm. long by 7.5 to 10 μ in diameter, smooth; mostly branching only at the tip, brown colored; conidia from a thick head around projections of the top branches; conidia ovate to elliptical, finely apiculated at the base, 10 to 18 by 8 to 10 μ , smooth.

Growth on Koji extract-gelatin abundant, wooly, grayish; reverse grayish to black; gelatin liquefied slowly, changed to pale brown.

Growth on potato abundant, smoke-gray (Rdg., XLVI, 21''') to dark grayish olive (Rdg., XLVI, 21''') or olive (Rdg., XXX, 21'').

Milk coagulated and digested; litmus changed to red.

Trichothecium roseum LINK.^{44, 51}

(Pl. 24—47)

Colonies on Czapek's solution-agar abundant, 2 to 5 mm. high, spreading, white at first, pinkish buff (Rdg., XXIX, 17'') in age; reverse pinkish buff to light vinaceous-cinnamon (Rdg., XXIX, 13'').

Colonies on Koji extract-agar abundant, spreading broadly, rugose, pale salmon color (Rdg., XIV, 9'), funiculose; reverse light ochraceous-salmon (Rdg., XV, 13') to light vinaceous-cinnamon (Rdg., XXIX, 13''). Conidiophores arising from submerged hyphae or as branched on trailing or anastomosing hyphae, unseptated and unbranched, 100 to 160 μ long by 2.5 to 3.5 μ in diameter; conidia produced at the tip of the conidiophore singly, one after another, forming a alternate chain; conidia pear-shaped, two-celled, 14 to 20 μ long by

6 to 12 μ in diameter.

Growth on Koji extract-gelatin abundant, markedly wrinkled and backled, pale cinnamon-pink (Rdg., XXIX, 13'') to seashell pink (Rdg., XIV, 11'); reverse pale pinkish cinnamon (Rdg., XXIX, 15'') to pinkish cinnamon (Rdg., XXIX, 15''); gelatin liquefied rapidly, uncolored.

Growth on potato abundant, compactly felted, at first white, then flesh color (Rdg., XIV, 7').

Milk peptonized, alkaline.

Dematium pullulans DE BARY.^{45, 51}

Syn. *Hormonema pullulans* (DE BARY) LAGERBERG et MELIN.⁷⁸

Pullularia pullulans (DE BARY) BERKHOUT.⁴¹

(Pl. 25—48)

Colonies on Czapek's solution-agar abundant, spreading, rugose, moist luster, slimy appearance, white to chamois (Rdg., XXX, 19'') or pinkish buff (Rdg., XXIX, 17''), often black spots appeared; reverse same colored.

Colonies on Koji extract-agar abundant, raised, margin black or blackish brown, central area white to light brownish olive (Rdg., XXX, 19''); reverse grayish, margin black; funiculose. Hyphae branched, closely septate, 2.5 to 8 μ in diameter; conidia formed on the hyphae, elliptical or oval, unicellular, 4 to 10 by 2 to 6 μ ; resting cells produced, thick walled, dark, oval to pearform, unicellular or two to three celled.

Growth on Koji extract-gelatin abundant, wrinkled and backled, olive to blackish olive; reverse black; gelatin not liquefied, becoming to pale brown.

Growth on potato poor, raised, white to yellow ocher (Rdg., XV, 17').

Milk strongly peptonized, alkaline.

Cladosporium herbarum (PERS.) LINK.^{35, 50, 41}

Syn. *Penicillium cladosporioides* FRES.,

Hormodendrum cladosporioides (FRES.) SACC.,¹⁰³

Sphaerella Tulasnei JANCZEWSKI.⁴⁵

(Pl. 26—49)

Colonies on Czapek's solution-agar abundant, spreading, floccose,

smoke gray or light grayish olive (Rdg., XLVI, 21''') to olive (Rdg., XXX, 21''); reverse dark olive-buff (Rdg., XL, 21''') to light brownish olive (Rdg., XXX, 19'') at center, olive green (Rdg., IV, 23) to black.

Colonies on Koji extract-agar abundant, raised, funiculose, smoke gray or light grayish olive (Rdg., XLVI, 21''') to olive-gray (Rdg., LI, 23'''); small drops appeared; reverse black, radiately wrinkled. Conidiophores septate, branched, mostly 30 to 100 μ long by 3.5 to 5 μ in diameter, arising from submerged hyphae or aerial hyphae; conidial tufts borne at the end of all the branches; conidia are produced by budding in great abundance, varying greatly in size and shape, 5 to 20 μ by 4 to 7 μ , subglobose, oval, elliptical or sausage-shape; walls at first smooth, rough in age; unicellular or two cell.

Growth on Koji extract-gelatin abundant, tufted, smoke gray (Rdg., XLVI, 21''') to deep grayish olive (Rdg., XLVI, 21'''); reverse black; gelatin not liquefied, uncolored.

Growth on potato not good, raised, light brownish olive (Rdg., XXX, 19').

Milk strongly peptonized, alkaline.

Stemphylium botryosum WALTER, var. *botrytis*

(PREUSS) LINDAU.^{29, 73}

(Pl. 26—50).

Colonies on Czapek's solution-agar not good, spreading, at first white, then deep olive (Rdg., XL, 21''') to black; reverse white to deep olive-buff (Rdg., XL, 21''').

Colonies on Koji extract-agar abundant, funiculose, deep grayish olive (Rdg., XL, 21''') or olive (Rdg., XXX, 21'') or black; reverse black. Conidiophores mostly arising as short branches of trailing or ropy hyphae, 10 to 40 μ long by 3 to 4 μ in diameter, septate, branched; conidia oval or long elliptical, on very short side branches, single, 2 to 5 septate with one transverse section, 15 to 50 μ long by 10 to 15 μ , brown, verrucose in age.

Growth on Koji extract-gelatin abundant, felted, grayish to black; reverse black; gelatin liquefied slightly, changed faintly brownish.

Growth on potato abundant, floccose, white to cream-buff (Rdg., XXX, 19') with aerial hyphae.

Milk alkaline, peptonized strongly.

Alternaria tenuis NEES.^{59, 73}

(Pl. 26—51)

Colonies on Czapek's solution-agar abundant, spreading broadly, flat, black, covered with white aerial hyphae in age; reverse black.

Colonies on Koji extract-agar abundant, deep olive (Rdg., XL, 21''') to black, covered with white aerial hyphae in age; reverse black. Conidiophores short, 50 to 100 μ long by 2 to 3.5 μ in diameter, branched, septate, with branched conidial chains at the ends; conidia variously elliptical, oval, to club-shape, 18 to 60 μ long by 7 to 14.5 μ , brown, 2 to 8 celled, resembling to a brick-wall, slightly constricted at the place of septation, walls rough in age.

Growth on Koji extract-gelatin abundant, felted, vinaceous-buff (Rdg., XL, 17'''); reverse brownish black; gelatin not liquefied, but colored to dark brown.

Growth on potato abundant, felted, white to deep grayish olive (Rdg., XLVI, 21''') and light brownish olive (Rdg., XXX, 19'').

Milk coagulated and peptonized; litmus slowly reduced.

Fusarium sp.

(Pl. 27—52)

Colonies on Czapek's solution-agar abundant, spreading, leather-like, radiately wrinkled in times, slightly fatty lustre; surface and reverse vinaceous-buff (Rdg., XL, 17'''), ochraceous-salmon (Rdg., XV, 13') at center.

Colonies on Koji extract-agar abundant, spreading, wrinkled at center, fatty lustre, flame scarlet (Rdg., II, 9), aerial hyphae flesh color (Rdg., XIV, 7'); reverse capucine yellow (Rdg., III, 15) to orange rufous (Rdg., II, 11). Conidiophores erect or creeping, mostly submerged, septate, branched, with very short branches, 3 to 4 μ or more; macro-conidia not produced; microconidia unicellular or dicelled, formed at the tip of conidiophores or directly from the hyphae, elliptical, fusiform, or slightly bent, 6 to 18 μ long by 3 to 5 μ ; clamydospores elliptical, 5 to 9 μ by 4 to 5.5 μ .

Growth on Koji extract-gelatin abundant, thin, orange; gelatin liquefied quickly.

Growth on potato abundant, rugose, white to cream-buff (Rdg., XXX, 19'').

Milk peptonized, alkaline; litmus reduced.

This species cannot be determined the species name, because the macro-conidia do not produced.

Epicoccum purpurascens EHRENBURG.^{51, 78}

(Pl. 27—53)

Colonies on Czapek's solution-agar abundant, somewhat raised, floccose to funiculose, at first olive (Rdg., XXX, 21'') or buffy citrine (Rdg., XVI, 19'), gradually white aerial hyphae cover the surface from central area, then through lemon yellow (Rdg., IV, 23) or lemon chrome (Rdg., IV, 21), becoming Eugenia red (Rdg., XIII, 1') to oxblood red (Rdg., I, 1); lemon yellow (Rdg., IV, 23) colored droplets appeared; reverse reddish black to black; substratum change to lemon yellow (Rdg., IV, 23). Conidiophores crowded, arising as a short branch of trailing or ropy hyphae, 5 to 30 μ long by 5 to 8 μ in diameter; the end of conidiophores swollen and tinged to dark color, and formed conidia; conidia subglobose, 15 to 30 μ in diameter, dark olive, walls with black warts, divided into irregular polygons.

Colonies on Koji extract-agar abundant, raised, markedly funiculose, white then yellow ocher (Rdg., XV, 17'); reverse same color.

Growth on Koji extract-gelatin abundant, felted, light vinaceous-cinnamon (Rdg., XXIX, 13'') to lemon chrome (Rdg., IV, 21); reverse reddish black; gelatin not liquefied, but colored to deep reddish brown.

Growth on potato moderate, wrinkled, white to light brownish olive (Rdg., XXX, 19'').

Milk coagulated and peptonized, alkaline; litmus reduced.

III. Key to the species of genus *Aspergillus* and
of genus *Penicillium*.

a. Key to species included in the genus *Aspergillus*.

—Conidial heads green or yellow green.

—Stalks smooth.

—Vesicle cylindrical clavate..... *Asp. clavatus* DESMAZIERES

—Vesicle flask-shaped or globose, not cylindrical clavate.

- Sterigmata in 1 series.
 - Conidia mostly elliptical or ovate and more than 4μ in long axis. Perithecia found, yellow.
(*Aspergillus glaucus* group)
 - Ascospores with furrow and frills. Conidiophores short.
 - Colonies and substratum becoming yellow or yellowish brown *A sp. Chevalieri* (MANGIN) THOM et CHURCH.
 - Colonies and substratum becoming brown to red.....
..... *Asp. Chevalieri* var. *ruber* nov. var.
 - Ascospores without frills. Conidiophores large.
 - Colonies and substratum becoming yellowish brown. ...
..... *Asp. repens* (CORDA) SACCARDO.
 - Colonies and substratum becoming rusty red. *Asp. ruber* (SPECKERMANN et BREMER) THOM et CHURCH.
 - Conidia mostly globose 4μ or less in long axis; conidial chains in narrow, solid columns. *Asp. fumigatus* FRESENIUS.
- Sterigmata in 2 series.
 - Conidial chains in columns. ... *Asp. nidulans* (EIDAM) WINTER
 - Conidial chains in radiate heads.
 - Heads blue green. ... *Asp. Siedwi* (BAINIER et SARTORY) THOM et CHURCH.
 - Heads glaucous, green or yellow-green to buff.
(*Aspergillus versicolor* group)
 - Conidiophores directly arising from substratum, or branching as short branches of branched sterigmata or single branched sterigmata from aerial hyphae.
..... *Asp. versicolor* (VUILLEMIN) TIRABOSCHI.
 - Conidiophores directly arising from submerged hyphae, large. *Asp. versicolor* var. *magnus* nov. var.
- Stalks pitted. (*Aspergillus flavus-oryzae* group)
 - Conidia smooth. *Asp. flavus* LINK.
 - Conidia asperated. *Asp. flavus* var. *asper* nov. var.
- Conidial heads never green.
 - Stalks smooth.
 - Conidial heads avellaneous or in brown shades, and in columns.
..... *Asp. terreus* THOM.
 - Conidial heads black, sterigmata 1 series.
..... *Asp. yezoensis* nov. sp.

b. Key to species included in the genus *Penicillium*.

- Penicillus or conidial apparatus characteristically monoverticillate. (Monoverticillata).
 - Branching of conidiophore when present, occasional, irregular and lacking the suggestion of a characteristic terminal verticil. (Section I. Monoverticillata-Stricta).
 - Sclerotium producing species. (Subsection 1. Sclerotigena.) ... *Penicillium yezoensum* HANZAWA.
 - Sclerotium not produced.
 - Colonies floccose. (Subsection 2. Floccosa)
 - Conidia globose or subglobose, spinulose. *Penicillium spinulosum* THOM.
 - Conidia globose or subglobose, smooth.
 - Conidiophores smooth. ... *Citromyces Pfefferianus* WEHMER.
 - Conidiophores spinulose. .. *Penicillium parallelosporum* nov. sp.
 - Funicles or ropes of hyphae consistently found among the aerial hyphae in the colony. (Subsection 3. Funiculosa).
 - Ropiness or funiculose condition well marked as the colonies are examined under the microscope. Conidia elliptical. *Penicillium carmino-violaceum* DIERCKX.
 - Ropiness reduced to trailing and more or less fascicled hyphae in colonies velvety or nearly so in appearance.
 - Conidia subglobose to globose, smooth.
 - Colonies bluish to yellowish green to drab; reverse yellowish to greenish to deep blackish green; conidia about 2.5 to 3 μ by up to 3 μ *Penicillium fellutanum* BOURGE.
 - Colonies almost velvety, pale bluish green, to green, to brown; conidia about 2.5 μ in diameter. *Penicillium citreo-viride* BOURGE.
 - Conidia subglobose to globose, rough or granular.
 - Colonies appearing velvety spreading, zonate, in bluish green shades becoming yellowish gray in age; conidia about 3 μ delicately punctate as seen under oil immersion. *Penicillium Paczoskii* ZALESKI.
 - Colonies spreading broadly, colorless to pale flesh color, with some green conidial area in the central area; conidiophore walls pitted or rough; conidia 2.5 to 3 μ , roughened. *Penicillium Terlikowski* ZALESKI.

- Colonies velvety in appearance. (Subsection 4. Velutina)
 - Conidia globose or subglose. ... *Penicillium columnare* THOM.
- Fertile hyphae mostly branching, with branches one-celled or long and septate, each bearing a terminal monoverticillate penicillus, but not producing apical verticils of metulae or branchlets. (Section II. Monoverticillata-Ramigena)
 - Conidia elliptical. *Penicillium ellipticum* nov. sp.
 - Conidia globose.
 - Conidiophore smooth.
 - Colonies radiately wrinkled; conidia 2.5 to 3 μ , faintly spinulose. *Penicillium Waksmani* ZALESKI.
 - Colonies not wrinkled; conidia 2 to 2.5 μ or slightly larger, smooth. *Penicillium Sartoryi* THOM.
 - Conidiophore spinulose. *Penicillium spinulo-ramigenum* nov. sp.
- Penicillus consisting of two or more series of elements including sterigmata and metulae with or without branches of one more series, with the branching system typically lopsided, one-sided, or asymmetrical. (Asymmetrica)
 - Colonies velvety in appearance. (Section I. Velutina)
 - Subsections with conidiophore walls smooth.
 - Conidia elliptical usually more than 4.5 μ in long axis. (Subsection 1. Elliptica-Magna) *Penicillium digitatum* SACCARDO.
 - Conidia less than 4.5 μ in long axis. (Subsection 3. Radiata) *Penicillium citreo-roseum* DIERCKX.
 - Subsection with conidiophore walls pitted or rough.
 - Colonies with broadly arachnoid margin in bluish green to green shades, with reverse mostly showing yellow to greenish colors. *Penicillium Roqueforti* THOM.
 - Colonies lanose; penicilli with metulae or branches divaricate. (Section IV. Lanata-Divaricata) *Penicillium Janczewskii* ZALESKI.
 - Colonies funiculose. (Section V. Funiculosa) *Penicillium solitum* WESTLING.
 - Colonies with part to all of the conidiophores aggregated into more or less definite and erect bundles or fascicles. (Section VI. Fasciculata)

- Colonies in blue green shades. (Subsection 2. *Aeruginosa*) ...
 *Penicillium flavo-glaucum* BOURGE.
- Colonies bright green or yellowish green. (Subsection 3. *Viridicata* (*Pen. viridicatum* series)
 *Penicillium palitans* WESTLING.
- Conidial areas in dull green or only transiently bluish green
 then green or dull yellowish green. (Subsection 4. *Glaucia*)
 -Zonation indistinct or reduced to ridges in the conidial mass;
 fascicles seen only at margin; conidial chains forming
 continuous crusts over the surface of mycelium. (Series:
 Crustaceum)
 -Conidia smooth. *Penicillium crustosum* THOM.
 -Conidia markedly spinulose.
 *Penicillium crustosum* var. *spinulosporum* nov. var.
- Zonation usually evident especially in outer areas of colonies
 after growing for seven to ten days. Zones fairly broad
 (about 2 mm. intervals).
 -Conidia becoming subglobose to globose when ripe.
 (Series: *Expansum*) *Penicillium expansum* THOM.

B. Local and seasonal distributions of the molds found in butter

As in the previous pages, 48 species and 5 varieties of molds were isolated from butter manufacturing in Hokkaido and described. The appearance of these molds in butter was different in local or in season in which the butter was manufactured. It is one of the most important factors in order to eliminate the mold-injuries of butter that the seasonal and local distributions of molds become clear. For this reason, the local and seasonal distribution of each molds species is represented in table 1 to 53.

The distributions and frequencies of mold species, from the local point of view, are shown more clearly in table 54, and from the monthly point of view, are shown in table 55. (The figures in these tables indicate the frequency of isolation of mold species.)

Looking through these table, it is seen that the most widely spread species of butter molds are *Oospora lactis*, *Oospora suaveolens*, *Aspergillus repens* and *Cladosporium herbarum*. As shown in the following pages, two of them, *Aspergillus repens* and *Cladosporium*

herbarum, have a strong resisting power to the environmental conditions. *Penicillium Roqueforti* is a common species in all creameries, but appeared frequently from autumn till spring and rarely in summer. *Alternaria tenuis* and *Fusarium* sp. are also common. They are often found from summer till autumn. Following these molds, *Aspergillus flavus* and *Penicillium yezoensum* are found broadly both in local or in seasons.

The appearances of *Aspergillus Sydowi* (in Kushiro-province), *Aspergillus yezoensis* (in south Hokkaido), *Citromyces pfefferianus* (in north Hokkaido), and *Stemphylium botryosum* var. *botrytis* (in south Hokkaido) are restricted within narrow limits of provinces.

From the seasonal point of view, the appearances of *Aspergillus Chevalieri*, *Aspergillus Chevalieri* var. *ruber* (at spring), *Aspergillus ruber* (from spring till summer), *Penicillium digitatum* (at winter), and *Botrytis cinerea* (at summer) are limited. Some of the other species are distributed in Hokkaido without the seasonal effect. The appearance of some of the remaining species are rare.

The molds isolated from butter may be divided into the following groups according to the number of creameries they found.

Found in 13 creameries	<i>Asp. repens</i>
	<i>Pen. Roqueforti</i>
	<i>Oo. lactis</i>
	<i>Oo. suaveolens</i>
	<i>Cl. herbarum</i>
Found in 12 creameries	<i>Fusarium</i> sp.
Found in 11 creameries	<i>Alternaria tenuis</i>
Found in 8 creameries	<i>Asp. flavus</i>
	<i>Pen. yezoensum</i>
Found in 7 creameries	<i>Pen. digitatum</i>
	<i>Pen. palitans</i>
Found in 6 creameries	<i>Asp. versicolor</i> var. <i>magnus</i>
Found in 5 creameries	<i>Asp. Chevalieri</i>
	<i>Stemph. botryosum</i> var. <i>botrytis</i>
Found in 4 creameries	<i>Asp. ruber</i>
	<i>Pen. Sartoryi</i>
Found in 3 creameries	<i>Rh. nigricans</i>
	<i>Asp. Chevalieri</i> var. <i>ruber</i>
	<i>Asp. yezoensis</i>
	<i>Citromyces Pfefferianus</i>

	<i>Trichoderma Koningi</i>
	<i>Botrytis cinerea</i>
Found in 2 creameries	<i>Asp. Sydowi</i>
	<i>Asp. versicolor</i>
	<i>Asp. terreus</i>
	<i>Pen. parallelosporum</i>
	<i>Pen. Paczoskii</i>
	<i>Pen. Janczewskii</i>
	<i>Pen. solitum</i>
	<i>Pen. flavo-glaucum</i>
	<i>Pen. crustosum</i>
	<i>Pen. crustosum var. spinulosporum</i>
	<i>Pen. expansum</i>
	<i>Paecilomyces varioti</i>
	<i>Trichothecium roseum</i>
Found in 1 creamery	<i>Oo. lupuli</i>
	<i>Asp. clavatus</i>
	<i>Asp. fumigatus</i>
	<i>Asp. nidulans</i>
	<i>Asp. flavus var. asper</i>
	<i>Pen. spinulosum</i>
	<i>Pen. carmino-violaceum</i>
	<i>Pen. fellutanum</i>
	<i>Pen. citreo-viride</i>
	<i>Pen. Terlikowski</i>
	<i>Pen. columnare</i>
	<i>Pen. ellipticum</i>
	<i>Pen. Waksmani</i>
	<i>Pen. spinulo-ramingenum</i>
	<i>Pen. citreo-roseum</i>
	<i>Scop. brevicaulis</i>
	<i>Dem. pullulans</i>
	<i>Epicoc. purpurascens</i>

In the similar manner, the molds may be divided into the following groups according to the number of months they appeared.

Found in 12 months	<i>Oo. lactis</i>
	<i>Oo. suaveolens</i>
	<i>Asp. repens</i>
	<i>Cl. herbarum</i>

Found in 9 months	<i>Pen. Roqueforti</i>
Found in 8 months	<i>Pen. yezoensum</i>
	<i>Pen. palitans</i>
	<i>Alt. tenuis</i>
Found in 6 months	<i>Asp. flavus</i>
	<i>Asp. yezoensis</i>
	<i>Fusarium</i> sp.
Found in 5 months	<i>Asp. ruber</i>
	<i>Stemph. botryosum</i> var. <i>botrytis</i>
Found in 4 months	<i>Asp. Chevalieri</i>
Found in 3 months	<i>Asp. Chevalieri</i> var. <i>ruber</i>
	<i>Asp. Sydwi</i>
	<i>Asp. versicolor</i> var. <i>magnus</i>
	<i>Citromyces Pfefferianus</i>
	<i>Pen. Sartoryi</i>
	<i>Pen. flavo-glaucum</i>
	<i>Trichoderma Koningi</i>
Found in 2 months	<i>Rh. nigricans</i>
	<i>Asp. versicolor</i>
	<i>Asp. terreus</i>
	<i>Pen. parallelosporum</i>
	<i>Pen. Paczoskii</i>
	<i>Pen. digitatum</i>
	<i>Pen. Janczewskii</i>
	<i>Pen. solitum</i>
	<i>Pen. crustosum</i> var. <i>spinulosporum</i>
	<i>Pen. expansum</i>
	<i>Paecilomyces varioti</i>
	<i>Botrytis cinerea</i>
	<i>Trichothecium roseum</i>
Found in 1 month	<i>Oo. lupuli</i>
	<i>Asp. clavatus</i>
	<i>Asp. fumigatus</i>
	<i>Asp. nidulans</i>
	<i>Asp. flavus</i> var. <i>asper</i>
	<i>Pen. spinulosum</i>
	<i>Pen. carmino-violaceum</i>
	<i>Pen. fellutanum</i>
	<i>Pen. citreo-viride</i>

Pen. Terlikowskii
Pen. columnare
Pen. ellipticum
Pen. Waksmani
Pen. spinulo-ramigenum
Pen. citreo-roseum
Pen. crustosum
Scop. brevicaulis
Dem. pullulans
Epicoc. purpurascens

The molds may be divided into the following groups due to the total frequencies of appearance.

Total frequency	Mold species
115	<i>Oo. lactis</i>
72	<i>Oo. suaveolens</i>
64	<i>Cl. herbarum</i>
54	<i>Asp. repens</i>
25	<i>Alt. tenuis</i>
19	<i>Fusarium</i> sp.
17	<i>Pen. Roqueforti</i>
12	<i>Asp. flavus</i>
	<i>Stemph. botryosum</i> var. <i>botrytis</i>
11	<i>Pen. yezoensum</i>
	<i>Pen. palitans</i>
8	<i>Asp. versicolor</i> var. <i>magnus</i>
	<i>Pen. digitatum</i>
7	<i>Asp. yezoensis</i>
	<i>Asp. Chevalieri</i>
6	<i>Asp. ruber</i>
5	<i>Citromyces Pfefferianus</i>
4	<i>Asp. Chevalieri</i> var. <i>ruber</i>
	<i>Asp. Sydowi</i>
	<i>Pen. Sartoryi</i>
	<i>Pen. flavo-glaucum</i>
3	<i>Rh. nigricans</i>
	<i>Trichoderma Koningi</i>
	<i>Botrytis cinerea</i>
2	<i>Asp. versicolor</i>

Asp. terreus
Pen. parallelosporum
Pen. Paczowskii
Pen. Janczewskii
Pen. solitum
Pen. crustosum
Pen. crustosum var. *spinulosporum*
Pen. expansum
Paecilomyces varioti
Trichothecium roseum
Oo. lupuli
Asp. clavatus
Asp. fumigatus
Asp. nidulans
Asp. flavus var. *asper*
Pen. spinulosum
Pen. carmino-violaceum
Pen. fellutanum
Pen. citreo-viride
Pen. Terlikowskii
Pen. columnare
Pen. ellipticum
Pen. Waksmani
Pen. spinulo-ramigenum
Pen. citreo-roseum
Scop. brevicaulis
Dem. pullulans
Epiloc. purpurascens

C. Some of the factors influencing the growth of molds in butter

Many factors may be considered as affecting the growth of molds, among which the temperature, salt concentrations, and acidity are the most noteworthy. The purpose of the studies reported on subsequent pages was to determine the influence of these factors upon the growth of molds.

I. Temperature

a. Growth temperature.

That temperature has a profound effect upon the growth of microorganisms is generally appreciated. Molds are no exception to this.

Butter is kept at a wide range of storage temperatures but these must be near 0°C. or below. In general, lots of butter will be exposed to higher temperatures for considerable periods of time.

All species of the molds isolated from butter were seeded in koji extract (12° Bå., pH 6.7) in order to observe the effect of different temperatures upon their growth. The temperatures used were 5°, 15°, 27°, 32°, 37° and 42°C. Growth, production of conidia, sporangia or perithecia, and pigmentation were observed at the end of two weeks. Table 56 gives the results of this experiment.

The molds isolated from butter may be divided into the following subdivisions according to their growth temperatures.

Grew at 42°C.:

Grew at 5°C.	<i>Oospora lactis</i>
	<i>Oo. suaveolens</i>
	<i>Oo. lupuli</i>
	<i>Aspergillus Chevalieri</i>
	<i>Asp. Chevalieri</i> var. <i>ruber</i>
	<i>Asp. repens</i>
	<i>Scop. brevicaulis</i>
	<i>Paecilomyces varioti</i>
	<i>Trichoderma Koningi</i>
	<i>Fusarium</i> sp.

Did not grow at 5°C.	<i>Asp. clavatus</i>
	<i>Asp. fumigatus</i>
	<i>Asp. nidulans</i>
	<i>Asp. Sydowi</i>
	<i>Asp. flavus</i>
	<i>Asp. flavus</i> var. <i>asper</i>
	<i>Asp. terreus</i>
	<i>Asp. yezoensis</i>
	<i>Pen. citreo-roseum</i>
	<i>Pen. Janczewskii</i>

Grew at 37°C.:

Grew at 5°C.	<i>Asp. ruber</i>
	<i>Stemph. botryosum</i> var. <i>botrytis</i>
Did not grow at 5°C.	<i>Pen. spinulosum</i>
	<i>Citromyces Pfefferianus</i>
	<i>Pen. fellutanum</i>
	<i>Pen. citreo-viride</i>
	<i>Pen. Paczoskii</i>
	<i>Pen. Terlikowskii</i>
	<i>Pen. columnare</i>
	<i>Pen. ellipticum</i>
	<i>Pen. Waksmani</i>
	<i>Pen. Sartoryi</i>
	<i>Pen. spinulo-ramigenum</i>
	<i>Pen. Roqueforti</i>
	<i>Pen. solitum</i>
	<i>Pen. crustosum</i>
	<i>Pen. crustosum</i> var. <i>spinulosporum</i>

Grew at 32°C.:

Grew at 5°C.	<i>Rh. nigricans</i>
	<i>Botrytis cinerea</i>
	<i>Dem. pullulans</i>
	<i>Cl. herbarum</i>
	<i>Alt. tenuis</i>
	<i>Epicoc. purpurascens</i>
Did not grow at 5°C.	<i>Asp. versicolor</i>
	<i>Asp. versicolor</i> var. <i>magnus</i>
	<i>Pen. yezoensum</i>
	<i>Pen. parallelosporum</i>
	<i>Pen. carmino-vicilaceum</i>
	<i>Pen. digitatum</i>
	<i>Pen. flavo-glaucum</i>
	<i>Pen. palitans</i>
	<i>Pen. expansum</i>
	<i>Trichothecium roseum</i>

It has been shown in experiment reported in the previous pages that the most common species of molds isolated from the butter are *Asp. repens*, *Oospora lactis*, *Oospora suaveolens*, *Penicillium Roqueforti*

and *Fusarium* sp. It is a noteworthy fact that these species, except *Penicillium Roqueforti*, have the broad growth-temperature range from 42° to 5°C. *Stemphylium botryosum* var. *botrytis*, *Cladosporium herbarum* and *Alternaria tenuis*, the most common staining molds of butter, showed the active growth at 5°C.

b. Thermal death point.

Heat is one of the cheapest and best agent for destruction of cells of microorganisms. It is used in dairy industries for killing bacteria. The raw materials, as milk and cream, are pasteurized, and the churn and other utensils are treated with steam or hot water to destroy the microorganisms. Pasteurization is a process of heating to a temperature considerably below the boiling point with the object of destroying a large percentage of the microorganisms that may be present. The two main types of pasteurization have been developed; (1) the flash method and (2) the holding method. The flash pasteurization consists of heating to a comparatively high temperature for a very short period, the material running through the pasteurizer and to the cooler in a continuous stream. The temperature used ordinarily range from 71° to 85°C. (160° to 185°F.) or even higher, while the time usually varies from one-half to one minute.

The holding pasteurization consists of heating to a comparatively low temperature for a considerable period. The usual exposures are from 60° to 65°C. (140° to 150°F.) for from 20 to 30 minutes.

The survival of molds after pasteurization were frequently observed by the author. To study the effect of heating on mold spores, the following experiments were made. The koji extract tubes were heated in a water bath in which the water was agitated and the temperature of the koji extract was constantly held at 50°, 55°, 60°, 65°, 70°, 75° or 80°C. Conidia from young cultures of molds were transferred to the tubes with a platinum loop. After the inoculated tubes were held at the temperature for ten minutes, they were immediately cooled to 27°C. The inoculated and pasteurized tubes were incubated at 27°C. for two weeks and observed the effect of pasteurization. The results of the experiment are shown in table 57.

A study of table 57 shows that all species of the molds survived 50°C. for 10 minutes, but were dead at 80°C., and a few mold spores

survive exposure to 70°C. in koji-extract for 10 minutes.

With reference to significant organisms, *Cladosporium herbarum*, *Alternaria tenuis*, and *Stemphylium botryosum* var. *botrytis*, which are found frequently to form dark colored spots or specks on butter, were destroyed at 55°C. This is showed that these dark colored molds did not originate from raw materials, but came secondarily from air, as the author previously reported.⁸² The common green species of *Penicillium* are mostly dead at 65°C. or below, but six, one fourth of this genus, survived 65°C. for 10 minutes. Among species of *Aspergillus*, however, the strains of *Aspergillus ruber*, *Aspergillus Chevalieri*, *Aspergillus Chevalieri* var. *ruber*, *Aspergillus repens* and *Aspergillus nidulans* all survived 70°C. for 10 minutes; the former three of them survived 75°C.

The mold isolated from butter may be divided into the following subdivisions according to their resistance to heating.

Destroyed at 80°C.

(Survive 75°C. for 10 minutes): *Aspergillus Chevalieri*
Asp. Chevalieri var. *ruber*
Asp. ruber

Destroyed at 75°C.

(Survive 70°C. for 10 minutes): *Asp. repens*
Asp. nidulans

Destroyed at 70°C.

(Survive 65°C. for 10 minutes): *Oospora lactis*
Asp. fumigatus
Asp. terreus
Asp. yezoensis
Citromyces Pfefferianus
Pen. columnare
Pen. Waksmani
Pen. Sartoryi
Pen. palitans
Pen. crustosum
Scop. brevicaulis
Paec. varioti
Trichoderma Koningi

Destroyed at 65°C.

(Survive 60°C. for 10 minutes): *Asp. clavatus*
Asp. flavus

Asp. flavus var. *asper*
Pen. yezoensum
Pen. spinulosum
Pen. citreo-viride
Pen. Paczoskii
Pen. spinulo-ramigenum
Pen. Roqueforti
Pen. Janczewskii
Pen. expansum

Destroyed at 60°C.

(Survive 55°C. for 10 minutes): *Oospora lupuli*
Asp. Sydowi
Asp. versicolor
Asp. versicolor var. *magnus*
Pen. parallelosporum
Pen. carmino-violaceum
Pen. fellutanum
Pen. Terlikowskii
Pen. digitatum
Pen. citreo-roseum
Pen. solitum
Pen. flavo-glaucum
Pen. crustosum var. *spinulosporum*
Fusarium sp.

Destroyed at 55°C. (Survive 50°C. for 10 minutes):

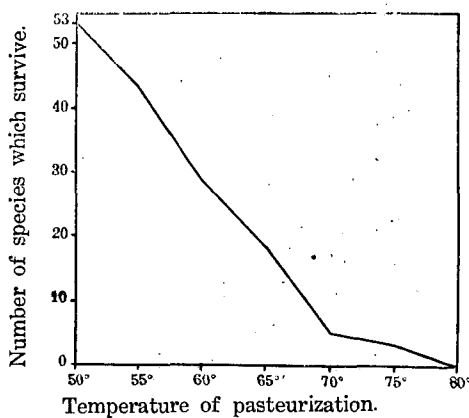


Fig. 1. The destruction of mold spores by heating.

Rh. nigricans
Oo. suaveolens
Pen. ellipticum
Botrytis cinerea
Trichothecium roseum
Dematium pullulans
Cladosporium herbarum
Stemph. botrycium var. *botrytis*
Alternaria tenuis
Epicoccum purpurascens

The destruction of mold spores by the pasteurization is shown more clearly in Fig. 1, where the results have been plotted.

II. Salt content

Sodium chloride has been considered a food preservative, for many years. The salt present in butter has an inhibiting effect on mold development as is shown by the fact that mold is much more troublesome in unsalted butter than in salted. Most butter contains about 15 to 16 per cent of water and about 2 per cent of salt, which is equivalent to a 12 to 15 per cent brine, and yet some molds grow on butter. Experiments were conducted to determine the effect of various concentrations of sodium chloride upon the growth of the species of molds isolated from butter.

Koji-extract (12 Bå.) was used as a substrate. Sodium chloride was added to various portions in different amounts, so the final salt content (by weight) in the different lots of substrate was 5, 10, 15, 20 and 25 per cent. An unsalted portion was left as a check. The solutions were tubed and sterilized. After inoculation they were incubated at 27° C. for 10 days to observe the growth, production of conidia or perithecia, soluble pigment formation and others. The record of the observations is given in table 58.

The molds isolated from butter may be divided into the following subdivisions according to their resistance to sodium chloride.

Grew at 25 per cent of salt content:

Grew better at 5-10 per cent of salt content:

Aspergillus repens

Asp. ruber

Grew better on the unsalted medium:

Asp. Chevalieri

Asp. Chevalieri var. *ruber*

Grew at 20 per cent of salt content:

Grew better at 5-10 per cent of salt content:

Penicillium Terlikowskii

Pen. Roqueforti

Pen. solitum

Pen. pilicins

Grew better on the unsalted medium:

Asp. nidulans

Asp. Sydowi

Asp. versicolor

Asp. versicolor var. *magnus*

Asp. flavus
Asp. flavus var. *asper*
Asp. terreus
Pen. yezoensis
Pen. spinulosum
Citromyces Pfefferianus
Pen. carmino-violaceum
Pen. fellutanum
Pen. citreo-viride
Pen. Paczoskii
Pen. columnare
Pen. Waksmani
Pen. Sartoryi
Pen. spinulo-ramigenum
Pen. Janczewskii
Pen. flavo-glaucum
Pen. crustosum
Pen. crustosum var. *spinulosporum*
Pen. expansum
Scop. brevicaulis
Pacz. varioti
Cl. herbarum

Grew at 15 per cent of salt content:

Rh. nigricans
Oospora lactis
Asp. yezoensis
Pen. parallelsporum
Pen. ellipticum
Pen. citreo-roseum
Stemph. botryosum var. *botrytis*
Al. tenuis
Fusarium sp.

Grew at 10 per cent of salt content:

Oospora suavelens
Oo. lupuli
Asp. clavatis
Asp. fumigatus
Pen. digitatum
Trichoderma Keningi

Dem. pullulans

Botrytis cinerea

Trichothecium roseum

Epizoc. purpurascens

The growth of every cultures was luxuriant in the unsalted medium after 10 days, as is shown in table 58. In the 5 per cent salt medium, development was greater than in the unsalted solution in the case of *Aspergillus repens*, *Aspergillus ruber*, *Penicillium Terlikowskii*, *Penicillium Roqueforti*, *Penicillium solitum* and *Penicillium palitans*; practically the same as in the unsalted medium with most other species, but only slight with *Trichothecium roseum* and *Epizocum purpurascens*.

When the concentration of salt was increased to 15 per cent, *Oospora siaveiens*, *Oospora lupuli*, *Aspergillus clavatus*, *Aspergillus fumigatus*, *Penicillium digitatum*, *Trichoderma Koningi*, *Botrytis cinerea*, *Trichothecium roseum*, *Dematium pullulans*, and *Epizocum purpurascens* were checked entirely.

When the salt content reached 20 per cent, *Aspergillus Chevalieri*, *Aspergillus Chevalieri* var. *ruber*, *Aspergillus repens*, *Aspergillus ruber*, *Aspergillus Sydowi*, *Penicillium spinulosum*, *Penicillium Waksmani*, *Penicillium Janzewskae*, *Penicillium crustaceum*, and *Scopulariopsis brevicaulis* showed abundant moderate growth, and *Aspergillus nidulans*, *Aspergillus versicolor*, *Aspergillus versicolor* var. *magnus*, *Aspergillus flavus*, *Aspergillus flavus* var. *asper*, *Aspergillus terreus*, *Penicillium yezcensum*, *Cirromyces Pfefferianus*, *Penicillium carminiliceum*, *Penicillium fel-lutanum*, *Penicillium citreoviride*, *Penicillium Pazoskii*, *Penicillium Terlikowskii*, *Penicillium columnare*, *Penicillium spinulo-ramigenum*, *Penicillium solitum*, *Penicillium flavo-glaucum*, *Penicillium palitans*, *Penicillium crustaceum* var. *spinulosporum*, *Penicillium expansum*, *Paecilomyces varioti* and *Clad sporium herbarum* slight growth, the others remained dormant.

Aspergillus Chevalieri, *Aspergillus Chevalieri* var. *ruber*, *Aspergillus repens*, and *Aspergillus ruber* were the only ones to grow in the 25 per cent concentration of salt and they grew well. As these species are resistant to heat and have a broad distributions, they are of major importance.

The presence of salt fairly stimulated the conidia formation and soluble pigment-production of most species.

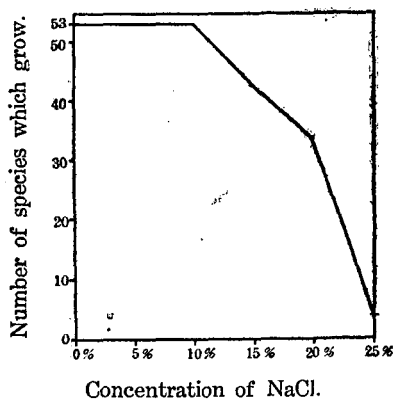


Fig. 2. Inhibitory effect of salt upon growth of molds.

The resistance of molds to sodiumchloride is shown more clearly in figure 2.

III. Acidity

In general, "the sweet cream butter" are manufactured in our country and U.S.A., contrariwise "the sour cream butter" in European countries. In acid media the growth of bacteria are checked, but the molds rather grow well. Experiments were conducted to show the effect of various concen-

trations of acid upon the growth of the species of molds isolated from butter.

Koji-extract (12° Bâ.) was used as a substrate, and lactic acid was added to various portions in different amounts, so the final acid content (by weight as lactic acid) in the different lots of substrate was 0.1, 0.4, 1.0, 2.0 and 5.0 per cent. A neutralized portion was left as a check. These solutions were tubed and sterilized. After inoculation they were incubated at 27°C. for 10 days to observe the growth, production of conidia or perithecia, soluble pigment-formation and others. The results of this experiment are shown in table 59.

The molds isolated from butter may be divided into the following subdivisions according to their resistance to lactic acid.

Grew at 5 per cent of lactic acid content:

Penicillium spinulosum
Citromyces Pfefferianus
Pen. fellutanum
Pen. citreo-viride
Pen. Terlikowskii
Pen. Sartoryi
Pen. spinulo-ramigenum
Pen. Roqueforti

Grew at 2 per cent of lactic acid content:

Rh. nigricans
Oospora suaveolens

Aspergillus ruber
Asp. Chevalieri var. *ruber*
Asp. fumigatus
Asp. nidulans
Asp. flavus
Asp. flavus var. *asper*
Asp. terreus
Asp. yezoensis
Pen. yezoensum
Pen. parallelosporum
Pen. carmino-violaceum
Pen. Paczoskii
Pen. ellipticum
Pen. columnare
Pen. Waksmani
Pen. digitatum
Pen. citreo-roseum
Pen. Janczewskii
Pen. solitum
Pen. flavo-glaucum
Pen. palians
Pen. crustosum
Pen. crustosum var. *spinulosporum*
Pen. expansum
Pezizomyces variolii
Trichoderma Koningii

Grew at 1 per cent of lactic acid content:

Corpora lactis
Asp. versicolor var. *magnus*
Asp. clavatus
Asp. Chevalieri
Asp. repens
Asp. Sydowi
Trichothecium roseum
Dematium pullulans
Cladosporium herbarum
Alternaria tenuis
Fusarium sp.

Grew at 0.4 per cent of lactic acid content:

Oospora lupuli
Asp. versicolor
Scop. brevicaulis
Botrytis cinerea
Stemph. botryosum var. *botrytis*
Epiloc. purpurascens

The resistance of molds to lactic acid content is shown more clearly in figure 3.

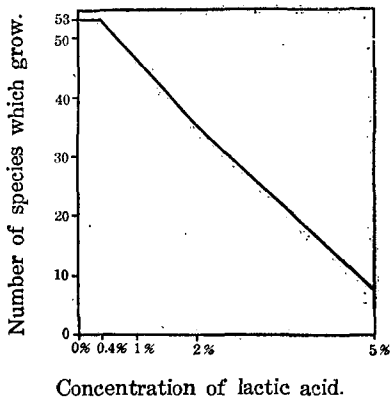


Fig. 3. Inhibitory effect of lactic acid upon growth of molds.

The growth of all the cultures was excellent in the neutralized medium. The development of the cultures in the Koji-extract containing 0.1 per cent acid was practically the same as in the neutralized medium, in some cases less and in other cases greater.

The 0.4 per cent acid concentration did not completely inhibit the growth of all the species of molds. When the percentage of acid was increased to 1.0 per cent, *Cospora lupuli*, *Aspergillus versicolor*,

Scopulariopsis brevicaulis, *Botrytis cinerea*, *Stemphylium botryosum* var. *botrytis*, and *Epizocum purpurascens* were checked entirely.

With 2.0 per cent acid, *Cospora suaveolens*, *Rhizopus nigricans*, *Paeziomyces varioli*, *Trichoderma Koningi*, all the species of genus *Penicillium*, and eight species of genus *Aspergillus*, were active.

Most cultures gave no growth with 5.0 per cent lactic acid. The only species to show any development in this medium were *Penicillium spinulosum*, *Citromyces Pfefferianus*, *Penicillium fellu'anum*, *Penicillium citro-viride*, *Penicillium Terlikowskii*, *Penicillium Sartorii*, and *Penicillium Roqueforti*.

D. Some of the Physiological Activities of Molds in Butter

In the previous pages, experimental results on the morphological or physiological characteristics of molds which were isolated from butter and on some of the factors influencing the growth on them

were described. It is considered advisable to determine the action of these molds on butter since it is conceivable that certain types might be commonly recovered which have no significance as factors in the deterioration of butter. The perfect sterile butter as a culture medium must be used in the study to determine the action of molds, but it is actually impossible to manufacture the fresh butter without contamination. In these studies, the sterile litmus milk and the tributyrine Koji-agar were employed as the substrates, and the mold actions on butter were indirectly determined according to the actions on these media.

I. Actions of molds upon milk

In these studies, litmus milk was employed as the substrate which contained the azolitmin in 1 per cent. It was inoculated with mold spores and incubated at 27°C. The peptonization, production of acid or alkali, and reducing power of these mold cultures were observed after 10 and 20 days. Table 60 gives the results of these experiments.

Table 60 indicates that all cultures except *Cospora lactis* gave more or less actual changes to litmus milk. Fourty of all fifty three species possessed the peptonizing power to casein in milk, especially, *Cospora suaveolens*, *Cospora lupuli*, *Penicillium citreo-viride*, *Penicillium spinulosporigenum*, *Penicillium Rozei*, *Penicillium Janczewskii*, *Penicillium pallans*, *Scopulariopsis brevicaulis*, *Trichoderma Koningi*, *Demicium pullulans*, *Cladophorium herbarum*, *Stemphylium botrytis* var. *botrytis* were very strong decomposers.

The *Aspergillus glaucus* group — *Aspergillus repens*, *Aspergillus ruber*, *Aspergillus Chevalieri*, and *Aspergillus Chevalieri* var. *ruber* — did not peptonize milk, but changed it fairly to alkaline.

Molds isolated from butter, may be divided as follows on the basis of their actions on milk.

Milk peptonized:

Milk changed to alkaline reaction:

Reductase produced:

Cospora suaveolens

Aspergillus Sydowi

Asp. versicolor

Penicillium Watsmani

Fusarium sp.

Epicoecum purpurascens

Reductase not produced :

Rhizopus nigricans

Asp. fumigatus

Asp. flavus

Asp. flavus var. *asper*

Asp. terreus

Pen. yezoensum

Pen. spinulosum

Pen. Terlikowskii

Pen. columnare

Pen. Roqueforti

Pen. Janczewskii

Trichothecium roseum

Dematium pullulans

Cladosporium herbarum

Stemph. botryosum var. *botrytis*

Asp. nidulans

Milk changed to acid reaction :

Reductase not produced :

Asp. clavatus

Asp. yezoensis

Pen. digitatum

Botrytis cinerea

Reductase produced :

Trichoderma Koningi

Reaction unchanged but reductase produced :

Cospora lupuli

Asp. versicolor var. *magnus*

Pen. parallelosporum

Pen. citreo-viride

Pen. spinulo-ramigenum

Pen. solitum

Pen. flavo-glaucum

Pen. palitans

Pen. crustosum

Pen. crustosum var. *spinulosporum*

Pen. expansum
Scop. brevicaulis
Alternaria tenuis

Milk not peptonized:

Milk changed to alkaline reaction:

Asp. Chevalieri
Asp. Chevalieri var. *ruber*
Asp. repens
Asp. ruber
Citromyces Pfefferianus
Pen. carmino-violaceum
Pen. fellutanum
Pen. Paczoskii
Pen. ellipticum
Pen. Sartorii
Pen. citreo-roseum
Paecilomyces varioti

Reaction unchanged:

Cospora lactis

II. Lipolytic action

Various microorganisms hydrolyze fat with the liberation of fatty acids and glycerol, and the change is referred to as lypolysis. The lower fatty acids found in butter fat, especially butyric and caproic acids, have conspicuous odors that are very objectionable in butter. When the odors of the lower fatty acids develop in butter, the condition is commonly referred to as rancidity.

In this investigation, the presence of a lipolytic enzyme of molds was demonstrated by means of the following methods. The medium used Koji-agar, 2.5 c.c. of the liquefied transparent agar was introduced into each test tube, one cm. in diameter, and sterilized by usual method. Just prior to coagulation, three droops of tributyrin was added to the medium. The tributyrin and the substrate was shaken and mixed thoroughly until the medium was of opaque suspension, and solidified it as soon as possible. After solidification of the medium, the tubes were inoculated with spores from young cultures of molds and incubated for any time. If the mold secrete a lipolytic enzyme, the tributyrin are hydrolized and changed into

soluble components, i.e. butyric acid and glycerin, and a transparent portion appears under the mycelial layer of the mold. The depth of the transparent portion is in proportion to the lipolytic action of the mold.

In order to observe the effect of different temperatures on the lipolytic action of molds, the temperatures used were 12°, 27° and 32°C. Table 61 gives the results of this experiments after 30 days. (The figures in this table show the depth of transparent layer in mm. which was formed by lipolytic action of mold.)

From these experiments, the following conclusions may be introduced. The lipolytic action of *Aspergillus repens* is the highest, and *Aspergillus clavatus*, *Aspergillus ruber*, *Aspergillus versicolor*, *Aspergillus fumigatus*, *Ciromyces Pfefferianus*, *Penicillium crustosum* etc. are very strong fat decomposers.

Most of molds have the optimum temperature of lipolysis at nearly 27°C. *Aspergillus Chevalieri*, *Penicillium favo-glaucum* and *Penicillium chrysogenum* showed the strongest lipolytic action at lower temperature (12°C.). On the contrary, *Aspergillus nidulans*, *Aspergillus terreus*, *Penicillium columbare*, *Cospora lactis*, *Cospora suaveolens* etc. decomposed the tributyrin at 32°C. stronger than at lower temperatures. *Rhizopus nigricans*, *Penicillium citreoviride*, *Penicillium Roquesii*, *Scopulariopsis brevicaulis*, *Paecilomyces varioti*, *Trichoderma Koningi*, and *Stemphylium botryosum* var. *botrytis* showed almost constant lipolytic action at any of these temperatures. *Aspergillus Sclerotii*, *Penicillium ellipticum*, *Penicillium Sarcocoidi*, *Cospora lupuli*, *Trichothecium roseum*, and *Epitoxum purpurascens* did not show the lipolytic action for 30 days incubation at every temperature.

As most of molds have the optimum temperature of lipolysis at nearly 27°C. as showing in previous data, the process of lipolysis at this temperature was observed on 7 days, 30 days and 60 days after inoculation. The results are shown in table 62.

The molds may be divided into the following subdivisions according to the processes of their lipolytic action at 27°C.

Lipolysis was shown mostly within 30 days:

Aspergillus clavatus
Asp. Chevalieri
Asp. repens
Asp. ruber

Asp. fumigatus
Asp. versicolor
Asp. flavus
Penicillium fellutanum

Lipolytic action was very stronger after 30 days then before :

Rhizopus nigricans
Cospora lactis
Cospora suaveolens
Asp. Chevalieri var. *ruber*
Asp. nidulans
Asp. flavus var. *asper*
Asp. terreus
Pen. spinulosum
Citromyces Pfefferianus
Pen. carmino-violaceum
Pen. citreo-viride
Pen. Paczoskii
Pen. Terlikowskii
Pen. ellipticum
Pen. Waksmani
Pen. spinulo-ramigenum
Pen. digitatum
Pen. Roqueforti
Pen. Janczewskii
Pen. solium
Pen. favo-glaucom
Pen. palians
Pen. crustosum var. *spinulosporum*
Pen. expansum
Scopulariopsis brevicaulis
Paezilomyces varioti
Trichoderma Koningi
Trichothecium roseum
Dema'tium pullulans
Stemph. torulosum var. *bo'rytis*
Alternaria tenuis
Fusarium sp.

Lipolysis increased gradually with the time, nearly as a

straight line:

Asp. versicolor var. *magnus*
Asp. yezoensis
Pen. yezoensum
Pen. parallelosporum
Pen. columnare
Pen. citreo-roseum
Pen. crustosum
Botrytis cinerea
Cladosporium herbarum

Lipolysis was not recognized:

Cospora lupuli
Asp. Sîdoui
Pen. Sartoryi
Epicozum purpurascens

SUMMARY AND CONCLUSION

1. Studies were made of the fungous flora of butter manufacturing in Hokkaido, some of the factors influencing the growth of molds, and their important physiological activities.

2. Five hundreds and eighteen cultures of molds were isolated from butter. They were classified and identified into 15 genera—48 species and 5 varieties, as follows:

Rhizopus nigricans, *Cospora lactis*, *Cospora suaveolens*, *Cospora lupuli*, *Aspergillus clavatus*, *Aspergillus Chevalieri*, *Aspergillus Chevalieri* var. *ruber*, *Aspergillus repens*, *Aspergillus ruber*, *Aspergillus fumigatus*, *Aspergillus nidulans*, *Aspergillus Sîdoui*, *Aspergillus versicolor*, *Aspergillus versicolor* var. *magnus*, *Aspergillus flavus*, *Aspergillus flavus* var. *asper*, *Aspergillus terreus*, *Aspergillus yezoensis*, *Penicillium yezoensum*, *Penicillium spinulosum*, *Citromyces Pfefferianus*, *Penicillium parallelosporum*, *Penicillium carmino-violaceum*, *Penicillium fellu'anum*, *Penicillium citreoviride*, *Penicillium Pazzoskii*, *Penicillium Terlikovskii*, *Penicillium columnare*, *Penicillium ellipticum*, *Penicillium Wa'tsmani*, *Penicillium Sartoryi*, *Penicillium spinuloramigenum*, *Penicillium digitatum*, *Penicillium citreoroseum*, *Penicillium Roqueforti*, *Penicillium Janczewskii*, *Penicillium solium*, *Penicillium flavo-glauum*, *Penicillium palians*, *Penicillium crustosum*, *Penicillium crustosum* var. *spinulosporum*, *Penicillium expansum*, *Scopulariopsis brevicaulis*, *Paezilomyces variolii*, *Trichoderma Koningi*,

Bo'rytis cinerea, *Trichothecium roseum*, *Dema'tium pullulans*, *Cladosporium herbarum*, *Alternaria tenuis*, *Stemphylium bo'ryosum* var. *bo'rytis*, *Fusarium* sp., and *Epicoxum purpurascens*.

3. Among them, *Aspergillus ye'oensis*, *Penicillium parallelosporum*, *Penicillium ellipticum*, and *Penicillium spinulo-ramigenum* were named as new species, and *Aspergillus Chevalieri* var. *ruber*, *Aspergillus versicolor* var. *magnus*, *Aspergillus flavus* var. *asper*, and *Penicillium crustosum* var. *spinulosporum*, were named as new varieties.

4. *Cospora lactis*, *Cospora suaveolens*, *Aspergillus repens* and *Cladosporium herbarum* were the most widely spread species of butter molds. *Penicillium Foqueforti* was a common species in all creameries, but appeared frequently from autumn till spring and rarely in summer. *Alternaria tenuis* and *Fusarium* sp. were also common, and they were often found from summer till autumn. Following them, *Aspergillus flavus* and *Penicillium ye'oensum* were found broadly both in local or in seasons.

5. The appearances of *Aspergillus Sydowi*, *Aspergillus ye'oensis*, and *Stemphylium bo'ryosum* var. *bo'rytis* were localized.

6. The distributions of *Aspergillus Chevalieri*, *Aspergillus Chevalieri* var. *ruber*, *Aspergillus ruber*, *Penicillium digitatum*, and *Bo'rytis cinerea* were limited by the seasonal effect.

7. *Cospora lactis*, *Cospora suaveolens*, *Cospora lupuli*, *Aspergillus Chevalieri*, *Aspergillus Chevalieri* var. *ruber*, *Aspergillus repens*, *Scoptariopsis brevicaulis*, *Paecilomyces varioides*, *Trichoderma Koninzi*, and *Fusarium* sp. could grow in broad temperature range from 42° to 5°C. *Stemphylium bo'ryosum* var. *bo'rytis*, *Cladosporium herbarum*, and *Alternaria tenuis*, the most common staining molds of butter, showed the active growth at 5°C.

8. *Aspergillus Chevalieri*, *Aspergillus Chevalieri* var. *ruber*, *Aspergillus ruber*, *Aspergillus repens*, and *Aspergillus nidulans* survived 70°C. for 10 minutes. The most common dark colored molds—*Cladosporium herbarum*, *Alternaria tenuis*, and *Stemphylium bo'ryosum* var. *bo'rytis*—were destroyed at 55°C. All species of the molds survived 50°C. for 10 minutes, but were killed at 86°C.

9. In the 25 per cent salt medium, *Aspergillus repens*, *Aspergillus ruber*, *Aspergillus Chevalieri*, *Aspergillus Chevalieri* var. *ruber* were the only ones to grow. All species of the molds developed to the 10 per cent salted medium.

10. Most cultures gave no growth with 5.0 per cent lactic acid, except *Penicillium spinulosum*, *Citromyces Pfefferianus*, *Penicillium fellutanum*, *Penicillium citreo-viride*, *Penicillium Terlikowskii*, *Penicillium Sartoryi*, and *Penicillium Roqueforti*. The 0.4 per cent acid concentration did not completely inhibit the growth of all the species of molds.

11. Milk were peptonized by most species, especially, *Penicillium citreo-viride*, *Penicillium spinulo-ramigenum*, *Penicillium Roqueforti*, *Penicillium Janczewskii*, *Penicillium palitans*, *Scopulariopsis brevicaulis*, *Cospora suaveolens*, *Oospora lupuli*, *Trichoderma Koningi*, *Dematium pululans*, *Cladosporium herbarum*, *Stemphylium botryosum* var. *botrytis* were very strong decomposers. *Aspergillus repens*, *Aspergillus ruber*, *Aspergillus Chevalieri*, and *Aspergillus Chevalieri* var. *ruber* did not peptonized milk, but changed it fairly to alkaline. *Oospora lactis* did not change the milk.

12. Almost all the species of molds possessed the lipolytic action, except *Aspergillus Sydowi*, *Penicillium Sartoryi*, *Cospora lupuli*, and *Epicoccum purpurascens*. Most of them had the optimum temperature of lipolysis at nearly 27°C. The lipolytic action of *Aspergillus repens* was the highest, and *Aspergillus clavatus*, *Aspergillus ruber*, *Aspergillus versicolor*, *Aspergillus fumigatus*, *Citromyces Pfefferianus*, *Penicillium digitatum*, *Penicillium Roqueforti*, *Penicillium crustosum*, *Penicillium crustosum* var. *spinulosporum*, *Trichoderma Koningi*, etc. were very strong fat decomposers.

TABLE 1. Distribution of *Rhizopus nigricans*.

Province	Oshima		Iburi		Ishikari		Teshio	Tokachi	Kushiro	Nemuro	Kitami		Frequency	
Creamery	P	I	T	A	F	C	B	N	D	K	L	E	X	
January														1
February	*													
March														
April														
May					*						*			2
June														
July														
August														
September														
October														
November														
December														
Frequency	1				1						1			3

TABLE 2. Distribution of *Oospora lactis*.

Province	Oshima		Iburi		Ishikari		Teshio	Tokachi	Kushiro	Nemuro	Kitami		Frequency	
Creamery	P	I	T	A	F	C	B	N	D	K	L	E	X	
January	*	*	*	*	*	*	*	*	*	*	*			11
February	*	*	*	*		*	*	*	*	*	*	*		11
March	*	*	*	*			*	*	*	*	*			9
April	*	*	*	*					*	*	*			7
May	*	*	*					*	*		*			6
June	*	*	*	*		*	*	*	*	*	*			10
July	*	*	*		*		*		*	*	*			8
August	*	*	*	*	*	*		*		*	*		*	10
September	*	*	*	*	*		*	*	*	*	*			10
October	*	*	*	*	*		*	*	*	*	*	*		11
November	*	*	*	*	*	*	*	*	*	*	*			11
December	*	*	*	*	*	*	*	*	*	*	*			11
Frequency	12	12	12	10	7	6	9	10	11	11	12	2	1	115

TABLE 5. Distribution of *Aspergillus clavatus*.

Province	Oshima		Iburi		Isikari			Teshio	Tokachi	Kushiro		Nemuro	Kitami		Frequency
Creamery	P	I	T	A	F	C	B	N	D	K	L	E	X		
January															1
February															
March															
April															
May															
June															
July															
August															
September															
October															
November									*						
December															
Frequency									1						1

TABLE 6. Distribution of *Aspergillus Chevalieri*.

Province	Oshima			Iburi			Isikari			Teshio		Tokachi		Kushiro		Nemuro		Kitami		Frequency
Creamery	P	I	T	A	F	C	B	N	D	K	L	E	X							
January																				7
February																				
March																				
April									*				*							
May					*					*										
June		*							*											
July																				
August																				
September																				
October										*										
November																				
December																				
Frequency		1			1				2	2			1						7	

TABLE 7. Distribution of *Aspergillus Chevalieri* var. *ruber*.

Province	Oshima		Iburi		Ishikari			Teshio	Tokachi	Kushiro		Nemuro	Kitami		Frequency
Creamery	P	I	T	A	F	C	B	N	D	K	L	E	X		
January															
February															
March															
April													*	1	
May			*							*				12	
June															
July															
August			*											1	
September															
October															
November															
December															
Frequency			2							1			1	4	

TABLE 8. Distribution of *Aspergillus repens*.

Province	Oshima		Iburi		Ishikari			Teshio		Tokachi		Kushiro		Nemuro		Kitami		Frequency
Creamery	P	I	T	A	F	C	B	N	D	K	L	E	X					
January					*		*				*		*				4	
February											*	*					2	
March											*						1	
April		*	*					*	*								4	
May	*	*	*		*	*		*	*	*	*	*					10	
June		*						*	*			*					4	
July	*	*		*		*	*		*	*	*						8	
August	*		*	*	*		*	*		*		*	*				9	
September				*			*	*			*						3	
October				*	*	*	*			*				*			6	
November		*					*										2	
December	*																1	
Frequency	4	5	3	4	4	3	6	4	4	4	6	4	3				54	

TABLE 9. Distribution of *Aspergillus ruber*.

Province	Oshima		Iburi		Ishikari			Teshio	Tokachi	Kushiro		Nemuro	Kitami		Frequency
Creamery	P	I	T	A	F	C	B	N	D	K	L	E	X		
January															
February															
March															
April													*	1	
May									*					1	
June													*	1	
July															
August			*		*									2	
September															
October															
November													*	1	
December															
Frequency			1		1				1				3	6	

TABLE 10. Distribution of *Aspergillus fumigatus*.

Province	Oshima			Iburi			Ishikari			Teshio	Tokachi	Kushiro	Nemuro	Kitami			Frequency
Creamery	P	I	T	A	F	C	B	N	D	K	L	E	X				
January																1	
February																	
March																	
April																	
May									*								
June																	
July																	
August																	
September																	
October																	
November																	
December																	
Frequency									1						1		

TABLE 11. Distribution of *Aspergillus nidulans*.

Province	Oshima		Iburi		Ishikari		Teshio	Tokachi	Kushiro	Nemuro	Kitami		Frequency	
Creamery	P	I	T	A	F	C	B	N	D	K	L	E	X	
January														
February														
March														
April														
May										*				1
June														
July														
August														
September														
October														
November														
December														
Frequency										1				1

TABLE 12. Distribution of *Aspergillus Scleroti*.

Province	Oshima		Iburi		Ishikari		Teshio	Tokachi	Kushiro		Nemuro	Kitami		Frequency
Creamery	P	I	T	A	F	C	B	N	D	K	L	E	X	
January														1
February														1
March														1
April														1
May									*					1
June														1
July														1
August									*	*				2
September														1
October									*					1
November														1
December														1
Frequency									3	1				4

TABLE 13. Distribution of *Aspergillus versicolor*.

Province	Oshima			Iburi			Ishikari			Teshio	Tokachi	Kushiro		Nemuro	Kitami		Frequency
Creamery	P	I	T	A	F	C	B	N	D	K	L	E	X				
January																	
February				*													1
March																	
April																	
May																	
June																	
July																	
August															*		1
September																	
October																	
November																	
December																	
Frequency				1											1		2

TABLE 14. Distribution of *Aspergillus versicolor* var. *magnus*.

Province	Oshima			Iburi			Ishikari			Teshio	Tokachi	Kushiro		Nemuro	Kitami		Frequency
Creamery	P	I	T	A	F	C	B	N	D	K	L	E	X				
January																	
February																	
March		*															1
April																	
May							*		*	*							3
June																	
July																	
August				*			*		*						*		4
September																	
October																	
November																	
December																	
Frequency		1		1			2		2	1					1		8

TABLE 15. Distribution of *Aspergillus flavus*.

Province	Oshima			Iburi			Ishikari			Teshio		Tokachi		Kushiro		Nemuro		Kitami		Frequency
Creamery	P	I	T	A	F	C	B	N	D	K	L	E	X							
January																				
February											*			1						
March																				
April																				
May	*	*	*		*									4						
June																				
July											*			1						
August																				
September		*												1						
October		*						*	*			*		4						
November								*						1						
December																				
Frequency	1	3	1		1			2	1		2	1		12						

TABLE 16. Distribution of *Aspergillus flavus* var. *asper*.

Province	Oshima			Iburi			Ishikari			Teshio		Tokachi		Kushiro		Nemuro		Kitami		Frequency
Creamery	P	I	T	A	F	C	B	N	D	K	L	E	X							
January																				
February																				
March																				
April										*										1
May																				
June																				
July																				
August																				
September																				
October																				
November																				
December																				
Frequency										1										1

TABLE 21. Distribution of *Citromyces Pfefferianus*.

Province	Oshima	Iburi			Isikari			Teshio	Tokachi	Kushiro	Nemuro	Kitami		Frequency
Creamery	P	I	T	A	F	C	B	N	D	K	L	E	X	
January														
February														
March														
April														
May														
June														
July														
August														
September													*	1
October												*	*	2
November							*						*	2
December														
Frequency							1					1	3	5

TABLE 22. Distribution of *Penicillium parallelosporum*

Province	Oshima			Iburi			Ishikari			Teshio			Tokachi			Kushiro			Nemuro			Kitami			Frequency
Creamery	P	I	T	A	F	C	B	N	D	K	L	E	X												
January																									
February																									
March																									
April																									
May																									
June																									
July					*																		1		
August										*													1		
September																									
October																									
November																									
December																									
Frequency					1					1													2		

TABLE 23. Distribution of *Penicillium carmino-violaceum*.

Province	Oshima			Iburi			Ishikari			Teshio	Tokachi	Kushiro	Nemuro	Kitami		Frequency
Creamery	P	I	T	A	F	C	B	N	D	K	L	E	X			
January																
February																
March											*			1		
April																
May						•										
June																
July																
August																
September																
October																
November																
December																
Frequency											1			1		

TABLE 24. Distribution of *Penicillium fellu'anum*.

Province	Oshima			Iburi			Ishikari			Teshio	Tokachi	Kushiro	Nemuro	Kitami	Frequency
Creamery	P	I	T	A	F	C	B	N	D	K	L	E	X		
January															1
February															
March															
April															
May								*							
June															
July															
August															
September															
October															
November															
December															
Frequency								1							1

TABLE 27. Distribution of *Penicillium Terlikowskii*.

Province	Oshima		Iburi		Ishikari			Teshio		Tokachi		Kushiro		Nemuro		Kitami		Frequency
Creamery	P	I	T	A	F	C	B	N	D	K	L	E	X					
January																		
February																		
March																		
April																		
May																		
June																		
July																		
August			*															1
September																		
October																		
November																		
December																		
Frequency			1															1

TABLE 28. Distribution of *Penicillium columnare*.

Province	Oshima		Iburi		Ishikari			Teshio		Tokachi		Kushiro		Nemuro		Kitami		Frequency
Creamery	P	I	T	A	F	C	B	N	D	K	L	E	X					
January											*							1
February																		
March																		
April																		
May																		
June																		
July																		
August																		
September																		
October																		
November																		
December																		
Frequency												1						1

TABLE 29. Distribution of *Penicillium ellipticum*.

[illegible]

TABLE 30. Distribution of *Penicillium Waksmani*.

[illegible]

TABLE 33. Distribution of *Penicillium digitatum*.

Province	Oshima	Iburi			Ishikari			Teshio	Tokachi	Kushiro	Nemuro	Kitami		Frequency
Creamery	P	I	T	A	F	C	B	N	D	K	L	E	X	
January	*		*	*						*	*			5
February							*		*		*			3
March														
April														
May														
June														
July														
August														
September														
October														
November														
December														
Frequency	1		1	1			1		1	1	2			8

TABLE 34. Distribution of *Penicillium citreo-roseum*.

[illegible]

TABLE 37. Distribution of *Penicillium solitum*.

Province	Oshima			Iburi			Ishikari			Teshio		Tokachi		Kushiro		Nemuro		Kitami		Frequency
Creamery	P	I	T	A	F	C	B	N	D	K	L	E	X							
January																				1
February																				
March																				1
April																				
May																		*		
June																				1
July																				
August								*												
September																				
October																				
November																				
December																				
Frequency								1				.	1							2

TABLE 38. Distribution of *Penicillium flavo-glaucum*.

[illegible]

TABLE 39. Distribution of *Penicillium pali'ans*.

Province	Oshima	Iburi		Ishikari			Teshio	Tokachi	Kushiro		Nemuro	Kitami		Frequency
Creamery	P	I	T	A	F	C	B	N	D	K	L	E	X	
January							*			*				2
February														
March											*			1
April	*			*										2
May				*						*				2
June				*										1
July														
August			*											1
September														
October									*					1
November														
December							*							1
Frequency	1		1	3			2		1	2	1			11

TABLE 40. Distribution of *Penicillium crustosum*.

Province	Oshima			Iburi			Ishikari			Teshio		Tokachi		Kushiro		Nemuro		Kitami		Frequency
Creamery	P	I	T	A	F	C	B	N	D	K	L	E	X							
January																				
February																				
March																				
April																				
May																				
June																				
July																				
August																				
September																				
October													*	*						2
November																				
December																				
Frequency												1	1							2

TABLE 45. Distribution of *Trichoderma Koningi*.

Province	Oshima	Iburi	Ishikari				Teshio	Tokachi	Kushiro	Nemuro	Kitami		Frequency	
Creamery	P	I	T	A	F	C	B	N	D	K	L	E	X	
January														
February														
March											*			1
April														
May														
June														
July														
August							*							1
September														
October						*								1
November														
December														
Frequency						1	1				1			3

TABLE 46. Distribution of *Botrytis cinerea*.

Province	Oshima	Iburi			Ishikari			Teshio	Tokachi		Kushiro	Nemuro	Kitami		Frequency
Creamery	P	I	T	A	F	C	B	N	D	K	L	E	X		
January															
February															
March															
April															
May															
June															
July					*									1	
August			*					*						2	
September															
October															
November															
December															
Frequency			1		1			1						3	

TABLE 51. Distribution of *Alternaria tenuis*.

Province	Oshima		Iburi		Ishikari			Teshio	Tokachi	Kushiro		Nemuro	Kitami		Frequency
Creamery	P	I	T	A	F	C	B	N	D	K	L	E	X		
January															
February															
March												*		1	
April		*								*				2	
May															
June										*			*	2	
July			*	*				*						3	
August			*	*			*	*	*	*				6	
September	*		*	*				*	*	*	*			7	
October				*				*						2	
November										*	*			2	
December															
Frequency	1	1	3	4			1	4	2	5	2	1	1	25	

TABLE 52. Distribution of *Fusarium* sp.

Province	Oshima		Iburi		Ishikari			Teshio	Tokachi	Kushiro		Nemuro	Kitami		Frequency
Creamery	P	I	T	A	F	C	B	N	D	K	L	E	X		
January															
February															
March				*									*		2
April															
May															
June															
July			*	*						*	*				4
August			*		*										2
September	*		*				*	*	*		*	*			7
October						*				*	*				3
November															
December															
Frequency	1		3	2	1	1	1	1	1	2	3	1	1		18

TABLE 53. Distribution of *Epicoccum purpurascens*.

[illegible]

TABLE 54. The local distribution of molds in butter.

[illegible]

Creamery	P	I	T	A	F	C	B	N	D	K	L	E	X	
<i>Pen. Paczoskii</i>				1	1									2
<i>Pen. Terlikowskii</i>			1											1
<i>Pen. columnare</i>										1				1
<i>Pen. ellipticum</i>				1										1
<i>Pen. Waksmani</i>													1	1
<i>Pen. Sartoryi</i>	1	1		1						1				4
<i>Pen. spinulo- ramigenum</i>		1												1
<i>Pen. digitatum</i>	1		1	1			1		1	1	2			7
<i>Pen. citreo-roseum</i>			1											1
<i>Pen. Roqueforti</i>	1	1	1	3	2	1	1	1	1	2	1	1	1	13
<i>Pen. Janczewskii</i>	1	1												2
<i>Pen. solitum</i>							1						1	2
<i>Pen. flavo-glaucum</i>			2	2										2
<i>Pen. palitans</i>	1		1	3			2		1	2	1			7
<i>Pen. crustosum</i>												1	1	2
<i>Pen. crustosum v. spinulosporum</i>										1			1	2
<i>Pen. expansum</i>				1	1									2
<i>Scopulariopsis brevicaulis</i>			1											1
<i>Paecilomyces varioti</i>						1	1							2
<i>Trichoderma Koningi</i>						1	1				1			3
<i>Botrytis cinerea</i>			1		1			1						3
<i>Trichothecium roseum</i>					1							1		2
<i>Dematium pullulans</i>					1									1
<i>Cladosporium herbarum</i>	6	7	5	6	5	2	5	6	4	4	4	6	4	13
<i>Stemph. botryosum v. botrytis</i>	4	1	3		3	1								5
<i>Alternaria tenuis</i>	1	1	3	4			1	4	2	5	2	1	1	11
<i>Fusarium sp.</i>	1		3	2	1	1	1	1	1	3	3	1	1	12
<i>Epicoecum purpurascens</i>					1									1
Number of species isolated	16	16	20	18	19	9	15	10	19	20	14	11	16	203

TABLE 55. The seasonal distribution of molds in butter.

	January	February	March	April	May	June	July	August	September	October	November	December	Frequency
<i>Rhizopus nigricans</i>		1			2								3
<i>Oospora lactis</i>	11	11	9	7	6	10	8	10	10	11	11	11	115
<i>Oospora suaveolens</i>	5	6	6	6	7	6	4	7	7	7	4	7	72
<i>Oospora lupuli</i>									1				1
<i>Aspergillus clavatus</i>											1		1
<i>Asp. Chevalieri</i>				2	2	2				1			7
<i>Asp. Chevalieri</i> var. <i>ruber</i>				1	2			1					4
<i>Asp. repens</i>	4	2	1	4	10	4	8	9	3	6	2	1	54
<i>Asp. ruber</i>				1	1	1		2			1		6
<i>Asp. fumigatus</i>					1								1
<i>Asp. nidulans</i>					1								1
<i>Asp. Sydowi</i>					1			2		1			4
<i>Asp. versicolor</i>		1						1					2
<i>Asp. versicolor</i> var. <i>magnus</i>			1		3			4					8
<i>Asp. flavus</i>		1			4		1		1	4	1		12
<i>Asp. flavus</i> var. <i>asper</i>				1									1
<i>Asp. terreus</i>				1	1								2
<i>Asp. yezoensis</i>	1				2			1	1	1		1	7
<i>Penicillium yezoensum</i>		1	1	1		2	2	2	1		1		11
<i>Pen. spinulosum</i>			1										1
<i>Citromyces Pfefferianus</i>									1	2	2		5
<i>Pen. parallelosporium</i>							1	1					2
<i>Pen. carmino-violaceum</i>			1										1
<i>Pen. fellutanum</i>					1								1
<i>Pen. citreo-viride</i>					1								1
<i>Pen. Paczoskii</i>								1	1				2
<i>Pen. Tertikowskii</i>								1					1

	January	February	March	April	May	June	July	August	September	October	November	December	Frequency
<i>Pen. columnare</i>	1												1
<i>Pen. ellipticum</i>												1	1
<i>Pen. Waksmani</i>												1	1
<i>Pen. Sartoryi</i>			1	2	1								4
<i>Pen. spinulo- ramigenum</i>	1												1
<i>Pen. digitatum</i>	5	3											8
<i>Pen. citreo-roseum</i>								1					1
<i>Pen. Roqueforti</i>	1	1	3	1	2		2			2	4	1	17
<i>Pen. Janczewskii</i>									1	1			2
<i>Pen. solitum</i>					1			1					2
<i>Pen. flavo-glaucum</i>				1	2							1	4
<i>Pen. palitans</i>	2		1	2	2	1		1		1		1	11
<i>Pen. crustosum</i>										2			2
<i>Pen. crustosum v. spinulo-sporum</i>					1			1					2
<i>Pen. expansum</i>				1	1								2
<i>Scopulariopsis brevicaulis</i>								1					1
<i>Paecilomyces varioti</i>								1		1			2
<i>Trichoderma Koningi</i>			1					1		1			3
<i>Botrytis cinerea</i>							1	2					3
<i>Trichothecium roseum</i>					1			1					2
<i>Dematium pullulans</i>	1												1
<i>Cladosporium herbarum</i>	6	1	4	4	4	5	11	10	6	7	4	2	64
<i>Stemph. botryosum v. botrytis</i>		1			1	1	1	1		3	3	1	12
<i>Alternaria tenuis</i>			1	2		2	3	6	7	2	2		25
<i>Fusarium</i> sp.		1	2				4	2	7	3			19
<i>Epicoccum purpurascens</i>												1	1
Number of species isolated	11	12	14	16	26	10	12	26	13	18	12	12	518

TABLE 56. Influence of temperature upon the growth of mold cultures.

Temperature. °C.	Growth					
	5°	15°	27°	32°	37°	42°
<i>Rhizopus nigricans</i>	+++	++++	+++++	+++++	—	—
<i>Oospora lactis</i>	+	+++	+++	++++	+++	+++
<i>Oospora suaveolens</i>	+++	++++	++++	+++++	++	±
<i>Oospora lupuli</i>	+	+++	++++	++++	+++	+++
<i>Aspergillus clavatus</i>	—	+++	++++	++++	+	+
<i>Asp. Chevalieri</i>	±	++	+++	+++	++	++
<i>Asp. Chevalieri</i> var. <i>ruber</i>	±	+++	++++	++++	++	++
<i>Asp. repens</i>	+	+++	++++	++++	+	±
<i>Asp. ruber</i>	+	+++	++++	++++	±	—
<i>Asp. fumigatus</i>	—	+++	++++	++++	++++	+++
<i>Asp. nidulans</i>	—	+++	++++	++++	++++	+++
<i>Asp. Sydowi</i>	—	+++	++++	++++	±	±
<i>Asp. versicolor</i>	—	+++	++++	++++	—	—
<i>Asp. versicolor</i> var. <i>magnus</i>	—	++	+++	++++	—	—
<i>Asp. flavus</i>	—	+++	++++	++++	+++++	+++++
<i>Asp. flavus</i> var. <i>asper</i>	—	++	+++	+++	++++	+++
<i>Asp. terreus</i>	—	+++	++++	+++++	+++++	+++++
<i>Asp. yezoensis</i>	—	+++	++++	++++	+++++	+++++
<i>Penicillium yezoensum</i>	—	++++	+++++	++++	—	—
<i>Pen. spinulosum</i>	—	+++	++++	+++++	+++	—
<i>Citromyces Pfefferianus</i>	—	+++	++++	++++	+	—
<i>Pen. parallelosporum</i>	—	+++	++++	+++	—	—
<i>Pen. carmino-violaceum</i>	—	+++	+++++	++++	—	—
<i>Pen. fellutanum</i>	—	++++	++++	+++++	±	—
<i>Pen. citreo-viride</i>	—	+++	++++	+++++	++	—
<i>Pen. Faczorskii</i>	—	+++	++++	+++++	±	—

Temperature °C	Growth					
	5°	15°	27°	32°	37°	42°
<i>Pen. Terlikowskii</i>	—	+++	++++	+++++	+	—
<i>Pen. columnare</i>	—	+++	++++	++++	+++	—
<i>Pen. ellipticum</i>	—	++	++++	++++	+++	—
<i>Pen. Waksmani</i>	—	+++	++++	++++	+	—
<i>Pen. Sartoryi</i>	—	+++	++++	++++	+	—
<i>Pen. spinulo- ramigenum</i>	—	+++	++++	+++++	+	—
<i>Pen. digitatum</i>	—	+++	++++	+++	—	—
<i>Pen. citreo-roseum</i>	—	+++	+++++	+++++	++++	++
<i>Pen. Roqueforti</i>	—	+++	++++	+++++	+	—
<i>Pen. Janczewskii</i>	—	++++	+++++	+++++	++++	±
<i>Pen. solitum</i>	—	+++	++++	+++	++	—
<i>Pen. flavo-glaucum</i>	—	++++	+++++	++++	—	—
<i>Pen. palitans</i>	—	++++	++++	++	—	—
<i>Pen. crustosum</i>	—	+++	++++	+++++	++++	—
<i>Pen. crustosum</i> var. <i>spinulosporum</i>	—	+++	++++	++++	±	—
<i>Pen. expansum</i>	—	+++	++++	++++	—	—
<i>Scopulariopsis</i> <i>brevicaulis</i>	+	+++	++++	++++	+++	++
<i>Paecilomyces varioti</i>	±	+++	+++	++++	+++	+++
<i>Trichoderma Koningi</i>	±	++	+++	+++	++++	++++
<i>Botrytis cinerea</i>	+++	+++	++++	++++	—	—
<i>Trichothecium roseum</i>	—	++	+++	++++	—	—
<i>Dematium pullulans</i>	+	++++	+++++	+++++	—	—
<i>Cladosporium herbarum</i>	++	++++	+++++	+++++	—	—
<i>Stemph. botryosum</i> var. <i>botrytis</i>	+++	+++	++++	+++++	+	—
<i>Alternaria tenuis</i>	++	++++	+++++	+++++	—	—
<i>Fusarium</i> sp.	+	+++	+++	+++	+++	+
<i>Epicoccum</i> <i>purpurascens</i>	+++	+++	++++	+++	—	—

TABLE 57. Comparative effect of heating mold spores in Koji extract to temperatures of from 50° to 80°C. for 10 minutes.

Temperature heating. °C.	50°	55°	60°	65°	70°	75°	80°
<i>Rhizopus nigricans</i>	+	—	—	—	—	—	—
<i>Oospora lactis</i>	+	+	+	+	—	—	—
<i>Oospora suaveolens</i>	+	—	—	—	—	—	—
<i>Oospora lupuli</i>	+	+	—	—	—	—	—
<i>Aspergillus clavatus</i>	+	+	+	—	—	—	—
<i>Asp. Chevalieri</i>	+	+	+	+	+	+	—
<i>Asp. Chevalieri</i> var. <i>ruber</i>	+	+	+	+	+	+	—
<i>Asp. repens</i>	+	+	+	+	+	—	—
<i>Asp. ruber</i>	+	+	+	+	+	+	—
<i>Asp. fumigatus</i>	+	+	+	+	—	—	—
<i>Asp. nidulans</i>	+	+	+	+	+	—	—
<i>Asp. Sydowi</i>	+	+	—	—	—	—	—
<i>Asp. versicolor</i>	+	+	—	—	—	—	—
<i>Asp. versicolor</i> var. <i>magnus</i>	+	+	—	—	—	—	—
<i>Asp. flavus</i>	+	+	+	—	—	—	—
<i>Asp. flavus</i> var. <i>asper</i>	+	+	+	—	—	—	—
<i>Asp. terreus</i>	+	+	+	+	—	—	—
<i>Asp. yezoensis</i>	+	+	+	+	—	—	—
<i>Penicillium yezoensum</i>	+	+	+	—	—	—	—
<i>Pen. spinulosum</i>	+	+	+	—	—	—	—
<i>Citromyces Pfefferianus</i>	+	+	+	+	—	—	—
<i>Pen. parallelosporum</i>	+	+	—	—	—	—	—
<i>Pen. carmino-violaceum</i>	+	+	—	—	—	—	—
<i>Pen. fellutanum</i>	+	+	—	—	—	—	—
<i>Pen. citreo-viride</i>	+	+	+	—	—	—	—
<i>Pen. Pazoskii</i>	+	+	+	—	—	—	—

Temperature heating. °C.	50°	55°	60°	65°	70°	75°	80°
<i>Pen. Terlikowskii</i>	+	+	-	-	-	-	-
<i>Pen. columnare</i>	+	+	+	+	-	-	-
<i>Pen. ellipticum</i>	+	-	-	-	-	-	-
<i>Pen. Waksmani</i>	+	+	+	+	-	-	-
<i>Pen. Sartoryi</i>	+	+	+	+	-	-	-
<i>Pen. spinulo- ramigenum</i>	+	+	+	-	-	-	-
<i>Pen. digitatum</i>	+	+	-	-	-	-	-
<i>Pen. citreo-roseum</i>	+	+	-	-	-	-	-
<i>Pen. Roqueforti</i>	+	+	+	-	-	-	-
<i>Pen. Janczewskii</i>	+	+	+	-	-	-	-
<i>Pen. solitum</i>	+	+	-	-	-	-	-
<i>Pen. flavo-glaucum</i>	+	+	-	-	-	-	-
<i>Pen. palitans</i>	+	+	+	+	-	-	-
<i>Pen. crustosum</i>	+	+	+	+	-	-	-
<i>Pen. crustosum var. spinulo-sporum</i>	+	+	-	-	-	-	-
<i>Pen. expansum</i>	+	+	+	-	-	-	-
<i>Scopulariopsis brevicaulis</i>	+	+	+	+	-	-	-
<i>Paecilomyces varioti</i>	+	+	+	+	-	-	-
<i>Trichoderma Koningi</i>	+	+	+	+	-	-	-
<i>Botrytis cinerea</i>	+	-	-	-	-	-	-
<i>Trichothecium roseum</i>	+	-	-	-	-	-	-
<i>Dematium pullulans</i>	+	-	-	-	-	-	-
<i>Cladosporium herbarum</i>	+	-	-	-	-	-	-
<i>Stemph. botryosum var. botrytis</i>	+	-	-	-	-	-	-
<i>Alternaria tenuis</i>	+	-	-	-	-	-	-
<i>Fusarium sp.</i>	+	+	-	-	-	-	-
<i>Epicoccum purpurascens</i>	+	-	-	-	-	-	-

+ survived, - killed.

TABLE 58. Effect of salt upon the growth of mold cultures.

Salt concentration	Growth					
	0%	5%	10%	15%	20%	25%
<i>Rhizopus nigricans</i>	+++++	++++	+++	+	-	-
<i>Oospora lactis</i>	+++	++	±	±	-	-
<i>Oospora suaveolens</i>	++++	+++	++	-	-	-
<i>Oospora lupuli</i>	+++++	++++	+	-	-	-
<i>Aspergillus clavatus</i>	+++	++	+	-	-	-
<i>Asp. Chevalieri</i>	++++	++++	++++	+++	+++	+
<i>Asp. Chevalieri</i> var. <i>ruber</i>	+++++	++++	++++	+++	++	+
<i>Asp. repens</i>	+++	++++	++++	+++	++	+
<i>Asp. ruber</i>	+++	++++	++++	++++	+++	++
<i>Asp. fumigatus</i>	+++	++	++	-	-	-
<i>Asp. nidulans</i>	++++	++++	++++	++	+	-
<i>Asp. Sydowi</i>	++++	+++	+++	++	++	-
<i>Asp. versicolor</i>	++++	+++	+++	++	+	-
<i>Asp. versicolor</i> var. <i>magnus</i>	++++	+++	++	+	+	-
<i>Asp. flavus</i>	++++	++++	++++	+++	+	-
<i>Asp. flavus</i> var. <i>asper</i>	+++	+++	+++	++	+	-
<i>Asp. terreus</i>	++++	++++	++++	+++	+	-
<i>Asp. yezoensis</i>	++++	++++	++++	+++	-	-
<i>Penicillium yezoensum</i>	+++++	++++	++++	++	+	-
<i>Pen. spinulosum</i>	++++	++++	++++	+++	++	-
<i>Citromyces Pfefferianus</i>	++++	++++	++++	+++	+	-
<i>Pen. parallelосporum</i>	+++++	++++	+++	±	-	-
<i>Pen. carmino-</i> <i>violaceum</i>	+++++	++++	+++	++	+	-
<i>Pen. fellutanum</i>	++++	++++	+++	++	+	-
<i>Pen. citreo-viride</i>	+++++	++++	+++	++	+	-
<i>Pen. Paczoskii</i>	++++	++++	+++	++	+	-

Salt concentration	Growth					
	0%	5%	10%	15%	20%	25%
<i>Pen. Terlikowskii</i>	++++	++++	++++	++++	+	-
<i>Pen. columnare</i>	++++	++++	++++	++	+	-
<i>Pen. ellipticum</i>	++++	++	+	±	-	-
<i>Pen. Waksmani</i>	++++	++++	++++	+++	++	-
<i>Pen. Sartoryi</i>	++++	++++	+++	++	±	-
<i>Pen. spinulo- ramigenum</i>	++++	++++	++++	++	+	-
<i>Pen. digitatum</i>	+++	++	±	-	-	-
<i>Pen. citreo-roseum</i>	++++	++++	++	±	-	-
<i>Pen. Roqueforti</i>	++++	++++	+++	++	±	-
<i>Pen. Janczewskii</i>	++++	++++	++++	++++	+++	-
<i>Pen. solitum</i>	+++	++++	++++	++	+	-
<i>Pen. flavo-glaucum</i>	++++	++++	++++	++	+	-
<i>Pen. palitans</i>	++	+++	++++	++	+	-
<i>Pen. crustosum</i>	++++	++++	++++	+++	++	-
<i>Pen. crustosum var. spinulo-sporum</i>	++++	++++	++++	++++	++	-
<i>Pen. expansum</i>	++++	++++	++++	++++	+	-
<i>Scopulariopsis brevicaulis</i>	++++	++++	+++	++	++	-
<i>Paecilomyces varioti</i>	++++	++++	+++	++	+	-
<i>Trichoderma Koningi</i>	++++	+++	++	-	-	-
<i>Botrytis cinerea</i>	++++	+++	++	-	-	-
<i>Trichothecium roseum</i>	++++	++	+	-	-	-
<i>Dematium pullulans</i>	++++	+++	++	-	-	-
<i>Cladosporium herbarum</i>	++++	+++	++	+	+	-
<i>Stemph. botryosum var. botrytis</i>	++++	+++	++	+	-	-
<i>Alternaria tenuis</i>	++++	++++	+	±	-	-
<i>Fusarium sp.</i>	++++	+++	++	+	-	-
<i>Epicoccum purpurascens</i>	++++	++	+	-	-	-

TABLE 59. Effect of lactic acid upon growth of mold cultures.

Lactic acid concentration: %	Growth					
	0.0%	0.1%	0.4%	1.0%	2.0%	5.0%
pH:	5.7	4.4	3.8	3.4	3.1	2.7
<i>Rhizopus nigricans</i>	+++++	+++++	+++++	+++++	++	-
<i>Oospora lactis</i>	++++	++++	+++	++	-	-
<i>Oospora suaveolens</i>	++++	++++	++++	+++	+++	-
<i>Oospora lupuli</i>	++++	+++++	+++++	-	-	-
<i>Aspergillus clavatus</i>	+++	+++	+++	+++	-	-
<i>Asp. Chevalieri</i>	++++	+++	+++	++	-	-
<i>Asp. Chevalieri</i> var. <i>ruber</i>	++++	++++	+++	++	+	-
<i>Asp. repens</i>	++++	+++	++	+	-	-
<i>Asp. ruber</i>	++++	++++	++	+	+	-
<i>Asp. fumigatus</i>	+++	++++	++++	+++	++	-
<i>Asp. nidulans</i>	+++++	+++++	++++	+++	++	-
<i>Asp. Sydowi</i>	++++	++++	+++	++	-	-
<i>Asp. versicolor</i>	++++	+++	++	-	-	-
<i>Asp. versicolor</i> var. <i>magnus</i>	++++	+++	++	+	-	-
<i>Asp. flavus</i>	+++++	++++	++++	++++	++++	-
<i>Asp. flavus</i> var. <i>asper</i>	+++	+++	++	++	++	-
<i>Asp. terreus</i>	++++	+++++	+++++	++++	++++	-
<i>Asp. yezoensis</i>	++++	++++	++++	+++	+++	-
<i>Penicillium yezoensum</i>	+++++	+++++	+++++	+++++	+++	-
<i>Pen. spinulosum</i>	+++	++++	++++	++++	+++	++
<i>Citromyces Pfefferianus</i>	++++	++++	++++	++++	+++	±
<i>Pen. parallellosporum</i>	+++	+++	++++	++++	+++	-
<i>Pen. carmino-violaceum</i>	++++	++++	++++	+++	+++	-
<i>Pen. fellutanum</i>	++++	++++	++++	++++	+++	±
<i>Pen. citreo-viride</i>	+++	+++	++++	++++	+++	++
<i>Pen. Paczoskii</i>	++++	++++	+++	+++	+++	-

Lactic acid concentration: %	Growth					
	0.0%	0.1%	0.4%	1.0%	2.0%	5.0%
pH:	5.7	4.4	3.8	3.4	3.1	2.7
<i>Pen. Terlikowskii</i>	++++	+++++	++++	++++	++++	+++
<i>Pen. columnare</i>	++++	++++	++++	+++	++	-
<i>Pen. ellipticum</i>	++++	+++++	++++	+++	++	-
<i>Pen. Waksmani</i>	++++	++++	++++	+++++	+++++	-
<i>Pen. Sartoryi</i>	++++	+++++	++++	+++	+++	±
<i>Pen. spinulo- ramigenum</i>	+++	++++	++++	+++	+++	+
<i>Pen. digitatum</i>	++++	+++	+++	++	++	-
<i>Pen. citreo-roseum</i>	++++	++++	++++	+++	++	-
<i>Pen. Roqueforti</i>	+++	+++	++++	++++	++++	+
<i>Pen. Janczewskii</i>	++++	++++	+++++	+++++	++++	-
<i>Pen. solitum</i>	++++	++++	+++	+++	++	-
<i>Pen. flavo-glaucum</i>	++++	++++	+++	+++	+++	-
<i>Pen. palitans</i>	++++	+++	+++	++	++	-
<i>Pen. crustosum</i>	+++++	+++++	++++	+++	+++	-
<i>Pen. crustosum var. spinulo-sporum</i>	++++	++++	++++	+++	+++	-
<i>Pen. expansum</i>	++++	++++	++++	+++	+++	-
<i>Scopulariopsis brevicaulis</i>	++++	++	±	-	-	-
<i>Paecilomyces varioti</i>	++++	+++++	+++	+++	+++	-
<i>Trichoderma Koningi</i>	+++	+++	++++	++++	++	-
<i>Botrytis cinerea</i>	+++	+	±	-	-	-
<i>Trichothecium roseum</i>	+++++	++	+	±	-	-
<i>Dematium pullulans</i>	++++	++++	++++	++	-	-
<i>Cladosporium herbarum</i>	++++	+++	+	±	-	-
<i>Stemph. botryosum var. botrytis</i>	++++	++++	+++	-	-	-
<i>Alternaria tenuis</i>	++++	++++	+++	+	-	-
<i>Fusarium sp.</i>	++++	++++	++++	+++	-	-
<i>Epicoccum purpurascens</i>	++++	++++	+	-	-	-

TABLE 60. Action of molds on litmus-milk.

	Peptoni- zation		Coagu- lation		Litmus change to					
	10 days	20 days	10 ds.	20 ds.	blue		red		colorless	
					10 ds.	20 ds.	10 ds.	20 ds.	10 ds.	20 ds.
<i>Rhizopus nigricans</i>	++	++	-	+	+	++	-	-	-	-
<i>Oospora lactis</i>	-	-	-	-	-	-	-	-	-	-
<i>Oospora suaveolens</i>	++++	++++	-	-	+	+	-	-	-	+
<i>Oospora lupuli</i>	++++	++++	-	-	-	-	-	-	-	+
<i>Aspergillus clavatus</i>	+++	+++	-	-	-	-	+	++	-	-
<i>Aspergillus Chevalieri</i>	-	-	-	-	+++	+++	-	-	-	-
<i>Asp. Chevalieri</i> var. <i>ruber</i>	-	-	-	-	+++	+++	-	-	-	-
<i>Asp. repens</i>	-	-	-	-	+	++	-	-	-	-
<i>Asp. ruber</i>	-	-	-	-	+	++	-	-	-	-
<i>Asp. fumigatus</i>	+++	+++	-	-	+++	+++	-	-	-	-
<i>Asp. nidulans</i>	++	++	-	-	+	-	-	+	-	-
<i>Asp. Sydowi</i>	++	++	-	-	+	-	-	-	+	++
<i>Asp. versicolor</i>	++	++	-	-	+	-	-	-	-	+
<i>Asp. versicolor</i> var. <i>magnus</i>	+	++	-	-	-	-	-	-	+	++
<i>Asp. flavus</i>	+++	+++	-	-	+	+	-	-	-	-
<i>Asp. flavus</i> var. <i>asper</i>	+++	+++	-	-	+	+	-	-	-	-
<i>Asp. terreus</i>	+++	+++	-	-	+	+	-	-	-	-
<i>Asp. yezoensis</i>	+	+	-	-	-	-	+	+	-	-
<i>Penicillium yezoensum</i>	+++	++++	-	-	+	+	-	-	-	-
<i>Pen. spinulosum</i>	+	+++	-	-	+	+	-	-	-	-
<i>Citromyces Pfefferianus</i>	-	-	-	-	+++	+++	-	-	-	-
<i>Pen. parallelosporum</i>	+	+	-	-	-	-	-	-	-	+
<i>Pen. carmino- violaceum</i>	-	-	-	-	+++	+++	-	-	-	-
<i>Pen. fellutanum</i>	-	-	-	-	+	+++	-	-	-	-
<i>Pen. citreo-viride</i>	+++	++++	-	-	-	-	-	-	-	+
<i>Pen. Paczoskii</i>	-	-	-	-	+++	+++	-	-	-	-

	Peptoni- zation		Coagu- lation		Litmus change to					
	10 days	20 days	10 ds.	20 ds.	blue		red		colorless	
					10 ds.	20 ds.	10 ds.	20 ds.	10 ds.	20 ds.
<i>Pen. Terlikowskii</i>	+	+++	-	-	+	+	-	-	-	-
<i>Pen. columnare</i>	++	+++	-	-	+	+	-	-	-	-
<i>Pen. ellipticum</i>	-	-	-	-	+	+++	-	-	-	-
<i>Pen. Waksmani</i>	++	+++	-	-	+	-	-	-	-	+
<i>Pen. Sartoryi</i>	-	-	-	-	+++	+++	-	-	-	-
<i>Pen. spinulo- ramigenum</i>	+++	++++	-	-	-	-	-	-	-	+
<i>Pen. digitatum</i>	+	++	-	-	-	-	+	-	-	+
<i>Pen. citreo-roseum</i>	-	-	-	-	+	+	-	-	-	-
<i>Pen. Roqueforti</i>	++	++++	-	-	+	+	-	-	-	-
<i>Pen. Janczewskii</i>	++++	++++	-	-	+	+	-	-	-	-
<i>Pen. solitum</i>	++	+++	-	-	-	-	-	-	+	+
<i>Pen. flavo-glaucum</i>	++	+++	-	-	-	-	-	-	+	+
<i>Pen. palitans</i>	++	++++	-	-	-	-	-	-	+	+
<i>Pen. crustosum</i>	++	++	-	-	-	-	-	-	+	+
<i>Pen. crustosum var. spinulo-sporum</i>	++	++	-	-	-	-	-	-	+	+
<i>Pen. expansum</i>	++	++	-	-	-	-	-	-	+	+
<i>Scopulariopsis brevicaulis</i>	++++	++++	-	-	-	-	-	-	-	+
<i>Paecilomyces varioti</i>	-	-	-	-	+	+++	-	-	-	-
<i>Trichoderma Koningi</i>	++++	++++	+	-	-	-	+	+	+	+
<i>Botrytis cinerea</i>	+	+	+	-	-	-	+	+	-	-
<i>Trichothecium roseum</i>	+++	+++	-	-	+	+	-	-	-	-
<i>Dematium pullulans</i>	++++	++++	-	-	+	+	-	-	-	-
<i>Cladosporium herbarum</i>	++++	++++	-	-	+	+	-	-	-	-
<i>Stemph. botryosum var. botrytis</i>	++++	++++	-	-	+	+	-	-	-	-
<i>Alternaria tenuis</i>	+	++	+	-	-	-	-	-	-	+
<i>Fusarium sp.</i>	+	+	-	-	+	+	-	-	-	+
<i>Epicoccum purpurascens</i>	+	+	-	+	-	+	-	-	+	-

TABLE 61. Effect of temperature on the lipolytic action of molds.

Temperature.	Growth			Lipolytic power		
	12°C	27°C	32°C	12°C	27°C	32°C
<i>Rhizopus nigricans</i>	+++++	+++++	+++++	5	5	5
<i>Oospora lactis</i>	++	+++	++++	0.5	1	4
<i>Oospora suaveolens</i>	+++	++++	+++++	2.5	3	4
<i>Oospora lupuli</i>	—	±	—	0	0	0
<i>Aspergillus clavatus</i>	+	++++	++++	3	12	10
<i>Asp. Chevalieri</i>	+	+	+	8	7	5
<i>Asp. Chevalieri</i> var. <i>ruber</i>	+	++++	++++	1	10	10
<i>Asp. repens</i>	+	++++	++++	10	16	15
<i>Asp. ruber</i>	+	+++	+++	4	15	15
<i>Asp. fumigatus</i>	—	++++	++++	0	10	3
<i>Asp. nidulans</i>	+	++++	+++	1	2	3
<i>Asp. Sydowi</i>	—	±	—	0	0	0
<i>Asp. versicolor</i>	—	++++	—	0	15	0
<i>Asp. versicolor</i> var. <i>magnus</i>	—	++++	++++	0	4	4
<i>Asp. flavus</i>	+	++++	++++	2	7	3
<i>Asp. flavus</i> var. <i>asper</i>	±	++++	+++	0	6	5
<i>Asp. terreus</i>	±	++++	++++	0	3	2
<i>Asp. yezoensis</i>	+	++++	++++	1	3	3
<i>Penicillium yezoensum</i>	+++	++	±	2	2	0.5
<i>Pen. spinulosum</i>	+++	+++++	+++++	3	5	3
<i>Citromyces Pfefferianus</i>	++++	+++++	++++	6	10	2
<i>Pen. parallelosporum</i>	++++	+++++	±	1.5	5	0
<i>Pen. carmino-violaceum</i>	+	+++++	—	0	2	0
<i>Pen. fellutanum</i>	++	+++++	—	1	7	0
<i>Pen. citreo-viride</i>	+++++	+++++	+++++	4	5	5
<i>Pen. Paczoskii</i>	+	++++	—	0	5	0

Temperature.	Growth			Lipolytic power		
	12°C	27°C	32°C	12°C	27°C	32°C
<i>Pen. Terlikowskii</i>	++++	+++++	+++++	3	5	5
<i>Pen. columnare</i>	—	±	+	0	0.5	1
<i>Pen. ellipticum</i>	+	+	+	0	0	0
<i>Pen. Waksmani</i>	++++	++++	+++++	3	6	2
<i>Pen. Sartoryi</i>	±	±	+	0	0	0
<i>Pen. spinulo-ramigenum</i>	++++	+++++	+++++	2	5	2
<i>Pen. digitatum</i>	++	+++++	+	2	7	1
<i>Pen. citreo-roseum</i>	++	++++	+++	0	1.5	0.5
<i>Pen. Roqueforti</i>	++++	+++++	+++++	4	5	5
<i>Pen. Janczewskii</i>	+++	++++	±	2	5	0
<i>Pen. solitum</i>	+++++	++++	±	2	6.5	0
<i>Pen. flavo-glaucum</i>	+++++	+++++	—	4	2	0
<i>Pen. palitans</i>	++++	++++	+	5	4.5	0.5
<i>Pen. crustosum</i>	++++	+++++	+++++	2	10	10
<i>Pen. crustosum</i> var. <i>spinulo-sporum</i>	++++	+++++	++++	5	6	2
<i>Pen. expansum</i>	++++	+++++	+++++	2.5	5	5
<i>Scopulariopsis</i> <i>brevicaulis</i>	++	++++	+++	3	3	3
<i>Paecilomyces varioti</i>	++++	+++++	+++++	4	5	5
<i>Trichoderma Koningi</i>	++	++++	++++	5	5	6
<i>Botrytis cinerea</i>	+	++++	+++	5	7	6
<i>Trichothecium roseum</i>	—	+	—	0	0	0
<i>Dematium pullulans</i>	—	+++	±	0	2	2
<i>Cladosporium herbarum</i>	+	++	++	5	6	6
<i>Stemph. botryosum</i> var. <i>botrytis</i>	±	±	±	1.5	1.5	1.5
<i>Alternaria tenuis</i>	+	++	+	2	3	2
<i>Fusarium</i> sp.	—	+++	+++++	0	6	2
<i>Epicoccum</i> <i>purpurascens</i>	—	±	—	0	0	0

TABLE 62. The process of lipolysis of molds at 27°C.

Cultural days	Growth			Lipolytic power		
	7	30	60	7	30	60
<i>Rhizopus nigricans</i>	++++	+++++	+++++	4	5	10
<i>Oospora lactis</i>	+++	+++	++++	0	1	9
<i>Oospora suaveolens</i>	++++	+++++	+++++	2	3	8
<i>Oospora lupuli</i>	±	±	±	0	0	0
<i>Aspergillus clavatus</i>	++++	++++	++++	7	12	19
<i>Asp. Chevalieri</i>	+	+	+	5	7	11
<i>Asp. Chevalieri</i> var. <i>ruber</i>	++	++++	++++	5	10	25
<i>Asp. repens</i>	++++	++++	++++	9	16	20
<i>Asp. ruber</i>	±	+++	+++	6	15	20
<i>Asp. fumigatus</i>	++++	++++	++++	2	10	11
<i>Asp. nidulans</i>	+++	++++	++++	2	2	25
<i>Asp. Sydowi</i>	±	±	±	0	0	0
<i>Asp. versicolor</i>	++	++++	++++	1	15	23
<i>Asp. versicolor</i> var. <i>magnus</i>	+++	++++	++++	1	4	10
<i>Asp. flavus</i>	+	++++	++++	0	7	8
<i>Asp. flavus</i> var. <i>asper</i>	+++	++++	++++	4	6	27
<i>Asp. terreus</i>	++++	++++	++++	2	3	15
<i>Asp. yezoensis</i>	++++	++++	++++	1	3	6
<i>Penicillium yezoensum</i>	+	++	++++	0	2	7
<i>Pen. spinulosum</i>	++++	+++++	+++++	3	5	16
<i>Citromyces Pfefferianus</i>	++++	+++++	+++++	5	10	28
<i>Pen. parallelosporum</i>	+++	+++++	+++++	1.5	5	10
<i>Pen. carmino-</i> <i>violaceum</i>	++	+++++	+++++	0	2	10
<i>Pen. fellutanum</i>	++	+++++	+++++	0	7	10
<i>Pen. citreo-viride</i>	++++	+++++	+++++	3	5	16
<i>Pen. Paczoskii</i>	++	++++	++++	2	5	22

Cultural days	Growth			Lipolytic power		
	7	30	60	7	30	60
<i>Pen. Terlikowskii</i>	++++	+++++	+++++	2	5	20
<i>Pen. columnare</i>	-	±	+	0	0.5	2
<i>Pen. ellipticum</i>	+	+	+	0	0	0.5
<i>Pen. Waksmani</i>	++++	++++	++++	3	6	15
<i>Pen. Sartoryi</i>	±	±	±	0	0	0
<i>Pen. spinulo-ramigenum</i>	++++	+++++	+++++	5	5	20
<i>Pen. digitatum</i>	+++	+++++	+++++	5	7	30
<i>Pen. citreo-roseum</i>	+	++++	++++	0	1.5	5
<i>Pen. Roqueforti</i>	++++	+++++	+++++	5	5	25
<i>Pen. Janczewskii</i>	++++	+++++	+++++	5	5	10
<i>Pen. solitum</i>	++++	++++	++++	5	5	15
<i>Pen. flavo-glaucum</i>	+++	+++++	+++++	0.5	2	10
<i>Pen. palitans</i>	+++	++++	++++	3	4.5	15
<i>Pen. crustosum</i>	++++	+++++	+++++	1	10	19
<i>Pen. crustosum</i> var. <i>spinulo-sporum</i>	++++	+++++	+++++	5	6	30
<i>Pen. expansum</i>	++++	+++++	+++++	3	5	18
<i>Scopulariopsis</i> <i>brevicaulis</i>	++	+++	++++	0.5	3	13
<i>Paecilomyces varioti</i>	+++	+++++	+++++	1	4	13
<i>Trichoderma Koningi</i>	+++	++++	++++	5	5	32
<i>Botrytis cinerea</i>	+	++++	++++	0	7	18
<i>Trichothecium roseum</i>	+	+	++++	0	0	5
<i>Dematium pullulans</i>	+++	+++	++++	2	2	15
<i>Cladosporium herbarum</i>	±	++	+++++	0	6	10
<i>Stemph. botryosum</i> var. <i>botrytis</i>	±	±	+++++	0	1.5	20
<i>Alternaria tenuis</i>	++	++	+++++	1	3	17
<i>Fusarium</i> sp.	+++	+++	+++++	4	6	20
<i>Epicoccum</i> <i>purpurascens</i>	±	±	±	0	0	0

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EXPLANATION OF THE PLATES

PLATE 1

<i>Rhizopus nigricans</i> EURENBERG	1
<i>Oospora lactis</i> (FRESENIUS) SACCARDO	2
Sp: sporangiospore	
Sph: sporangiophore	
Cl: columella	

PLATE 2

<i>Oospora suaveolens</i> (LINDNER) LINDAU	3
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PLATE 3

<i>Oospora lupuli</i> (MATTEWS et LOTT) SACCARDO	5
<i>Aspergillus clavatus</i> DESMAZIERS	4
Cdp: conidiophore with conidial chains.	
V: vesicle with sterigmata.	
St: sterigmata.	
Cd: conidia.	

PLATE 4

<i>Aspergillus Chevalieri</i> (MANGIN) THOM et CHURCH	6
<i>Aspergillus Chevalieri</i> var. <i>ruber</i> nov. var.	7
Cdp: conidiophore with conidial chains.	
V: vesicle with sterigmata.	
St: sterigmata.	
Cd: conidia.	
As: ascus.	
Ap: ascospore.	

PLATE 5

<i>Aspergillus repens</i> (CORDA) SACCARDO	8
<i>Aspergillus ruber</i> (SPIEKERMAN et BREMER) THOM et CHURCH	9
Cdp: conidiophore with conidial chains.	
V: vesicle with sterigmata.	
St: sterigmata.	
Cd: conidia.	
Ap: ascospore.	

PLATE 6

<i>Aspergillus fumigatus</i> FRESENIUS	10
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<i>Aspergillus nidulans</i> (EIDAM) WINTER	11
<i>Aspergillus Sydowi</i> (BAINIER et SARTORY) THOM et CHURCH	12
Cdp : conidiophore with conidial chains.	
V : vesicle with sterigmata.	
V ₁ : reduced conidial apparatus.	
St : sterigmata.	
Cd : conidia.	

PLATE 7

<i>Aspergillus versicolor</i> (VUILLEMIN) TIRABOSCHI	13
<i>Aspergillus versicolor</i> var. <i>magnus</i> nov. var.	14
Cdp : conidiophore with conidial chains.	
V : vesicle with sterigmata.	
V ₁ : reduced conidial apparatus.	
St : sterigmata.	
Cd : conidia.	

PLATE 8

<i>Aspergillus flavus</i> LINK	15
<i>Aspergillus flavus</i> var. <i>asper</i> nov. var.	16
Cdp : conidiophore with conidial chains.	
V : vesicle with sterigmata.	
St : sterigmata.	
Cd : conidia.	

PLATE 9

<i>Aspergillus terreus</i> THOM	17
<i>Aspergillus yezoensis</i> nov. sp.	18
Cdp : conidiophore with conidial chains.	
V : vesicle with sterigmata.	
St : sterigmata.	
Cd : conidia.	

PLATE 10

<i>Penicillium yezoensum</i> HANZAWA	19
<i>Penicillium spinulosum</i> THOM	20
Cdp : conidiophore with conidial chains.	
Pn : penicillus.	
Cd : conidia.	

PLATE 11

<i>Citromyces Pfefferianus</i> WEHMER	21
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<i>Penicillium parallelo-sporum</i> nov. sp.	22
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Cdp : conidiophore with conidial chains.

Pn : penicillus.

Cd : conidia.

PLATE 12

<i>Penicillium carmino-violaceum</i> DIERCKX	23
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<i>Penicillium fellutanum</i> BOURGE	24
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Cdp : conidiophore with conidial chains.

Pn : penicillus.

Cd : conidia.

PLATE 13

<i>Penicillium citreo-viride</i> BOURGE	25
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<i>Penicillium Paczoskii</i> ZALESKI	26
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Cdp : conidiophore with conidial chains.

Pn : penicillus.

Cd : conidia.

PLATE 14

<i>Penicillium Terlikowskii</i> ZALESKI	27
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<i>Penicillium columnare</i> THOM	28
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Cdp : conidiophore with conidial chains.

Pn : penicillus.

Cd : conidia.

PLATE 15

<i>Penicillium ellipticum</i> nov. sp.	29
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<i>Penicillium Waksmani</i> ZALESKI	30
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Cdp : conidiophore with conidial chains.

Pn : penicillus.

Cd : conidia.

PLATE 16

<i>Penicillium Sartoryi</i> THOM	31
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<i>Penicillium spinulo-ramigenum</i> nov. sp.	32
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Cdp : conidiophore with conidial chains.

Pn : penicillus.

Cd : conidia.

PLATE 17

<i>Penicillium digitatum</i> SACCARDO	33
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Cdp : conidiophore with conidial chains.
 Pn : penicillus.
 Cd : conidia.

PLATE 18

<i>Penicillium cüreo-roseum</i> DIERCKX	34
<i>Penicillium Roqueforti</i> THOM	35

Cdp : conidiophore with conidial chains.
 Pn : penicillus.
 Cd : conidia.

PLATE 19

<i>Penicillium Janczewskii</i> ZALESKI	36
<i>Penicillium solitum</i> WESTLING	37

Cdp : conidiophore with conidial chains.
 Pn : penicillus.
 Cd : conidia.

PLATE 20

<i>Penicillium flavo-glaucum</i> BOURGE	38
<i>Penicillium palitans</i> WESTLING	39

Cdp : conidiophore with conidial chains.
 Pn : penicillus.
 Cd : conidia.

PLATE 21

<i>Penicillium crustosum</i> THOM	40
<i>Penicillium crustosum</i> var. <i>spinulo-sporum</i> nov. var.	41

Cdp : conidiophore with conidial chains.
 Pn : penicillus.
 Cd : conidia.

PLATE 22

<i>Penicillium expansum</i> THOM	42
<i>Scopulariopsis brevicaulis</i> (SACCARDO) BAINIER	43

Cdp : conidiophore with conidial chains.
 Pn : penicillus.
 Cd : conidia.

PLATE 23

<i>Paecilomyces varioti</i> BAINIER	44
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Cdp : conidiophore with conidial chains.
Cd : conidia.

PLATE 24

<i>Trichoderma Koningi</i> OUDEMANS	45
<i>Botrytis cinerea</i> PERSOON	46
<i>Trichothecium roseum</i> LINK	47

Cdp : conidiophore with conidial heads.
Cd : conidia.

PLATE 25

<i>Dematium pullulans</i> DE BARY	48
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Cdp : fertile hyphae with conidia.
Rc : resting cells.

PLATE 26

<i>Cladosporium herbarum</i> (PERSOON) LINK	49
<i>Stemphylium botryosum</i> WALLR. var. <i>botrytis</i> (PREUSS) LINDAU	50
<i>Alternaria tenuis</i> NEES	51

Cdp : conidiophore with conidial chains.
Cd : conidia.

PLATE 27

<i>Fusarium</i> sp.	52
<i>Epicoccum purpurascens</i> EHRENBERG	52

Cdp : conidiophore.
Cd : conidia.

