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LATVIJAS UNIVERSITĀTES RAKSTI
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LAUKSAIMNIECĪBAS FAKULTĀTES SERIJA 1. 10.

Mēslojuma iespaids uz pļavas ražu un siena botanisko sastāvu

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(Augkopības kabinets)

Ilggadējos zāļājos — pļavās un ganībās zem ārējo augšanas apstākļu iespaida izveidojušās dažādas zāļaugu sabiedrības. Pēdējās var būt ļoti dažādas; viņas dažkārt mainās un pārveidojas vienā un tanī pat vietā atkarībā no atsevišķa gada klimatiskām, kā arī citām dabas vai cilvēka ietekmētām pārmaiņām augu augšanas apstākļos. Nosusinot vai apūdeņojot zemi, mainās tās mitruma apstākļi, kas arī atstāj iespaidu uz zemes siltumu, zemes vēdināšanos un augu barošanos. Zāļājus ecējot, irdinam zemes virsējo kārtu un arī veicinām zemes vēdināšanos. Mēslojot, dodot augu barības vielas, uzlabojam augu attīstīšanās apstākļus, cik tie atkarājas no vienas vai vairākām barības vielām. Kur uz zāļājiem uzskalojas barības vielas no augstāk stāvošiem labi mēslotiem tīrumiem, tur sastopam kuplākus un vērtīgākus augus. Atkarībā no zemes mitruma, zemes vēdināšanās, mēslošanas un citiem apstākļiem norisinās zemē sīkbūtņu darbība, kam savukārt iespaids uz zemes īpašībām un tālāk uz augu attīstīšanos. Tauriņziedainie augi ir slāpekļkrājēji augi, un viņu kuplāka attīstīšanās ir zināmā ciešā sakarā ar īpašām sīkbūtnēm, kas mitinās uz šo augu saknēm un ir īstās gaisa slāpekļa saistītājas.

Mēs vērojam, ka augu attīstīšanās un viņu sabiedrību izveidošanās atkarīga no dažādiem augšanas apstākļiem. Ja jau zināmā tīrumā vieni augi aug kuplāk un citi vājāk, ja jau tīrumā, atkarībā no zemes īpašībām, mitruma apstākļiem un mēslošanas, sastopam īpatnējas nezāles, tad jo spilgtāk šādas dažādības saskatāmas pļavās un ganībās, kuŗu augu sega jo raiba, kur dabiskās augšanas apstākļu dažādības mazāk izlīdzinātas, zemi apstrādājot. Dažādu apgabalu, dažādu novadu pļavas

nav vienādas, lai gan dažkārt zināmās tipiskās vietās sastopam stipri līdzīgas augu sabiedrības. Pļavas raksturojot, viņu ienesību noteicot, sadala tās tipos arī pēc augu segas, vismaz pēc valdošiem augiem. Augšanas apstākļu līdzība raksturīga īpatnība atsevišķam pļavu tipam.

Netrūkst literātūrā norādījumu par dažādu augšanas apstākļu iespaidu uz zāļāju augu sabiedrībām. Visvairāk tādus sastopam zīmējoties uz mēslošanu. Lai minam tikai ilggadējos pļavu mēslošanas mēģinājumus Rothamstedt'ā — Anglijā, kas uzsākti 1856. gadā un turpinājas vēl mūsu dienās. Arī Šveicē, Vācijā, Dānijā, Zviedrijā, Somijā un citās zemēs izdarīti plaši izmēģinājumi pļavu un ganību mēslošanā. Pie mums Latvijā arī zāļāju mēslošanas piekritēju skaits pastāvīgi pieaug, un nevien daži izmēģinājumi, bet arī praktisko lauksaimnieku novērojumi liecina par mēslošanas lielo iespaidu uz zāļāju ražām un iegūto ražu labumu pēc botāniskā sastāva. Tamdēļ bija nepieciešami ievadīt izmēģinājumus zāļāju mēslošanā un tuvāk novērot pārmaiņas, kādas seko zāļāju mēslošanai mūsu zemes apstākļos. Tādus izmēģinajumus uzsākušas mūsu izmēģinājumu iestādes un lauksaimniecības veicinātājas sabiedriskas organizācijas. Visplašākie novērojumi gūti purvzemēs Jaunpētermuižas izmēģinājumu stacijā, agr. doc. P. Konrada vadībā, kas publicēti īpašā lauksaimniecības pārvaldes izdevumā 1929. gadā. Tādi izmēģinājumi bija nepieciešami arī augkopības katedrai, lai rastu un sagādatu demonstrēšanas un mācības līdzekļus zāļāju jautājumos. Starp citiem ievadīti arī pļavas mēslošanas izmēģinājumi un tādi ierīkoti 1921. gadā Latvijas Universitātes lauksaimniecības fakultātes izmēģinājumu un pētīšanas saimniecībā Rāmavā. Šie izmēģinājumi uzsākti tūdaļ pēc augšminētās saimniecības pārņemšanas fakultātes rīcībā, bez iepriekšējas izmēģinājuma sagatavošanas un augšanas apstākļu vienlīdzības noskaidrošanas.

Pļava, kur izmēģinājumi izdarīti, kādreiz bijusi labākā stāvoklī, bet patreizējie mitruma apstākļi, lai gan rādījās esam apmierinoši, tomēr nebij noteikti pārzināmi. Pēc sava stāvokļa pļava pieskaitāma vidējā līmeņa pārplūstošām pļavām; atrodas tā Daugavas vecā gultnē un pavasaros, ledus iešanas laikā, tam Daugavā sastrēgstot, ūdens ceļas un ieplūst tā saucamā Olektes lejā. Ar to izskaidrojamas samērā apmierinošās siena ražas. Apskatot zemes griezumu, redzam virsējā kārtā (līdz 10 cm) trūdu bagātu smilts mālu, zem kā (līdz 100 cm) nāk smilšains māls ar ievērojamu kaļķa saturu. Apmēram 35—40 cm dziļumā vērojama plāna uzskalotas smilts kārta. Tuvāku raksturojumu sniedz studenta Šmita izdarītā zemes analize nemēslotā lauciņā 1924. g.:

H_2O	3,09%	K_2O	0,17%
CO_2	4,51%	CaO	5,81%
trūds	4,67%	Al_2O_3 }	4,34%
(Humus)		Fe_2O_3 }	
N	0,34%	SO_3	0,10%
P_2O_5	0,13%		

Kaitīgu vielu zeme nesatur; reakcija sārmaina.

Novērojot izmēģinājumus pirmos gados izrādījās, ka dabiskie augu augšanas apstākļi pietiekoši vienmērīgi, lai atšķirības ražas daudzumā un botāniskā sastāvā liktu uz viena vai otra uzlabošanas paņēmiena rēķina.

Kā jau minēts, mēslošanas izmēģinājumi iesākti 1921. gada pavasarī, kad pēc acumēra vienlīdzīgā pļavas gabalā iedalītas divas rindas lauciņu. Atsevišķu lauciņu platība 1 ārs; tie nošķirti viens no otra ar 1 metru platu ceļu. Katrā rindā iedalīti 12 lauciņi, lai mēslotu pēc sekošas schēmas:

1. un 1. a — bez mēslojuma;
ohne Düngung;
2. un 2. a — kalija sāls;
Kalisalz;
3. un 3. a — tomasmilti;
Thomasmehl;
4. un 4. a — čīles salpetris;
Chilesalpeter;
5. un 5. a — dedzināti kaļķi;
Kalk;
6. un 6. a — kalija sāls un tomasmilti;
Kalisalz und Thomasmehl;
7. un 7. a — kainīts un tomasmilti;
Kainit und Thomasmehl;
8. un 8. a — kalija sāls, tomasmilti un čīles salpetris;
Kalisalz, Thomasmehl und Chilesalpeter;
9. un 9. a — kalija sāls, tomasmilti un sērskābais amonjaks;
Kalisalz, Thomasmehl und schwefelsaures Ammoniak;
10. un 10. a — kalija sāls, tomasmilti, čīles salpetris un kaļķis;
Kalisalz, Thomasmehl, Chilesalpeter und Kalk;

11. un 11. a — kalija sāls un kaulu milti;
Kalisalz und Knochenmehl;
12. un 12. a — kūtsmēsli.
Stallmist.

1923. gadā lauciņu rindas pagarinātas, katra ar trim lauciņiem, lai vērotu, cik pamatots un mūsu apstākļos pareizs prof. Dr. F. Aereboe's uzskats: — „Stickstoff-Kalidüngung an Stelle der Kali-Phosphatdüngung muss heute als Lösung der Wiesendüngung sein," — (Neue Dünger-wirtschaft ohne Auslandsphosphate").

13. un 13. a — kalija sāls un sērskābais amonjaks;
Kalisalz und schwfelsaures Ammoniak;
14. un 14. a — kalija sāls un čīles salpetris;
Kalisalz und Chilesalpeter;
15. un 15. a — kalija sāls un superfosfāts;
Kalisalz und Superphosphat.

Pēdējais (15.) lauciņš ņemts salīdzināšanai ar diviem iepriekšējiem un ar 6. lauciņu.

Mēslojums dots gadskārtīgi šādos apmēros:
Die jährlich verabfolgte Düngermenge:

	kg uz 1 āra	kvintālos uz 1 ha
Kalija sāls 40% . . .	2,6	2,6
Tomasmilti $^{16}/_{18}$% . .	2,5	2,5
Čīles salpetris	1,3	1,3
Dedzināti kaļķi	9,0	9,0
Kainīts	8,2	8,2
Sērskābais amonjaks .	1,6	1,6
Kaulu milti	2,0	2,0
Superfosfāts	2,5	2,5
Kūtsmēsli	200,—	200,—

1921. gadā neizdevās dabūt slāpekļa mēslus, un tos sāka dot tikai 1922. gada pavasarī. Tas savukārt gan atkal deva iespēju zināmā mērā vērot augšanas apstākļu vienlīdzību, jo pirmā gadā katrā rindā palika 2 nemēsloti lauciņi, kopā 4 lauciņi un katrā rindā 3 lauciņi, kopā 6 lauciņi, tikai ar kalija sāli un tomasmiltiem mēsloti. Nemēslotie lauciņi noder turpmākos gados dabīgās pļavas raksturošanai un salīdzināšanai ar dažādi mēslotiem.

Kad atsevišķos gados lauciņi mēsloti, kad pirmā zāle un atāls pļauti, redzams sekojošā tabulā:

	Mēslots Gedüngt	*Pļauta 1. zāle* Erster Schnitt	*Atāls pļauts* Zweiter Schnitt
*) 1921. gadā	20. IV.	10. VII.	—
1922. „	28. IV.— 2. V.	10. VII.	26. IX.
**) 1923. „	26. IV.— 6. V.	13. VII.	10. IX.
*) 1924. „	28. IV.— 7. V.	1. VII.	6. IX.
1925. „	6. IV.—21. IV.	12. VI.	2. IX.
1926. „	21. IV.—11. V.	26. VI.	4. IX.
*) 1927. „	8. IV.— 3. V.	5. VII.	6. IX.
1928. „	24. IV.	18. VII.	—
*) 1929. „	6. V.	12. VII.	11. IX.

Lai sekotu mēslojuma iespaidam, pirmos gados izdarīja lauciņu apskates dažādā laikā un mēģināja novērotās atšķirības izteikt ar dažādām atzīmēm. Vēlākos gados šis paņēmiens atmests, jo siena ražas noteikšana, izsveŗot to, kā arī ražas botaniskās analizes deva daudz noteiktākus, pareizākus un vispār saprotamākus skaitļus, uzskatamākus un vieglāk salīdzināmus resultātus. Siena ražas noteiktas, izsveŗot pļavā izžāvēto sienu; tikai dažos gados atāla sienu nebija iespējams pietiekoši izžāvēt, un raža aprēķināta, uzzinot iežūšanu mazākos paraugos. 1921. gadā, tāpat 1928. gadā atāls bija niecīgs, 1928. gadā arī laika apstākļi bija visai neizdevīgi, lai ievāktu atāla ražu, tamdēļ tā iztrūkst ražas tabulā (187. l. p.

Pļavas ražas botaniskais sastāvs noteikts, analizējot sienu, pie kam paraugi iegūti dažādi. Pirmos trijos gados botaniskai analizei paraugus ieguva, izvēloties uz katra atsevišķa lauciņa raksturīgā vietā 4 kvadr. pēdas = 0,3716 kv. m. un zāli pirms pirmās zāles pļaujas izgrieza ar dzirklēm. Tā iegūto zāli rūpīgi salika uz papīra un novietoja pajumtē izžāvēšanai. Izžuvušos paraugus satina un novietoja sausā vietā; analizēja rudenī un ziemā. Minētā platība (4 kv. pēdas) paraugu iegūšanai ņemta tamdēļ, ka līdzinās $^1/_{10.000}$ pūrvietas, lai reizā ar botanisko raksturojumu pārbauditu mazu lauciņu lietošanas iespēju — ražu aprēķināšanā, kas tomēr izrādījās nedroša. Turpmākos gados paraugi iegūti pie pļaušanas: gar vālu ejot, zināmā attālumā

*) Apzīmētos gados attiecīgie lauciņi mēsloti ar kūtsmēsliem un kaļķi. Mit Stallmist gedüngt und gekalkt.

**) 1923. gadā nevarēja dabūt sērskābo amonjaku, kamdēļ 9. un 9. a lauciņi šajā gadā sļāpekļa mēslus nedabūja. — Im Jahre 1923 Düngung mit schwefelsaurem Ammoniak ausgeblieben.

ņemti zāles kušķīši; no pēdējiem sastādīts caurmēra paraugs ap 1 kg, ko izžāvēja līdzīgi iepriekš minētiem, lai brīvākā laikā izdarītu siena analizi. Galīgai botaniskai analizei caurmēra paraugi sagatavoti augkopības kabinetā, izklājot atsevišķa lauciņa siena paraugu uz galda un ņemot pa kušķītim dažādās vietās, kamēr paraudziņš sasniedza vismaz 100 gr. Šā iegūtā paraugā sastopamie augi šķiroti sekošās grupās:

I. tauriņzieži, kā: sarkanais un baltais āboliņš, dedestiņi, vanagzirņi, vanagnadziņi un t. l.

II. labās stiebru zāles, kā: pļavas auzene, timotiņš, pļavas skarene, parastā skarene, baltā smilga un t. l.

III. vidējās stiebru zāles, kā: sarkanā auzene, trīsuļi un t. l.

IV mazvērtīgās stiebru zāles, kā: ciņu zāle un zaķu auza.

V. grīšļaugi, kā: dzelzs zāle un citi grīšļi; arī Luzula.

VI. dažādi platlapji, kā: gundegas, skābenes, bitenes, dzelzenes, pienenes un t. l.

VII. sporaugi: skostas.

Pēc tam noteikts katras grupas svars atsevišķi un aprēķināts svara procentos, kā arī absolūtais svars lauciņa (1 āra) ražā. Lai sekotu atsevišķu augu izplatībai atsevišķās grupās, izdarīts acumēra novērtējums pēc desmit ballu sistēmas, izteicot apmēram katra vairāk sastopama auga daudzumu desmitās svara daļās, no grupas kopējā svara rēķinot. Tā radušies arī uz dažādiem lauciņiem sastopamo augu saraksti. Sīki augi vai augu daļas ar niecīgu svaru ievietoti sarakstos ar atzīmi +, kas norāda gan uz šo augu klātbūtni, bet reizā rāda, ka sienā viņu ļoti maz. Izdarītas tikai pirmās pļaujas botaniskās analizes, jo pirmās zāles raža dod galveno masu un pilnīgāk atspoguļo pļavu augu sabiedrības. Protams, tā paliek neatzīmēti daži augi, kas attīstās vasaras otrā pusē, tomēr viņu skaits un masa samērā niecīgi, lai kautcik ievērojami mainītu atsevišķu lauciņu botanisko raksturojumu. Galvenie pirmā pļaujā sastopamie augi arī atālā dod lielāko masas daļu, un ja atālā parādās kādi maznozīmīgi platlapji, tad no tauriņziežiem, stiebru zālēm un grīšļiem pirmā ražā neatzīmēti augi nav novēroti. Tajā pašā pļavā kādā cita rakstura izmēģinājumā studente A. Reinharde, noteicot atsevišķu augu grupu daudzumu ražā, kā arī atsevišķu augu daudzumu grupās, to apstiprina.

Atsevišķu augu grupu daudzums 1927. g. ražā:
Die botanische Zusammensetzung einer Heuernte vom Jahre 1927 nach Pflanzengruppen:

	1. zālē: Erster Schnitt	atālā: Zweiter Schnitt
Tauriņzieži — Schmetterlingsblütler	32,2%	29,9%
Labās stiebru zāles — Gute Gräser	10,9 „	16,1 „
Vidējās stiebru zāles — Mittelgute Gräser	14,2 „	12,9 „
Mazvērtīgās stiebru zāles — Minderwertige Gräser	9,7 „	9,0 „
Grīšļaugi — Riedgräser	18,2 „	14,1 „
Dažādi platlapji — Verschiedene Kräuter	13,4 „	16,8 „
Sporaugi — Sporenpflanzen	1,4 „	1,2 „
	100%	100%

Augu daudzums grupās tos pašos paraugos:
Die Menge der Pflanzen innerhalb der Gruppen:

Tauriņzieži: Schmetterlingsblütler:

	1. zālē: Erster Schnitt	atālā: Zweiter Schnitt
Sarkanais āboliņš — Trifolium pratense Baltais āboliņš — Trifolium repens	69,8%	66,8%
Vanagnadziņi — Lotus corniculatus	9,2 „	9,3 „
Dedestiņi — Lathyrus pratensis	16,6 „	20,1 „
Vanagzirņi — Vicia cracca	3,5 „	3,2 „
Bobis — Medicago lupulina	0,9 „	0,6 „
	100%	100%

Labās stiebru zāles: Gute Gräser:

Pļavas auzene — Festuca pratensis	65,5%	57,1%
Timotiņš — Phleum pratense	22,3 „	15,5 „
Pļavas skarene — Poa pratensis Parastā skarene — Poa trivialis	12,2 „	27,4 „
	100%	100%

Vidējās stiebru zāles: Mittelgute Gräser:

Sarkanā auzene — Festuca rubra	72,5%	100,0%
Trīsuļi — Briza media	27,5 „	— „
	100%	100%

Mazvērtīgās stiebru zāles: Minderwertige Gräser:	1. zālē: Erster Schnitt	atālā: Zweiter Schnitt
Ciņu zāle — Aira caespitosa	78,0%	54,5%
Zaķu auza — Avena pubescens	22,0 „	45,5 „
	100%	100%
Platlapji: Verschiedene Kräuter:		
Skābene — Rumex acetosa	8,0%	1,9%
Kodīgā gundega — Ranunculus acer	10,8 „	13,3 „
Ķimenes — Carum carvi	1,3 „	5,5 „
Zalšu zāle — Polygonum bistorta	0,5 „	— „
Purva madaras — Galium palustre	0,9 „	7,9 „
Madaras — Galium mollugo	24,3 „	12,0 „
Pienenes — Taraxacum officinale	+ „	4,6 „
Vīgrieznes — Ulmaria pentapetala	+ „	7,3 „
Dzelzenes — Centaurea jacea	32,5 „	43,1 „
Sveķenes — Lychnis flos cuculis	1,7 „	— „
Brūngalvīte — Brunella vulgaris	0,8 „	— „
Rasas krēsliņš — Alchemilla vulgaris	1,9 „	+ „
Bitenes — Geum rivale	1,6 „	3,3 „
Vīdriekši — Sium latifolium	7,2 „	— „
Baltās puķes — Chrisanthemum leuc.	0,8 „	— „
Gandrenes — Geranium spec.	1,6 „	1,1 „
Polīši — Plantago lanceolata	0,9 „	— „
Radzenes — Cerastium triviale	5,2 „	— „
	100%	100%

Tā tad minētais piemērs apstiprina iepriekš izteikto, ka iespējams spriest par zāļaugu sabiedrībām pļavā pēc 1. pļaujas botaniskā sastāva.

Protams, būtu pārdrošība apgalvot, ka pārmaiņas augu sabiedrībās uz dažādi mēslotiem lauciņiem būtu tikai dažādas mēslošanas sekas; arī katra atsevišķa gada laika apstākļiem — nokrišņu daudzumam un sadalījumam augšanas laikā, siltumam, gaismai u. t. l. ir savs iespaids uz atsevišķu gadu ražām un pēdējo sastāvu. Šie apstākļi tomēr atsevišķos gados uz visiem lauciņiem līdzīgi, tamdēļ atšķirības zināmu gadu ražās, galvenā kārtā, ir mēslojuma dažādības sekas.

Par siltuma apstākļiem un nokrišņu daudzumu Rāmavā ziņas

trūcīgas, bet ņemot vērā arī tuvāko meteoroloģisko staciju novērojumu datus, iespējams uzstādīt apmēra skaitļus, kas dod pietiekošus norādījumus par minētiem augšanas faktoriem dažādos gados, pļavu augu augšanas laikā.

Nokrišņu daudzums dažādos gados mm:
Niederschlagsmengen in mm:

	1921	1922	1923	1924	1925	1926	1927	1928	1929
Aprīlī	53	36	30	40	42	31	36	35	18
Maijā	37	36	52	51	33	60	60	83	64
Jūnijā	70	58	69	60	53	44	52	181	39
	160	130	151	151	128	135	148	299	121
Jūlijā	74	76	87	70	55	22	64	98	59
Augustā	40	96	88	110	120	56	49	119	34
Septembrī	92	42	50	77	84	66	66	128	62
	206	214	225	257	259	144	179	345	155
	366	344	376	408	387	279	327	644	276

Siltuma apstākļi dažādos gados C°:
Wärmeverhältnisse in C°:

	1921	1922	1923	1924	1925	1926	1927	1928	1929
Aprīlī	8.7	4.4	2.7	2.3	7.4	5.4	4.7	5.1	0.7
Maijā	14.4	11.7	10.9	12.9	14.3	12.8	8.2	10.9	12.7
Jūnijā	15.7	15.3	12.8	16.9	14.7	16.8	14.9	11.7	13.6
Jūlijā	16.9	18.4	18.2	18.2	20.7	19.1	21.3	15.7	16.5
Augustā	17.2	15.9	15.0	17.8	16.6	15.6	18.0	15.1	16.5
Septembrī	10.9	11.8	12.8	13.7	11.6	11.9	13.0	12.0	12.4

Salīdzinot dažādu gadu nokrišņu daudzumus līdz pirmās zāles pļaujai, kas parasti izdarīta jūnija beigās vai jūlija sākumā, pārāk acīs durošos starpību nenovērojam, izņemot 1928. gadu, kad vasaras pirmā pusē nokrišņu apmēram divreiz tik daudz kā citos gados. 1929. gada vasaras pirmā pusē vismazāk nokrišņu. Arī vasaras otrā pusē 1928. gada nokrišņu skaitlis nenormāli augsts; mazāk nokrišņu šajā laikā bijis 1926. un 1929. gadā. Vispār nokrišņu ziņā bagātākā ir 1928. gada vasara: zemākos skaitļus uzrāda 1926. un 1929. gada vasara.

Salīdzinot atsevišķu mēnešu siltuma caurmēra skaitļus veģetā-

cijas laikā, ārkārtēji zemu aprīļa temperatūras caurmēru uzāda 1929. gads; samērā zemas — 1923. un 1924. gadā. 1921. un 1925. gadā aprīļa caurmēra temperatūras visaugstākās. Maija mēneša caurmēra temperatūras dažādos gados arī stipri atšķiras: max. 14.4° C un min. 8.2° C. Zemākā maija mēneša caurmēra temperatūra 1927. gadā. Zemākā jūnija mēneša caurmēra temperatūra 1928. gadā. Vasaras otrā pusē temperatūras svārstības nav tik ievērojamas; tikai 1928. gadā tā zemāka. Ar to izskaidrojama zemā raža 1928. gadā vispār un vājā atāla ataugšana. Protams, novēlotā pirmās zāles pļaušana arī atstājusi savu iespaidu uz atāla attīstīšanos, un atāla ražas novākšana izrādījās par nenozīmīgu.

Mēģinājumu izvešanā, ražas novākšanā un botaniskā sastāva noteikšanā man daudz palīdzēja priv. doc. K. Pols un asistents A. Bārs.

Mēslojuma iespaids, lai gan ne pārāk spilgti, manāms jau pirmā gadā, nevien ražas daudzumā, bet arī botaniskā sastāvā. 1922. gadā ražas lielumā un botaniskā sastāvā jau saskatāma ievērojama starpība dažādi mēslotos lauciņos. Turpmākos gados pilnīgāki mēslotos lauciņos ražas turas ievērojamā augstumā, tikai laika ziņā neizdevīgos 1927. un 1928. gados ražas pazeminājušās.

Kāda nozīme mēslojumam siena ražu iznākumā, liecina sekojošie skaitļi, kas iegūti kā caurmēra skaitļi no pamat- un kontrollauciņu ražām (skat. tab. 187. l. p.).

Ražas iznākums
Gesamternte

Laucina Nr. Parcellen Nr.	1921. g. no 1 āra	1922. g. no 1 āra		1923. g. no 1 āra		1924. g. no 1 āra		1925. g. no 1 āra		1926. g. no 1 āra		1927. g. no 1 āra		1928. g. no 1 āra	1929. g. no 1 āra		9 resp. 7 gados iegūts siena no 1 ha Gesamternte pro ha in 9 resp. 7 J.	Ražots vairāk, salīdzinot ar nemēsl. no 1 ha. — Von Gedüngt mehr geerntet	Mēslojuma izmaksa pēc 1929. g. mēslu cenām. — Gesamtdünger Umkosten	1 kvintals vairāk ražota siena izmaksā. Ein mehrgeerntetes Qu. kostete
	1. zāle I. Schnitt	1. zāle I. Schnitt	atals II. Schnitt	1. zāle I. Schnitt	atals II. Schnitt	1. zāle I. Schnitt	atals II. Schnitt	1. zāle I. Schnitt	atals II. Schnitt	1. zāle I. Schnitt	atals II. Schnitt	1. zāle I. Schnitt	atals II. Schnitt	1. zāle I. Schnitt	1. zāle I. Schnitt	atals II. Schnitt				
	kg	kg	kg	kg	kg	kg	kg	kg	kg	kg	kg	kg	kg	kg	kg	kg	kvint.	kvint.	Ls	Ls
1	24.6	25.8	10.2	23.3	5.3	28.3	9.8	24.4	12.3	28.4	7.4	18.1	8.3	17.5	21.0	11.8	*) 276.5/215.9	—	—	—
2	33.2	37.7	17.6	38.5	10.2	37.7	13.9	34.8	21.7	33.6	12.1	22.0	11.9	18.7	26.7	15.0	385.3	108.8	332.10	3.05
3	28.7	29.1	12.7	26.2	7.4	30.7	12.3	26.6	16.6	30.3	10.6	20.6	9.3	17.7	28.5	11.8	319.1	42.6	191.25	4.49
4	25.4	32.3	14.7	30.7	7.4	32.8	9.8	26.4	12.9	30.5	7.8	19.2	7.4	18.2	25.7	12.8	314.0	37.5	332.80	8.87
5	29.9	28.7	11.9	27.0	5.7	30.3	9.0	24.6	14.3	28.5	10.8	17.7	7.5	16.7	22.2	11.5	296.3	19.8	96.00	4.85
6	32.8	45.6	19.7	47.5	13.5	45.9	18.4	42.0	28.5	45.7	18.0	37.2	17.0	33.5	41.0	14.4	502.7	226.2	523.35	2.31
7	34.4	41.0	16.0	44.2	13.1	46.7	18.0	42.2	25.4	42.4	17.0	33.7	14.6	32.7	37.5	13.5	435.4	158.9	637.74	4.00
8	36.0	50.8	18.4	56.1	14.3	54.5	16.8	41.8	24.4	50.2	15.4	41.4	15.8	42.0	47.2	16.6	541.7	265.2	856.15	3.23
9	36.0	47.5	22.5	48.6	14.3	51.6	18.8	47.9	26.0	50.8	16.6	41.1	16.8	44.2	49.5	16.8	549.0	272.5	894.55	3.28
10	32,3	50.0	18.8	54.5	14.3	54.1	16.4	43.4	22.5	46.1	14.3	37.7	16.6	35.2	46.2	16.2	518.6	242.1	990.55	4.09
11	31.9	36.0	19.7	42.2	12.3	43.8	17.2	37.7	23.5	41.8	12.7	31.8	16.5	31.2	38.0	13.1	449.4	172.9	612.54	3.54
12	31.1	40.1	13.1	45.9	7.8	38.5	14.7	29.5	16.4	32.5	8.2	33.9	17.9	34.7	38.5	17.6	420.4	143.9	**)	**)
13	—	—	—	33.6	—	36.0	18.0	38.3	26.6	40.1	13.5	25.8	12.9	30.0	26.0	13.2	314.0	98.1	583.10	5.94
14	—	—	—	28.7	—	35.2	18.4	37.5	26.6	37.3	12.7	27.3	14.5	25.0	27.0	12.8	303.0	87.1	549.50	6.31
15	—	—	—	27.0	—	33.2	23.8	40.1	38.5	44.8	18.2	35.7	19.0	32.5	33.5	13.2	359.5	143.6	475.60	3.31

*) Pirmais skaitlis ir 9 gadu ražas un otrs 7 gadu ražas skaitlis.
Die erste Zahl bezieht sich auf 9, die zweite auf 7 Jahre.

**) Aprēķināms pēc vietas apstākļiem.
Nach örtlichen Verhältnissen zu berechnen.

Tabulā sakopotie skaitļi rāda, ka ar mēslošanu iespējams sasniegt ražas dubultošanos. No atsevišķām augu barības vielām redzamāko iespaidu atstāj kalijs, tomēr kalijs kopā ar fosforskābi un slāpekli dod iespēju sasniegt augstākās ražas. Spriežot pēc pēdējo triju lauciņu ražām, nav dodama sevišķa priekšrocība nedz slāpekļa, nedz fosforskābes mēsliem; fosforskābes mēsliem, liekas, lielāka nozīme. Saskaitot atsevišķu lauciņu ražas par visu izmēģinājuma laiku, dabūjam siena kopražu no 1 āra kg, resp., 1 ha kvintālos. Aprēķinot mēslojuma izmaksu uz 1 āra izmēģinājuma laikā un tālāk uz 1 ha, iespējams aprēķināt 1 kvintāla vairāk ražotā siena izmaksu, kas dod iespēju vērot, cik izdevīgs saimnieciski viens vai otrs mēslojums. Protams, ar ražas pieaugumu pieaugs ražas novākšanas izdevumi, bet tie nevar būt ievērojami un pilnīgi sedzas ar barības vērtības pieaugumu. Ka barība labāka un vērtīgāka, liecina siena botaniskais sastāvs. Kā tabulā sakopotie skaitļi rāda, tad visaugstākās ražas sasniegtas, mēslojot pļavu ar kalija, fosforskābes un slāpekļa mēsliem, tomēr vairāk ražotā siena pašizmaksa viszemākā, kad mēslots tikai ar kalija sāli un tomasmiltiem. Kaļķis, lietots viens pats, atstāj ļoti niecīgu iespaidu; dodot to kopā ar kaliju, fosforskābi un čīles salpetri, vērojams negatīvs kaļķa iespaids.

Tabulā uzrādītie skaitļi liecina, ka raža uz pietiekoši mēslotiem lauciņiem nevien atsevišķos gados, bet arī par visiem novērošanas gadiem turas ievērojamā augstumā. Bez ražu starpībām novērojama arī augu pārgrupēšanās. Visumā uz pilnīgāki mēslotiem lauciņiem pieņemas vērtīgākie zāļaugi, ar ko reizā uzlabojas botaniskais sastāvs, ceļas iegūtā siena barības vērtība. Siena tirgus cenas un barības vērtības sakarību ar tā botanisko sastāvu ir savā laikā izpētījis un aprakstījis prof. Šindlers. Lai rādītu dažāda mēslojuma iespaidu uz zāļaugu sabiedrību maiņu, seko atsevišķu izmēģinājumu ražu botaniskā sastāva caurmēra skaitļi procentos pa atsevišķiem gadiem (1.—15. lauciņos).

	Tauriņzieži Schmetterlingsblütler %	Stiebru zāles Gramineen: labās gūte %	vidējās mittlere %	mazvērt. minderwertige %	Grīšlaugi Riedgräser %	Platlapji Verschiedene Kräuter %	Sporaugi Sporenpflanzen %	Lauciņi	
								1	
1921	9.5	14.3	18.2	11.5	8.0	35.5	3.0		1921
1922	18.7	10.8	13.6	7.7	4.4	44.8	—		1922
1923	9.8	7.7	20.4	11.3	3.3	46.5	1.0		1923
1924	15.9	15.4	8.7	7.9	4.0	47.8	0.2		1924
1925	9.0	15.8	13.2	13.2	2.3	46.3	0.3		1925
1926	12.0	13.7	13.5	20.3	1.5	38.0	1.0		1926
1927	25.2	9.3	16.5	19.5	1.7	27.8	+		1927
1928	4.0	18.5	19.5	26.8	3.3	27.9	+		1928
1929	3.5	10.8	23.0	35.4	8.4	18.8	0.1	Nemēslots Ungedüngt	1929
Caurmērs	11.9	12.9	16.3	17.2	4.1	37.0	0.6		
								2	
1921	13.5	17.0	21.0	11.5	5.5	29.0	2.5		1921
1922	41.0	7.6	9.5	6.0	1.8	34.1	—		1922
1923	17.0	4.8	21.0	10.7	2.9	43.5	0.1		1923
1924	23.2	16.1	12.7	6.6	3.8	37.6	—		1924
1925	19.1	16.9	14.8	8.0	1.2	40.0	—		1925
1926	19.1	21.5	8.7	16.1	3.4	31.2	—		1926
1927	24.2	14.3	11.0	16.2	0.7	33.6	—		1927
1928	8.6	18.8	29.1	23.1	5.0	15.4	—		1928
1929	11.8	8.3	28.7	38.7	1.5	11.0	—	Kalija sāls Kalisalz	1929
Caurmērs	19.7	13.9	17.4	15.2	2.8	30.7	0.3		
								3	
1921	8.0	15.2	24.3	15.5	7.0	28.5	1.5		1921
1922	36.5	4.5	7.3	6.5	5.2	40.0	—		1922
1923	10.6	11.4	19.2	7.9	2.1	48.8	—		1923
1924	12.5	13.5	18.8	7.5	4.5	43.2	+		1924
1925	11.1	20.2	16.9	7.8	3.0	41.0	—		1925
1926	12.3	17.4	23.7	16.2	1.8	28.6	—		1926
1927	11.3	13.0	20.9	25.1	1.3	28.4	—		1927
1928	0.8	17.8	36.5	26.8	2.6	15.5	—		1928
1929	1.3	6.9	23.9	56.8	1.6	9.5	—	Tomas milti Thomasmehl	1929
Caurmērs	11.6	13.3	21.3	18.9	3.2	31.5	0.2		

	Tauriņzieži Schmetterlingsblütler %	Stiebru zāles Gramineen: labās gute %	Stiebru zāles Gramineen: vidējās mittlere %	Stiebru zāles Gramineen: mazvērt. minderwertige %	Grīšļaugi Riedgräser %	Platlapji Verschiedene Kräuter %	Sporaugi Sporenpflanzen %	Lauciņi	
1921	8.0	18.9	27.6	16.0	8.0	20.0	1.5	4	1921
1922	20.1	10.0	14.7	6.5	5.2	43.5	—		1922
1923	7.0	11.8	24.4	8.9	5.8	42.1	—		1923
1924	7.9	15.6	18.2	7.8	3.8	46.7	—		1924
1925	5.8	16.0	20.3	11.7	2.4	43.8	—		1925
1926	12.5	16.6	14.7	17.9	3.7	34.6	—		1926
1927	8.5	12.4	25.7	21.6	2.3	29.5	—		1927
1928	1.4	15.6	25.6	30.1	2.3	25.0	—		1928
1929	1.5	13.9	20.6	42.1	5.9	16.0	—	Čīles salpetris Chilesalpeter	1929
Caurmērs	8.1	14.5	21.3	18.1	4.3	33.5	0.2		
1921	8.5	19.7	27.8	12.5	7.5	22.5	1.5	5	1921
1922	23.0	10.8	15.0	10.3	5.3	35.6	—		1922
1923	8.8	11.9	16.5	16.2	1.7	44.9	—		1923
1924	15.6	17.5	18.6	8.3	5.3	34.7	+		1924
1925	7.0	17.7	22.4	12.2	3.8	36.9	—		1925
1926	14.6	15.9	21.0	12.6	6.0	29.9	—		1926
1927	15.4	12.8	20.1	22.4	3.8	25.5	—		1927
1928	2.2	17.5	22.4	38.4	5.2	14.3	—		1928
1929	2.2	10.0	21.1	50.3	7.5	8.9	—	Kaļķis Kalk	1929
Caurmērs	10.8	15.0	20.5	20.4	5.1	28.0	0.2		
1921	18.0	20.9	14.6	12.0	7.5	24.5	2.5	6	1921
1922	53.7	7.9	5.5	3.7	2.9	26.3	—		1922
1923	29.4	12.0	9.2	10.2	5.9	33.3	—		1923
1924	21.6	24.4	12.6	6.5	3.9	30.7	0.3		1924
1925	15.4	30.7	16.6	9.4	2.5	25.4	—		1925
1926	28.7	23.4	11.7	11.1	5.2	19.9	—		1926
1927	45.5	14.3	13.0	9.7	0.5	17.0	—		1927
1928	3.7	40.5	23.9	19.9	1.7	10.3	—		1928
1929	7.7	14.6	25.7	38.9	5.6	7.5	—	Kalijsāls + tomasmilti Kalisalz - Thomasmehl	1929
Caurmērs	24.8	21.0	14.8	13.6	3.9	21.6	0.3		

	Tauriņzieži Schmetterlingsblütler %	Stiebru zāles Gramineen: labās gute %	vidējās mittlere %	mazvērt. minderwertige %	Grīšļaugi Riedgräser %	Platlapji Verschiedene Kräuter %	Sporaugi Sporenpflanzen %	Lauciņi	
								7	
1921	16.0	16.6	18.9	12.50	10.0	22.0	4.0		1921
1922	50.3	8.5	9.6	3.1	2.3	26.2	—		1922
1923	20.2	14.6	11.8	6.5	5.0	41.9	—		1923
1924	19.5	18.0	21.7	7.8	2.3	30.5	0.2		1924
1925	16.1	18.2	22.7	13.2	2.3	27.3	0.2		1925
1926	23.3	28.9	12.1	11.0	2.0	22.7	—		1926
1927	42.1	16.8	13.5	13.3	2.4	11.9	—		1927
1928	3.4	22.3	30.3	25.1	3.7	15.2	—	Kainīts + tomasmilti	1928
1929	6.9	11.2	24.5	46.7	2.3	8.4	—	Kainit-Thomasmehl	1929
Caurmērs	22.0	17.2	18.3	15.5	3.6	22.9	0.5		
								8	
1921	18.5	23.4	17.1	12.5	7.0	20.0	1.5		1921
1922	46.0	9.8	7.0	3.9	1.0	32.3	—		1922
1823	21.3	13.6	7.8	4.1	0.7	52.5	—		1923
1924	13.6	30.0	14.5	4.7	4.3	32.6	0.3		1924
1925	10.7	32.2	12.3	11.7	2.9	30.2	—		1925
1926	19.5	33.8	13.9	11.6	1.8	19.4	—		1926
1927	30.6	21.9	14.4	11.4	0.4	21.3	—		1927
1928	3.8	24.8	35.0	21.3	1.9	13.2	—		1928
1929	5.5	17.5	29.7	38.0	1.0	8.3	—	Kalijsāls + tomasmilti + ēlēs salpeteris Kalisalz — Thomasmehl — Chilesalpeter	1929
Caurmērs	18.8	23.0	16.9	13.2	2.3	25.6	0.2		
								9	
1921	15.5	22.4	11.6	10.5	7.0	28.0	5.0		1921
1922	39.1	15.7	8.5	1.6	2.6	32.5	—		1922
1923	20.6	18.3	5.3	5.0	0.3	50.5	—		1923
1924	13.0	37.7	13.5	5.9	1.2	28.6	0.1		1924
1925	9.3	44.6	14.2	5.3	1.7	24.9	—		1925
1926	18.5	39.0	9.4	9.3	3.1	20.7	—		1926
1927	31.7	23.6	15.4	10.0	1.4	17.9	—		1927
1928	5.1	34.1	30.7	17.9	0.1	12.1	—		1928
1929	6.6	23.4	25.5	31.9	0.6	12.0	—	Kalijsāls + tomas milti + sērskab. amonjaks Kalisalz — Thomasmehl — schwefels. Ammoniak	1929
Caurmērs	17.7	28.7	14.9	10.8	2.0	25.3	0.6		

	Tauriņzieži Schmetterlingsblütler %	Stiebru zāles Gramineen labās gute %	Stiebru zāles Gramineen vidējās mittlere %	Stiebru zāles Gramineen mazvērt. minderwertige %	Grīšļaugi Riedgräser %	Platlapji Verschiedene Kräuter %	Sporaugi Sporenpflanzen %	Lauciņi	
								10	
1921	16.0	21.0	16.0	5.0	8.5	31.0	2.5		1921
1922	43.7	10.7	8.6	3.4	0.8	32.8	—		1922
1923	26.7	22.6	8.4	10.7	0.4	31.2	—		1923
1924	11.6	37.5	15.9	7.3	1.1	26.3	0.3		1924
1925	9.0	33.0	16.5	9.2	2.1	30.2	—		1925
1926	15.3	33.2	14.5	13.7	2.0	21.3	—		1926
1927	27.9	16.2	19.9	10.6	0.8	24.6	—		1927
1928	8.4	23.5	40.1	17.1	0.3	10.6	—		1928
1929	6.9	17.1	32.8	30.1	3.0	10.1	—	Kalijsāls + tomas milti + čīles salp. + kaļķis Kalisalz — Thomasmehl — Chilesalpeter — Kalk	1929
Caurmērs	18.4	23.8	19.2	11.9	2.1	24.3	0.3		
								11	
1921	15.5	21.7	16.8	4.5	7.5	31.5	2.5		1921
1922	37.4	10.9	8.4	3.5	1.6	38.2	—		1922
1923	18.5	12.9	6.8	6.2	2.4	53.2	—		1923
1924	20.9	20.3	9.4	4.9	1.8	42.7	—		1924
1925	20.7	19.6	13.3	11.0	1.3	34.1	—		1925
1926	24.8	22.9	11.9	10.2	3.8	26.4	—		1926
1927	31.6	15.9	14.4	9.6	0.5	28.0	—		1927
1928	12.3	22.8	21.4	15.5	4.6	23.4	—		1928
1929	18.4	14.7	22.7	31.6	1.8	10.6	—	Kalija sāls + kaulu milti Kalisalz — Knochenmehl	1929
Caurmērs	22.2	17.9	13.9	10.8	2.8	32.1	0.3		
								12	
1921	13.5	20.7	17.8	7.5	4.0	35.0	1.5		1921
1922	37.3	7.5	6.5	4.6	5.1	39.0	—		1922
1923	11.9	10.2	8.5	10.8	5.1	53.5	-		1923
1924	11.0	21.4	15.4	7.6	3.5	39.3	1.8		1924
1925	10.2	20.6	17.5	12.1	3.3	36.1	0.2		1925
1926	14.5	19.1	12.0	21.3	1.2	31.9	—		1926
1927	24.7	19.8	11.4	12.8	3.6	27.7	—		1927
1928	3.0	25.6	29.1	17.1	2.7	22.5	+	Kūtsmēsli Stallmist	1928
1929	5.9	19.2	23.0	34.5	2.9	14.5	—		1929
Caurmērs	14.7	18.1	15.7	14.3	3.5	33.3	0.4		

	Tauriņzieži Schmetterlingsblütler %	Stiebru zāles Gramineen: labās gute %	Stiebru zāles Gramineen: vidējās mittlere %	Stiebru zāles Gramineen: mazvērt. minderwertige %	Grīšļaugi Riedgräser %	Platlapji Verschiedene Kräuter %	Sporaugi Sporenpflanzen %	Lauciņi	
								13	
1921	—	—	—	—	—	—	—		1921
1922	—	—	—	—	—	—	—		1922
1923	25.8	12.0	11.2	13.1	3.7	34.2	—		1923
1924	24.0	21.9	12.8	8.8	10.0	22.5	—		1924
1925	7.8	25.5	19.9	9.5	0.9	36.4	—		1925
1926	11.5	30.8	8,8	9.8	1.9	37.2	—		1926
1927	11.4	20.0	16.9	17.0	1.7	33.0	—		1927
1928	4.1	21.2	28.3	23.0	3.3	20.1	—		1928
1929	1.3	12.8	20.2	48.8	4.0	12.9	—	Kalija sāls + sērskab. amonjaks Kalisalz — schwefelsaures Ammoniak	1929
Caurmērs	12.3	20.6	16.9	18.6	3.6	28.0	—		
								14	
1921	—	—	—	—	—	—	—		1921
1922	—	—	—	—	—	—	—		1922
1923	18.6	13.3	17.5	15.0	4.7	30.9	—		1923
1924	14.6	22.6	17.6	8.3	4.4	32.4	0.1		1924
1925	13.3	16.8	21.0	13.3	1.7	33.9	—		1925
1926	10.7	31.6	15.3	13.2	5.2	24.0	—		1926
1927	14.7	23.0	19.9	17.1	1.6	23.7	—		1927
1928	3.1	26.6	31.0	21.9	1.5	15.9	—		1928
1929	2.1	13,1	20.9	46.7	6.8	10.3	0.1	Kalija sāls + ēļļes salpeters Kalisalz — Chilesalpeter	1929
Caurmērs	11.0	21.0	20,4	19.4	3.9	24.3	—		
								15	
1921	—	—	—	—	—	—	—		1921
1922	—	—	—	—	—	—	—		1922
1923	33.0	13.4	8,4	7.7	6.4	31.1	—		1923
1924	19.8	25.7	16.2	6.0	3.8	28.5	—		1924
1925	19.7	25.5	10.8	12,9	1.3	29.8	—		1925
1926	14.9	39.0	8.7	15,0	5.3	17.1	—		1926
1927	36.8	20.6	13.5	10.0	3.0	16.1	—		1927
1928	3.2	39.7	28 0	18.6	1.5	9.0	—		1928
1929	6.8	10.4	19.8	49.6	5.8	7.6	—	Kalija sāls + superfosfāts Kalisalz — Superphosphat	1929
Caurmērs	19.2	24.9	15.0	17.1	3.9	19.9	—		

Pārskatamāki kļūst resultāti, kad iegūtos skaitļus sakopojam pēc atsevišķām augu grupām atsevišķos lauciņos dažādos gados un izceļam atsevišķu lauciņu caurmēra skaitļus par 9, resp., 7 gadiem.

Tauriņzieži. Schmetterlingsblütler.

	1921. g.	1922. g.	1923. g.	1924. g.	1925. g.	1926. g.	1927. g.	1928. g.	1929. g.		Caurmērs Durchschnitt
	%	%	%	%	%	%	%	%	%		%
1.	9.5	18.7	9.8	15.9	9.0	12.0	25.2	4.0	3.5	=	11.9
2.	13.5	41.0	17.0	23.2	19.1	19.1	24.2	8.6	11.8	=	19.7
3.	8.0	36.5	10.6	12.5	11.1	12.3	11.3	0.8	1.3	=	11.6
4.	8.0	20.1	7.0	7.9	5.8	12.5	8.5	1.4	1.5	=	8.1
5.	8.5	23.0	8.8	15.6	7.0	14.6	15.4	2.2	2.2	=	10.8
6.	18.0	53.7	29.4	21.6	15.4	28.7	45.5	3.7	7.7	=	24.8
7.	16.0	50.3	20.2	19.5	16.1	23.3	42.1	3.4	6.9	=	22.0
8.	18.5	46.0	21.3	13.6	10.7	19.5	30.6	3.8	5.5	=	18.8
9.	15.5	39.1	20.6	13.0	9.3	18.5	31.7	5.1	6.6	=	17.7
10.	16.0	43.7	26.7	11.6	9.0	15.3	27.9	8.4	6.9	=	18.4
11.	15.5	37.4	18.5	20.9	20.7	24.8	31.6	12.3	18.4	=	22.2
12.	13.5	37.3	11.9	11.0	10.2	14.5	24.7	3.0	5.9	=	14.7
13.	—	—	25.8	24.0	7.8	11.5	11.4	4.1	1.3	=	12.3
14.	—	—	18.6	14.6	13.3	10.7	14.7	3.1	2.1	=	11.0
15.	—	—	33.0	19.8	19.7	14.9	36.8	3.2	6.8	=	19.2

Labās stiebru zāles. Gute Gräser.

1.	14.3	10.8	7.7	15.4	15.8	13.7	9.3	18.5	10.8	=	12.9
2.	17.0	7.6	4.8	16.1	16.9	21.5	14.3	18.8	8.3	=	13.9
3.	15.2	4.5	11.4	13.5	20.2	17.4	13.0	17.8	6.9	=	13.3
4.	18.9	10.0	11.8	15.6	16.0	16.6	12.4	15.6	13.9	=	14.5
5.	19.7	10.8	11.9	17.5	17.7	15.9	12.8	17.5	10.0	=	15.0
6.	20.9	7.9	12.0	24.4	30.7	23.4	14.3	40.5	14.6	=	21.0
7.	16.6	8.5	14.6	18.0	18.2	28.9	16.8	22.3	11.2	=	17.2
8.	23.4	9.8	13.6	30.0	32.2	33.8	21.9	24.8	17.5	=	23.0
9.	22.4	15.7	18.3	37.7	44.6	39.0	23.6	34.1	23.4	=	28.7
10.	21.0	10.7	22.6	37.5	33.0	33.2	16.2	23.5	17.1	=	23.8
11.	21.7	10.9	12.9	20.3	19.6	22.9	15.9	22.8	14.7	=	17.9
12.	20.7	7.5	10.2	21.4	20.6	19.1	19.8	25.6	19.2	=	18.1
13.	—	—	12.0	21.9	25.5	30.8	20.0	21.2	12.8	=	20.6
14.	—	—	13.0	22.6	16.8	31.6	23.0	26.6	13.1	=	21.0
15.	—	—	13.4	25.7	25.5	39.0	20.6	39.7	10.4	=	24.9

Vidējās stiebru zāles. Mittelgute Gräser.

	1921. g.	1922. g.	1923. g.	1924. g.	1925. g.	1926. g.	1927. g.	1928. g.	1929. g.	Caurmērs Durchschnitt	
	%	%	%	%	%	%	%	%	%	%	
1.	18.2	13.6	20.4	8.7	13.2	13.5	16.5	**19.5**	**23.0**	=	16.3
2.	21.0	9.5	21.0	12.7	14.8	8.7	11.0	**29.1**	**28.7**	=	17.4
3.	24.3	7.3	19.2	18.8	16.9	23.7	20.9	36.5	23.9	=	21.3
4.	27.6	14.7	24.4	18.2	20.3	14.7	25.7	25.6	20.6	=	21.3
5.	27.8	15.0	16.5	18.6	22.4	21.0	20.1	22.4	21.1	=	20.5
6.	14.6	5.5	9.2	12.6	16.6	11.7	13.0	23.9	25.7	=	14.8
7.	18.9	9.6	11.8	21.7	22.7	12.1	13.5	30.3	24.5	=	18.3
8.	17.1	7.0	7.8	14.5	12.3	13.9	14.4	35.0	29.7	=	16.9
9.	11.6	8.5	5.3	13.5	14.2	9.4	15.4	30.7	25.5	=	14.9
10.	16.0	8.6	8.4	15.9	16.5	14.5	19.9	40.1	32.8	=	19.2
11.	16.8	8.4	6.8	9.4	13.3	11.9	14.4	21.4	22.7	=	13.9
12.	17.8	6.5	8.5	15.4	17.5	12.0	11.4	29.1	23.0	=	15.7
13.	—	—	11.2	12.8	19.9	8.8	16.9	28.3	20.2	=	16.9
14.	—	—	17.5	17.6	21.0	15.3	19.9	31.0	20.9	=	20.4
15.	—	—	8.4	16.2	10.8	8.7	13.5	28.0	19.8	=	15.0

Mazvērtīgās stiebru zāles. Minderwertige Gräser.

1.	11.5	7.7	11.3	7.9	13.2	20.3	19.5	26.8	35.4	=	17.2
2.	11.5	6.0	10.7	6.6	8.0	16.1	16.2	23.1	38.7	=	15.2
3.	15.5	6.5	7.9	7.5	7.8	16.2	25.1	26.8	56.8	=	18.9
4.	16.0	6.5	8.9	7.8	11.7	17.9	21.6	30.1	42.1	=	18.1
5.	12.5	10.3	16.2	8.3	12.2	12.6	22.4	38.4	50.3	=	20.4
6.	12.0	3.7	10.2	6.5	9.4	11.1	9.7	19.9	38.9	=	13.6
7.	12.5	3.1	6.5	7.8	13.2	11.0	13.3	25.1	46.7	=	15.5
8.	12.5	3.9	4.1	4.7	11.7	11.6	11.4	21.3	38.0	=	13.2
9.	10.5	1.6	5.0	5.9	5.3	9.3	10.0	17.9	31.9	=	10.8
10.	5.0	3.4	10.7	7.3	9.2	13.7	10.6	17.1	30.1	=	11.9
11.	4.5	3.5	6.2	4.9	11.0	10.2	9.6	15.5	31.6	=	10.8
12.	7.5	4.6	10.8	7.6	12.1	21.3	12.8	17.1	34.5	=	14.3
13.	—	—	13.1	8.8	9.5	9.8	17.0	23.0	48.8	=	18.6
14.	—	—	15.0	8.3	13.3	13.2	17.1	21.9	46.7	=	19.4
15.	—	—	7.7	6.0	12.9	15.0	10.0	18.6	49.6	=	17.1

Grīšļaugi. Riedgräser.

	1921. g.	1922. g.	1923. g.	1924. g.	1925. g.	1926. g.	1927. g.	1928. g.	1929. g.		Caurmērs Durchschnitt
	%	%	%	%	%	%	%	%	%	=	%
1.	8.0	4.4	3.3	4.0	2.3	1.5	1.7	3.3	8.4	=	4.1
2.	5.5	1.8	2.9	3.8	1.2	3.4	0.7	5.0	1.5	=	2.8
3.	7.0	5.2	2.1	4.5	3.0	1.8	1.3	2.6	1.6	=	3.2
4.	8.0	5.2	5.8	3.8	2.4	3.7	2.3	2.3	5.9	=	4.3
5.	7.5	5.3	1.7	5.3	3.8	6.0	3.8	5.2	7.5	=	5.1
6.	7.5	2.9	5.9	3.9	2.5	5.2	0.5	1.7	5.6	=	3.9
7.	10.0	2.3	5.0	2.3	2.3	2.0	2.4	3.7	2.3	=	3.6
8.	7.0	1.0	0.7	4.3	2.9	1.8	0.4	1.9	1.0	=	2.3
9.	7.0	2.6	0.3	1.2	1.7	3.1	1.4	0.1	0.6	=	2.0
10.	8.5	0.8	0.4	1.1	2.1	2.0	0.8	0.3	3.0	=	2.1
11.	7.5	1.6	2.4	1.8	1.3	3.8	0.5	4.6	1.8	=	2.8
12.	4.0	5.1	5.1	3.5	3.3	1.2	3.6	2.7	2.9	=	3.5
13.	—	—	3.7	10.0	0.9	1.9	1.7	3.3	4.0	=	3.6
14.	—	—	4.7	4.4	1.7	5.2	1.6	1.5	6.8	=	3.9
15.	—	—	6.4	3.8	1.3	5 3	3.0	1.5	5.8	=	3.9

Platlapji. Verschiedene Kräuter.

1.	35.5	44.8	46.5	47.8	46.3	38.0	27.8	27.9	18.8	=	37.0
2.	29.0	34.1	43.5	37.6	40.0	31.2	33.6	15.4	11.0	=	30.7
3.	28.5	40.0	48.8	43.2	41.0	28.6	28.4	15.5	9.5	=	31.5
4.	20.0	43.5	42.1	46.7	43.8	34.6	29.5	25.0	16.0	=	33.5
5.	22.5	35.6	44.9	34.7	36.9	29.9	25.5	14.3	8.9	=	28.0
6.	24.5	26.3	33.3	30.7	25.4	19.9	17.0	10.3	7.5	=	21.6
7.	22.0	26.2	41.9	30.5	27.3	22.7	11.9	15.2	8.4	=	22.9
8.	20.0	32.3	52.5	32.6	30.2	19.4	21.3	13.2	8.3	=	25.6
9.	28.0	32.5	50.5	28.6	24.9	20.7	17.9	12.1	12.0	=	25.3
10.	31.0	32.8	31.2	26.3	30.2	21.3	24.6	10 6	10.1	=	24.3
11.	31.5	38.2	53.2	42.7	34 1	26.4	28.0	23.4	10.6	=	32.1
12.	35.0	39.0	53.5	39.3	36.1	31.9	27.7	22.5	14.5	=	33.3
13.	—	—	34.2	22.5	36.4	37.2	33.0	20.1	12.9	=	28.0
14.	—	—	30.9	32.4	33.9	24.0	23.7	15.9	10.3	=	24.3
15.	—	—	31.1	28.5	29.8	17.1	16.1	9.0	7.6	=	19.9

No pēdējās tabulās sakopotiem skaitļiem izriet šādi slēdzieni:

I. Tauriņzieži:

a) Katrs mēslojums pirmos gados veicina tauriņziežu attīstīšanos.

b) Slāpekļa un kūtsmēsli turpmākos gados samazina tauriņziežus, kas sevišķi spilgti saskatāms, salīdzinot tabulas caurmēra skaitļus.

c) Viena pati kalijsāls ceļ tauriņziežu % ražā vairāk, kā cits kāds vienpusīgs mēslojums.

d) Vislabāko iespaidu uz tauriņziežu pieņemšanos ražā atstāj kalija-fōsforskābes mēslojums.

e) Kalija sāls, salīdzinot ar kainitu, šajā izmēģinājumā vairāk cēlusi tauriņziežu % ražā.

f) Čīles salpetris un sērskābais amonjaks, liekas, iedarbojas līdzīgi.

g) Tauriņziežu ārkārtējā samazināšanās 1928. un 1929. g. izskaidrojama ar nelabvēlīgiem laika apstākļiem.

II. Labās stiebru zāles:

a) Labās stiebru zāles pateicīgas par katru slāpekļa mēslojumu.

b) Čīles salpetris un sērskābais amonjaks iedarbojas līdzīgi.

c) Vienpusīgs mēslojums maz paceļ labo stiebru zāļu daudzumu ražā.

III. Vidējās stiebru zāles:

a) Vidējās stiebru zāles mazāk svārstās atkarībā no mēslojuma.

b) Vidējās stiebru zāles pieticīgākas un mazāk jūtīgas pret nelabvēlīgiem laika apstākļiem (1928. un 1929. g.).

c) Saskatāms, ka vidējām stiebru zālēm čīles salpetris patīkamāks par sērskābo amonjaku un kainīts par 40% kalijsāli.

IV. Mazvērtīgās stiebru zāles:

a) Mazvērtīgās stiebru zāles vēl vienaldzīgākas pret mēslojumu.

b) Neizdevīgos laika apstākļos mazvērtīgās stiebru zāles pieņemas uz labāko pļavu augu rēķina.

V. Grīšļaugi:

a) Izmēģinājumu lauciņos grīšļaugi maz izplatīti.

b) Pilnmēslojums (8., 9. un 10. lauc.) uz grīšļaugiem atstāj nelabvēlīgu iespaidu.

VI. Dažādi platlapji:

a) Platlapji izmēģinājumu pļavas augu sabiedrībā ieņem redzamu vietu.

b) Kuplāka platlapju attīstīšanās vērojama ar slāpekli un kūtsmēsliem mēslotos lauciņos.

c) Kalija-fosforskābes mēslojums platlapjus samazina.

Sporaugi, galvenā kārtā skostas, nav sevišķi izcelti, jo viņu ražā visai maz, un dažos gados tie pat iztrūkst. Ja dažos gados viņu it kā vairāk, vai tos sastopam atsevišķu lauciņu ražā, tad tas izskaidrojams ar pavasaŗa plūdu iespaidu: kad uzskalota smilts vai uz atsevišķa lauciņa radies nosērējums, tad tādās vietās skostas parasta parādība.

Tālāk seko apvienots caurmēra skaitļu sakopojums par 9, resp., 7 novērošanas gadiem: atsevišķu augu grupu (izņemot sporaugus) caurmēra skaitļi no dažādi mēslotiem lauciņiem, un vērtīgāko pirmo triju augu grupu procentu kopskaitļi.

Caurmēra skaitļi par 9 resp. 7 novērošanas gadiem
Die Durchschnittszahlen von 9 resp. 7 Jahren

	Tauriņzieži Schmetterlingsblütler	Labās stiebru zāles Gute Gräser	Vidējās stiebru zāles Mittelgute Gräser	Mazvērt. stiebru zāles Minderwertige Gräser	Grīšļaugi Riedgräser	Platlapji Verschiedene Kräuter	Pirmās 3 grupas kopā Die ersten 3 Gruppen zusammen
	%	%	%	%	%	%	%
1	11.9	12.9	16.3	17.2	4.1	37.0	41.1
2	19.7	13.9	17.4	15.2	2.8	30.7	51.0
3	11.6	13.3	21.3	18.9	3.2	31.5	46.2
4	8.1	14.5	21.3	18.1	4.3	33.5	43.9
5	10.8	15.0	20.5	20.4	5.1	28.0	46.3
6	24.8	21.0	14.8	13.6	3.9	21.6	60.6
7	22.0	17.2	18.3	15.5	3.6	22.9	57.5
8	18.8	23.0	16.9	13.2	2.3	25.6	58.7
9	17.7	28.7	14 9	10.8	2.0	25.3	61.3
10	18.4	23.8	19.2	11.9	2.1	24.3	61.4
11	22.2	17.9	13.9	10.8	2.8	32.1	54.0
12	14.7	18.1	15.7	14.3	3.5	33.3	48.5
13	12.3	20.6	16.9	18.6	3.6	28.0	49.8
14	11.0	21.0	20.4	19.4	3.9	24.3	52.4
15	19.2	24.9	15.0	17.1	3.9	19.9	59.1

Atzīmētie skaitļi apstiprina un pat papildina to, kas iepriekš teikts par dažādu mēslu iespaidu uz augu sabiedrības vienas vai otras grupas attīstību, jo saskaitot vērtīgāko grupu skaitļus, redzam, ka šo grupu augu daudzums svārstās no 41,1—61,4%.

Ražas botaniskais sastāvs, raksturojot viņu procentos, stipri mainās atkarībā no mēslojuma un jau it skaidri liecina par zināmai pļavai noderīgako mēslojumu. Tomēr nevar būt bez intereses arī dažādu augu grupu absolūtais svars ražā, jo, ražām mainoties pēc svara, ne vienmēr procentos izteiktais skaitlis jau liecina par šās augu grupas pieņemšanos vai samazināšanos noteiktos svara skaitļos uz zināmas platības vienības.

Turpmākās tabulās sakopoti skaitļi par dažādu grupu augu svaru kilogramos uz 1 āra pa atsevišķiem izmēģinājuma gadiem. Šajās tabulās, salīdzinot zināmas grupas svara skaitļus, saskatāmās atšķirības izskaidrojamas ar mēslojuma iespaidu.

Dažādu augu grupu absolūtais svars atkarībā no mēslojuma no 1 āra pēc gadiem

Das Gewicht einzelner Pflanzengruppen in Abhängigkeit von der Düngung pro Ar nach Jahren

1921. gads	Tauriņzieži Schmetterlingsblütler	Stiebru zāles Gramineen			Grīšļaugi Riedgräser	Platlapji Kräuter	Sporaugi Sporenpflanzen	Kopā S-ma
		labās gute	vidējās mittelgute	mazvērt. minderwertige				
	kg	kg	kg	kg	kg	kg	kg	kg
1	2.4	3.6	4.4	2.8	2.0	8.7	0.7	24.6
2	4.4	5.5	6.7	3.7	1.8	9.3	0.8	33.2
3	2.3	4.4	7.0	4.3	2.0	8.2	0.5	28.7
4	2.0	5.1	6.7	4.1	2.0	5.1	0.4	25.4
5	2.5	5.8	8.3	3.8	2.2	6.8	0.5	29.9
6	5.9	6.8	4.8	4.0	2.5	8.0	0.8	32.8
7	5.5	5.7	6.5	4.3	3.4	7.6	1.4	34.4
8	6.7	8.4	6.2	4.5	2.5	7.2	0.5	36.0
9	5.6	8.0	4.2	3.8	2.5	10.1	1.8	36.0
10	5.2	6.8	5.2	1.6	2.7	10.0	0.8	32.3
11	4.9	6.9	5.4	1.4	2.4	10.1	0.8	31.9
12	4.2	6.5	5.5	2.3	1.2	10.9	0.5	31.1
1922. g.								
1	4.8	2.8	3.5	2.0	1.1	11.6	—	25.8
2	15.5	2.9	3.5	2.3	0.7	12.8	—	37.7
3	10.6	1.3	2.1	1.9	1.5	11.7	—	29.1
4	6.5	3.2	4.8	2.1	1.7	14.0	—	32.3
5	6.6	3.1	4.3	3.0	1.5	10.2	—	28.7
6	24.5	3.6	2.5	1.7	1.3	12.0	—	45.6
7	20.6	3.5	3.9	1.3	1.0	10.7	—	41.0
8	23.4	5.0	3.5	2.0	0.5	16.4	—	50.8
9	18.6	7.5	4.0	0.8	1.3	15.3	—	47.5
10	21.9	5.3	4.3	1.7	0.4	16.4	—	50.0
11	13.5	3.9	3.0	1.3	0.6	13.7	—	36.0
12	15.0	3.0	2.6	1.9	2.0	15.6	—	40.1
1923. g.								
1	2.3	1.8	4.8	2.6	0.8	10.8	0.2	23.3
2	6.5	1.9	8.1	4.1	1.1	16.8	—	38.5
3	2.8	3.0	5.0	2.1	0.5	12 8	—	26.2
4	2.2	3.6	7.5	2.7	1.8	12.9	—	30.7
5	2.4	3.2	4.5	4.4	0.4	12.1	—	27.0
6	13.9	5.7	4.4	4.9	2.8	15.8	—	47.5
7	8.9	6.5	5.2	2.9	2.2	18.5	—	44.2
8	12.0	7.6	4.4	2.3	0.4	29.4	—	56.1
9	10.0	8.9	2.6	2.4	0.2	24.5	—	48.6
10	14.6	12.3	4.6	5.8	0.2	17.0	—	54.5
11	7.8	5.5	2.8	2.6	1.0	22.5	—	42.5
12	5.5	4.7	3.9	4.9	2.4	24.5	—	45.9
13	8.7	4.0	3.8	4.4	1.2	11.5	—	33.6
14	5.3	3.8	5.0	4.3	1.4	8.9	—	28.7
15	8.9	3.6	2.3	2.1	1.7	8.4	—	27.0

1924. gads	Tauriņzieži Schmetterlingsblütler	Stiebru zāles Gramineen			Grīšļaugi Riedgräser	Platlapji Kräuter	Sporaugi Sporenpflanzen	Kopā S-ma
		labās gute	vidējās mittelgute	mazvērt. minderwertige				
	kg	kg	kg	kg	kg	kg	kg	kg
1	4.5	4.4	2.5	2.2	1.2	13.4	0.1	28.3
2	8.7	6.1	4.8	2.5	1.4	14.2	—	37.7
3	3.8	4.1	5.8	2.3	1.4	13.3	—	30.7
4	2.6	5.1	6.0	2.6	1.2	15.3	—	32.8
5	4.7	5.3	5.7	2.5	1.6	10.5	—	30.3
6	9.9	11.2	5.8	3.0	1.8	14.1	0.1	45.9
7	9.2	8.4	10.1	3.6	1.1	14.2	0.1	46.7
8	7.4	16.4	7.9	2.5	2.3	17.8	0.2	54.5
9	6.7	19.4	6.9	3.1	0.6	14.8	0.1	51.6
10	6.3	20.3	8.6	3.9	0.6	14.2	0.2	54.1
11	9.1	8.9	4.1	2.2	0.8	18.7	—	43.8
12	4.3	8.3	5.9	2.9	1.3	15.1	0.7	38.5
13	8.6	7.9	4.7	3.1	3.6	8.1	—	36.0
14	5.1	8.0	6.2	2.9	1.6	11.4	—	35.2
15	6.6	8.5	5.3	2.0	1.2	9.4	—	33.2
1925. g.								
1	2.2	3.9	3.2	3.2	0.5	11.3	0.1	24.4
2	6.7	5.9	5.2	2.8	0.4	13.8	—	34.8
3	2.9	5.4	4.5	2.1	0.8	10.9	—	20.6
4	1.5	4.2	5.4	3.1	0.6	11.6	—	26.4
5	1.7	4.4	5.5	3.0	0.9	9.1	—	24.6
6	6.4	12.9	7.0	3.9	1.1	10.7	—	42.0
7	6.8	7.7	9.6	5.6	0.9	11.5	0.1	42.2
8	4.5	13.5	5.1	4.9	1.2	12.6	—	41.8
9	4.5	21.4	6.8	2.5	0.8	11.9	—	47.9
10	3.9	14.3	7.2	4.0	0.9	13.1	—	43.4
11	7.8	7.4	5.0	4.1	0.5	12.9	—	37.7
12	3.0	6.1	5.2	3.5	1.0	10.6	0.1	29.5
13	3.0	9.8	7.6	3.6	0.4	13.9	—	38.3
14	5.0	6.3	7.9	5.0	0.6	12.7	—	37.5
15	7.9	10.2	4.3	5.2	0.5	12.0	—	40.1
1926. g.								
1	3.4	3.9	3.8	5.8	0.4	10.8	0.3	28.4
2	6.4	7.2	2.9	5.4	1.2	10.5	—	33.6
3	3.7	5.3	7.2	4.9	0.5	8.7	—	30.3
4	3.8	5.0	4.5	5.5	1.1	10.6	—	30.5
5	4.2	4.5	6.0	3.6	1.7	8.5	—	28.5
6	13.1	10.7	5.3	5.1	2.4	9.1	—	45.7
7	9.9	12.2	5.1	4.7	0.9	9.6	—	42.4
8	9.8	16.9	7.1	5.8	0.9	9.7	—	50.2
9	9.4	19.8	4.8	4.7	1.6	10.5	—	50.8
10	7.1	15.3	6.7	6.3	0.9	9.8	—	46.1
11	10.4	9.6	5.0	4.2	1.6	11.0	—	41.8
12	4.7	6.2	3.9	6.9	0.4	10.4	—	32.5
13	4.6	12.4	3.6	3.9	0.7	14.9	—	40.1
14	4.0	11.8	5.8	4.9	1.9	8.9	—	37.3
15	6.7	17.5	3.9	6.7	2.3	7.7	—	44.8

1927. gads	Taurinzieži Schmetterlingsblütler kg	Stiebru zāles Gramineen: labās gute kg	vidējās mittelgute kg	mazvērt. minderwertige kg	Grīšļaugi Riedgräser kg	Platlapji Kräuter kg	Sporaugi Sporenpflanzen kg	Kopā S-ma kg
1	5.0	1.8	3.2	3.8	0.3	5.5	—	19.6
2	5.7	3.3	2.7	3.8	0.1	7.9	—	23.5
3	2.5	2.9	4.6	5.5	0.3	6.3	—	22.1
4	1.7	2.5	5.2	4.3	0.5	6.0	—	20.2
5	3.0	2.4	3.9	4.3	0.7	4.9	—	19.2
6	17.6	5.5	5.0	3.8	0.2	6.6	—	38.7
7	14.8	5.9	4.8	4.6	0.9	4.2	—	35.2
8	13.1	9.4	6.2	4.9	0.2	9.1	—	42.9
9	13.5	10.0	6.6	4.3	0.6	7.6	—	42.6
10	10.9	6.4	7.8	4.1	0.3	9.7	—	39.2
11	10.5	5.3	4.8	3.2	0.2	9.3	—	33.3
12	8.7	7.0	4.1	4.5	1.3	9.8	—	35.4
13	3.1	5.5	4.6	4.6	0.5	9.0	—	27.3
14	4.2	6.6	5.7	5.0	0.5	6.8	—	28.8
15	10.0	5.6	3.7	2.7	0.8	4.4	—	27.2
1928. g.								
1	0.7	3.2	3.4	4.7	0.6	4.9	—	17.5
2	1.6	3.5	5.5	4.3	0.9	2.9	—	18.7
3	0.1	3.2	6.5	4.7	0.5	2.7	—	17.7
4	0.3	2.8	4.7	5.5	0.4	4.5	—	18.2
5	0.4	2.9	3.7	6.4	0.9	2.4	—	16.7
6	1.2	13.6	8.0	6 7	0.6	3.4	—	33.5
7	1.1	7.3	9.9	8.2	1.2	5.0	—	32.7
8	1.6	10.4	14.7	9.0	0.8	5.5	—	42.0
9	2.3	15.1	13.6	7.7	0.1	5.4	—	44.2
10	3.0	8.3	14.1	6.0	0.1	3.7	—	35.2
11	3.9	7.1	6.7	4.8	1.4	7.3	—	31 2
12	1.0	8.9	10.1	5.9	1.0	7.8	—	34.7
13	1.2	6.4	8.5	6.9	1.0	6.0	—	30.0
14	0.8	6.6	7.7	5.5	0.4	4.0	—	25.0
15	1.0	12.9	9.1	6.1	0.5	2.9	—	32.5
1929. g.								
1	0.7	2.3	4.8	7.4	1.8	4.0	—	21.0
2	3.1	2.2	7.7	10.3	0.4	3.0	—	26.7
3	0.4	2.0	6.8	16.2	0.4	3.0	—	28.5
4	0.4	3.6	5.3	10.8	1.5	4.1	—	25.7
5	0.5	2.2	4.7	11.2	1.6	2.0	—	22.2
6	3.2	6.0	10.5	15.9	2.3	3.1	—	41.0
7	2.6	4.1	9.2	17.5	0.9	3.2	—	37.5
8	2.6	8.3	14.0	17.9	0.5	3.9	—	47.2
9	3.3	11.6	12.6	15.8	0.3	5.9	—	49.5
10	3.2	7.9	15.1	13.9	1.4	4.7	—	46.2
11	7.0	5.6	8.6	12.0	0.7	4.0	0.1	38.0
12	2.3	7.4	8.8	13.3	1.1	5.6	—	38.5
13	0.3	3.3	5.3	12.7	1.0	3.4	—	26.0
14	0.6	3 5	5.7	12.6	1.8	2.8	—	27.0
15	2.3	3.5	6.6	16.6	1.9	2.6	—	33.5

Ražas svara skaitļi, sakārtoti pēc augu grupām no atsevišķiem lauciņiem par visu izmēģinājumu laiku, dod iespēju nevien salīdzināt atsevišķu grupu svaru pa gadiem, bet aprēķināt arī caurmēra skaitļus katram lauciņam.

Dažādu augu grupu absolūtais svars siena ražā no 1 āra pēc lauciņiem.

Das Gewicht einzelner Pflauzengruppen pro Ar nach Parzellen.

		Tauriņzieži Schmetterlingsblütler kg	Stiebru zāles Gramineen			Grīšļaugi Riedgräser kg	Platlapji Kräuter kg	Sporaugi Sporenpflanzen kg
			labās gute kg	vidējās mittelgute kg	mazvērt. minderwertige kg			
1. Nemēslots Ungedüngt	1921	2.4	3.6	4.4	2.8	2.0	8.7	0.7
	1922	4.8	2.9	3.4	2.0	1.1	11.6	—
	1923	2.3	1.8	4.8	2.6	0.8	10.8	0.2
	1924	4.5	4.4	2.5	2.2	1.2	13.4	0.1
	1925	2.2	3.9	3.2	3.2	0.5	11.3	0.1
	1926	3.4	3.9	3.8	5.8	0.4	10.8	0.3
	1927	5.0	1.8	3.2	3.8	0.3	5.5	—
	1928	0.7	3.2	3.4	4.7	0.6	4.9	—
	1929	0.7	2.3	4.8	7.4	1.8	4.0	—
	Caurmērs	2.9	3.1	3.7	3.8	1.0	9.0	0.15
2. Kalijsāls Kalisalz	1921	4.4	5.5	6.7	3.7	1.8	9.3	0.8
	1922	15.5	2.9	3.5	2.3	0.7	12.8	—
	1923	6.5	1.9	8.1	4.1	1.1	16.8	—
	1924	8.7	6.1	4.8	2.5	1.4	14.2	—
	1925	6.7	5.9	5.2	2.8	0.4	13.8	—
	1926	6.4	7.2	2.9	5.4	1.2	10.5	—
	1927	5.7	3.3	2.7	3.8	0.1	7.9	—
	1928	1.6	3.5	5.5	4.3	0.9	2.9	—
	1929	3.1	2.2	7.7	10.3	0.4	3.0	—
	Caurmērs	6.5	4.3	5.2	4.4	0.9	10.1	0.1
3. Tomasmilti Thomasmehl	1921	2.3	4.4	7.0	4.3	2.0	8.2	0.5
	1922	10.6	1.3	2.1	1.9	1.5	11.7	—
	1923	2.8	3.0	5.0	2.1	0.5	12.8	—
	1924	3.8	4.1	5.8	2.3	1.4	13.3	—
	1925	2.9	5.4	4.5	2.1	0.8	10.9	—
	1926	3.7	5.2	7.2	4.9	0.5	8.7	—
	1927	2.5	2.9	4.6	5.5	0.3	6.3	—
	1928	0.1	3.2	6.5	4.7	0.5	2.7	—
	1929	0.4	2.0	6.8	16.2	0.4	3.0	—
	Caurmērs	3.3	3.5	5.5	4.9	0.9	8.4	0.1

			Tauriņzieži Schmetterlingsblütler	Stiebru zāles Gramineen			Grīšļauģi Riedgräser	Platlapji Kräuter	Sporaugi Sporenpflanzen
				labās gute	vidējās mittelgute	mazvērt. minderwertige			
			kg	kg	kg	kg	kg	kg	kg
4. Čīles zalpetris Chilesalpeter		1921.	2.0	5.1	6.7	4.1	2.0	5.1	0.4
		1922.	6.5	3.2	4.8	2.1	1.7	14.0	—
		1923.	2.2	3.6	7.5	2.7	1.8	12.9	—
		1924.	2.6	5.1	6.0	2.6	1.2	15.3	—
		1925.	1.5	4.2	5.4	3.1	0.6	11.6	—
		1926.	3.8	5.1	4.5	5.5	1.1	10.6	—
		1927.	1.7	2.5	5.2	4.3	0.5	6.0	—
		1928.	0.3	2.8	4.7	5.5	0.4	4.5	—
		1929.	0.4	3.6	5.3	10.8	1.5	4.1	—
		Caurmērs	2.3	3.9	5.6	4.5	1.2	9.3	0.04
5. Kalķis Kalk		1921.	2.5	5.8	8.3	3.8	2.2	6.8	0.5
		1922.	6.6	3.1	4.3	3.0	1.5	10.2	—
		1923.	2.4	3.2	4.5	4.4	0.4	12.1	—
		1924.	4.7	5.3	5.7	2.5	1.6	10.5	—
		1925.	1.7	4.4	5.5	3.0	0.9	9.1	—
		1926.	4.1	4.5	6.0	3.6	1.7	8.5	—
		1927.	3.0	2.4	3.9	4.3	0.7	4.9	—
		1928.	0.4	2.9	3.7	6.4	0.9	2.4	—
		1929.	0.5	2.2	4.7	11.2	1.6	2.0	—
		Caurmērs	2.9	3.7	5.2	4.7	1.3	7.4	0.05
6. Kalijsāls-tomasmilti Kalisalz-Thomasmehl		1921.	5.9	6.8	4.8	4.0	2.5	8.0	0.8
		1922.	24.5	3.6	2.5	1.7	1.3	12.0	—
		1923.	13.9	5.7	4.4	4.9	2.8	15.8	—
		1924.	9.9	11.2	5.8	3.0	1.8	14.1	0.1
		1925.	6.4	12.9	7.0	3.9	1.1	10.7	—
		1926.	13.1	10.7	5.3	5.1	2.4	9.1	—
		1927.	17.6	5.5	5.0	3.8	0.2	6.6	—
		1928.	1.2	13.6	8.0	6.7	0.6	3.4	—
		1929.	3.2	6.0	10.5	15.9	2.3	3.1	—
		Caurmērs	10.6	8.4	5.9	5.4	1.7	9.2	0.10
7. Kainīts-tomasmilti Kainit-Thomasmehl		1921.	5.5	5.7	6.5	4.3	3.4	7.6	1.4
		1922.	20.6	3.5	3.9	1.3	1.0	10.7	—
		1923.	8.9	6.5	5.2	2.9	2.2	18.5	—
		1924.	9.2	8.4	10.1	3.6	1.1	14.2	0.1
		1925.	6.8	7.7	9.6	5.6	0.9	11.5	0.1
		1926.	9.9	12.2	5.1	4.7	0.9	9.6	—
		1927.	14.8	5.9	4.8	4.6	0.9	4.2	—
		1928.	1.1	7.3	9.9	8.2	1.2	5.0	—
		1929.	2.6	4.1	9.2	17.5	0.9	3.2	—
		Caurmērs	8.8	6.8	7.1	5.9	1.4	9.3	0.20

			Tauriņzieži Schmetterlingsblütler	Stiebru zāles Gramineen			Grīšlaugi Riedgräser	Platlapji Kräuter	Sporaugi Sporenpflanzen
				labās gūte	vidējās mittelgute	mazvērt. minderwertige			
			kg	kg	kg	kg	kg	kg	kg
8. Kalijsāls-tomasmilti-Cīles zalp. Kalisalz-Thomasmehl-Chilesalpeter		1921.	6.7	8.4	6.2	4.5	2.5	7.2	0.5
		1922.	23.4	5.0	3.5	2.0	0.5	16.4	—
		1923.	12.0	7.6	4.4	2.3	0.4	29.4	—
		1924.	7.4	16.4	7.9	2.5	2.3	17.8	0.2
		1925.	4.5	13.5	5.1	4.9	1.2	12.6	—
		1926.	9.8	16.9	7.1	5.8	0.9	9.7	—
		1927.	13.1	9.4	6.2	4.9	0.2	9.1	—
		1928.	1.6	10.4	14.7	9.0	0.8	5.5	—
		1929.	2.6	8.3	14.0	17.9	0.5	3.9	—
		Caurmērs	9.0	10.6	7.7	6.0	1.0	12.4	0.08
9. Kalijsāls-tom. m.-sērskāb. am. Kalisalz-Thomasm.-schwefels. Am.		1921.	5.6	8.0	4.2	3.8	2.5	10.1	1.8
		1922.	18.6	7.5	4.0	0.8	1.3	15.3	—
		1923.	10.0	8.9	2.6	2.4	0.2	24.5	—
		1924.	6.7	19.4	6.9	3.1	0.6	14.8	0.1
		1925.	4.5	21.4	6.8	2.5	0.8	11.9	—
		1926.	9.4	19.8	4.8	4.7	1.6	10.5	—
		1927.	13.5	10.0	6.6	4.3	0.6	7.6	—
		1928.	2.3	15.1	13.6	7.7	0.1	5.4	—
		1929.	3.3	11.6	12.6	15.8	0.3	5.9	—
		Caurmērs	8.2	13.5	6.9	5.0	0.9	11.8	0.2
10. Līdzīgi 8 + kaļķis Gleich 8 + Kalk		1921.	5.2	6.8	5.2	1.6	2.7	10.0	0.8
		1922.	21.9	5.3	4.3	1.7	0.4	16.4	—
		1923.	14.6	12.3	4.6	5.8	0.2	17.0	—
		1924.	6.3	20.3	8.6	3.9	0.6	14.2	0.2
		1925.	3.9	14.3	7.2	4.0	0.9	13.2	—
		1926.	7.1	15.3	6.7	6.3	0.9	9.8	—
		1927.	10.9	6.4	7.8	4.1	0.3	9.7	—
		1928.	3.0	8.3	14.1	6.0	0.1	3.7	—
		1929.	3.2	7.9	15.1	13.9	1.4	4.7	—
		Caurmērs	8.4	10.8	8.2	5.2	0.8	10.9	0.1
11. Kalijsāls-kaulu milti Kalisalz-Knochenmehl		1921.	4.9	6.9	5.4	1.4	2.4	10.1	0.8
		1922.	13.5	3.9	3.0	1.3	0.6	13.7	—
		1923	7.8	5.5	2.8	2.6	1.0	22.5	—
		1924.	9.1	8.9	4.1	2.2	0.8	18.7	—
		1925.	7.8	7.4	5.0	4.1	0.5	12.9	—
		1926.	10.4	9.6	5.0	4.2	1.6	11.0	—
		1927.	10.5	5.3	4.8	3.2	0.2	9.3	—
		1928.	3.9	7.1	6.7	4.8	1.4	7.3	—
		1929.	7.0	5.6	8.6	12.0	0.7	4.0	0.1
		Caurmērs	8.3	6.7	5.0	4.0	1.0	12.2	0.1

			Tauriņzieži Schmetterlingsblütler	Stiebru zāles Gramineen			Grīšļaugi Riedgräser	Platlapji Kräuter	Sporaugi Sporenpflanzen
				labās gute	vidējās mittelgute	mazvērt. minderwertige			
			kg	kg	kg	kg	kg	kg	kg
12. Kūtsmēsli Stallmist		1921.	4.2	6.5	5.5	2.3	1.2	10.9	0.5
		1922.	15.0	3.0	2.6	1.9	2.0	15.6	—
		1923.	5.5	4.7	3.9	4.9	2.4	24.5	—
		1924.	4.3	8.3	5.9	2.9	1.3	15.1	0.7
		1925.	3.0	6.1	5.2	3.5	1.0	10.6	0.1
		1926.	4.7	6.2	3.9	6.9	0.4	10.4	—
		1927.	8.7	7.0	4.1	4.5	1.3	9.8	—
		1928.	1.0	8.9	10.1	5.9	1.0	7.8	—
		1929.	2.3	7.4	8.8	13.3	1.1	5.6	—
13.		Caurmērs	5.4	6.5	5.5	5.1	1.3	12.3	0.13
Kalijsāls-sērskāb. amonj. Kalisalz-schwefels. Ammon.		1921.	—	—	—	—	—	—	—
		1922.	—	—	—	—	—	—	—
		1923.	8.7	4.0	3.8	4.4	1.2	11.5	—
		1924.	8.6	7.9	4.7	3.1	3.6	8.1	—
		1925.	3.0	9.8	7.6	3.6	0.4	13.9	—
		1926.	4.6	12.4	3.6	3.9	0.7	14.9	—
		1927.	3.1	5.5	4.6	4.6	0.5	9.0	—
		1928.	1.2	6.4	8.5	6.9	1.0	6.0	—
		1929.	0.3	3.3	5.3	12.7	1.0	3.4	—
14.		Caurmērs	4.2	6.8	5.4	5.6	1.2	9.5	—
Kalijsāls-Čīles zalpetris Kalisalz-Chilesalpeter		1921.	—	—	—	—	—	—	—
		1922.	—	—	—	—	—	—	—
		1923.	5.3	3.8	5.0	4.3	1.4	8.9	—
		1924.	5.1	8.0	6.2	2.9	1.6	11.4	—
		1925.	5.0	6.3	7.9	5.0	0.6	12.7	—
		1926.	4.0	11.8	5.8	4.9	1.9	8.9	—
		1927.	4.2	6.6	5.7	5.0	0.5	6.8	—
		1928.	0.8	6.6	7.7	5.5	0.4	4.0	—
		1929.	0.6	3.5	5.7	12.6	1.8	2.8	—
15.		Caurmērs	3.6	6.7	6.3	5.7	1.2	7.9	—
Kalijsāls-superfosfāts Kalisalz-Superphosphat		1921.	—	—	—	—	—	—	—
		1922.	—	—	—	—	—	—	—
		1923.	8.9	3.6	2.3	2.1	1.7	8.4	—
		1924.	6.6	8.5	5.3	2.0	1.2	9.4	—
		1925.	7.9	10.2	4.3	5.2	0.5	12.0	—
		1926.	6.7	17.5	3.9	6.7	2.3	7.7	—
		1927.	10.0	5.6	3.7	2.7	0.8	4.4	—
		1928.	1.0	12.9	9.1	6.1	0.5	2.9	—
		1929.	2.3	3.5	6.6	16.6	1.9	2.6	—
		Caurmērs	6.2	8.8	5.0	5.9	1.2	6.7	—

Salīdzinot atsevišķu lauciņu caurmēra skaitļus, redzam atšķirības, kas kļūst spilgtākas, kad šos caurmēra skaitļus apvienojam īpašā tabulā

Dažādu augu grupu caurmēra svars ražā no 1 āra.
Das Durchschnittsgewicht einzelner Pflanzengruppen pro Ar.

	Tauriņzieži Schmetterlingsblütler	Labās stiebru zāles Gute Gräser	Vidējās stiebru zāles Mittelgute Gräser	Mazvērt. stiebru zāles Minderwertige Gräser	Grīšļaugi Riedgräser	Platlapji Kräuter	Sporaugi Sporenpflanzen
	kg	kg	kg	kg	kg	kg	kg
1.	2.9	3.1	3.7	3.8	1.0	9.0	0.15
2.	6.5	4.3	5.2	4.4	0.9	10.1	0.10
3.	3.3	3.5	5.5	4.9	0.9	8.4	0.10
4.	2.3	3.9	5.6	4.5	1.2	9.3	0.04
5.	2.9	3.7	5.2	4.7	1.3	7.4	0.05
6.	10.6	8.4	5.9	5.4	1.7	9.2	0.10
7.	8.8	6.8	7.1	5.9	1.4	9.3	0.20
8.	9.0	10.6	7.7	6.0	1.0	12.4	0.08
9.	8.2	13.5	6.9	5.0	0.9	11.8	0.20
10.	8.4	10.8	8.2	5.2	0.8	10.9	0.10
11.	8.3	6.7	5.0	4.0	1.0	12.2	0.10
12.	5.4	6.5	5.5	5.1	1.3	12.3	0.13
13.	4.2	6.8	5.4	5.6	1.2	9.5	—
14.	3.6	6.7	6.3	5.7	1.2	7.9	—
15.	6.2	8.8	5.0	5.9	1.2	6.7	—

Šajā tabulā mēs redzam, ka lielāks tauriņziežu caurmēra svars no 1 āra sasniegts 6. lauciņā, kas dabūjis 40% kalijsāls un tomasmiltu mēslojumu. Vispār kalija un fosforskābes mēsli vairo tauriņziežus, un pēdējie pārāk nesamazinās arī tajos lauciņos, kas dabūjuši slāpekļa mēslus. Salīdzinot 6. un 7. lauciņa ražas skaitļus, zīmējoties uz tau-

riņziežiem, vērojam kalijsāls pārākumu par kainitu. Atsaucīgākas uz pilnīgāku mēslojumu labās stiebru zāles, viņām seko vidējās stiebru zāles. Mazvērtīgās stiebru zāles mazāk reaģē; visai niecīgām maiņām padoti grīšļaugi. Pēdējie pilnīgi neizzūd, bet arī nepieņemas, izņemot dažus nelabvēlīgus gadus, kad laika apstākļu dēļ labākie augi vājāk attīstījušies. Arī platlapji visai daudz nemainās, tomēr 8., 9., 10., 11. un 12. lauciņā viņi vairojušies arī pēc svara zem mēslojuma īpatnēja iespaida.

Turpmākās tabulās atzīmēti izmēģinājuma lauciņos sastopamie augi; dažādu augu daudzums dažādās augu grupās noteikts pēc acumēra pie analizes, lietojot 10 punktu sistēmu.

Sakopotās ziņas rāda, ka daži augi izmēģinājumu pļavā ir pastāvīgi augu sabiedrības locekļi; citiem augiem turpretī, atkarībā no laika vai citiem apstākļiem, gadījuma raksturs.

	1923.	1924.	1925.	1926.	1927.	1928.	1929.	1923.	1924.	1925.	1926.	1927.	1928.	1929.
	1. lauciņš I. Parzelle							2. lauciņš II. Parzelle						
Sarkanais āboliņš — Trifolium pratense	5	4,5	4	4	2,5	5		9	4	7,5	4	3	2	4
Baltais āboliņš — Trifolium repens	+	+	0,5	+	+	+		+	+	+	0,5	+	+	+
Dedestiņi — Lathyrus pratensis	4	5	4	4	6	4		1	4,5	1,5	3,5	2,5	4	3,5
Vanagzirņi — Vicia cracca	1	0,5	1,5	2	1,5	1		—	+	1	2	4,5	4	2,5
Vanagnadziņi — Lotus corniculatus	+	—	—	—	—	—		—	1,5	—	—	—	—	—
Pļavas auzene — Festuca pratensis	2	2	2,5	4	7	2,5		2	2	2	3	2,5	3,5	3
Timotiņš — Phleum pratense	+	1,5	+	0,5	1,5	—		3	1	1	+	1	2	0,5
Pļavas skarene — Poa pratensis	2	5	4	3	0,5	2		2	1,5	6	3,5	3,5	2	2,5
Parastā skarene — Poa trivialis	6	1,5	3,5	2,5	1	4		3	5	1	3,5	3	2,5	3
Baltā smilga — Agrostis alba	+	—	—	—	+	1,5		+	0,5	—	—	—	+	1
Sarkanā auzene — Festuca rubra	7,5	7	9	5	5	8		10	8,5	7	9	6	4,5	9
Trisuļi — Briza media	2,5	3	1	5	5	2		+	1,5	3	1	4	5,5	1
Ciņu zāle — Aira caespitosa	8	3	4,5	5	3,5	8		10	7,5	3	9	3,5	5	9,5
Zaķu auza — Avena pubescens	2	7	5,5	5	6,5	2		+	2,5	7	1	6,5	5	0,5
Grīšļaugi — Carex spec.	+	+	+	+	+	+		+	+	+	+	+	+	+
Dzeltenes — Centaurea jacea	2	1,5	0,5	1,5	0,5	—		0,5	2	2,5	3	0,5	1	0,5
Skābenes — Rumex acetosa	1	2	1	1,5	0,5	1,5		1,5	2,5	2	1	2,5	—	—
Bitenes — Geum rivale	0,5	1	0,5	0,5	0,5	0,5		+	0,5	0,5	+	1	1	—
Ķimenes — Carum carvi	1	1	2,5	1,5	2,5	+		1,5	1	1,5	3	1,5	2,5	1,5
Madaras — Galium mollugo	1	1	4	1	1,5	3		2	1	1	0,5	2,5	1,5	2
Rasas krēsliņš — Alchemilla vulgaris	0,5	+	+	+	0,5	+		+	+	+	+	+	1	0,5
Radzene — Cerastium triviale	1	+	—	0,5	0,5	0,5		+	—	+	—	+	0,5	+
Pļavas mauragas — Hieracium pratense	0.5	+	+	—	—	0,5		—	0,5	—	+	+	—	0,5
Pienenes — Taraxacum officinale	1	0,5	+	0,5	+	+		1,5	0,5	+	+	+	+	0,5
Pļavas ķērsa — Cardamine pratensis	+	+	—	—	—	0,5		—	—	—	—	+	—	—
Kodīgā gundega — Ranunculus acer	1,5	2,5	1	0.5	0,5	2,5		0,5	1,5	2,5	2,5	0,5	+	2
Purva madaras — Galium palustre	—	—	+	+	0,5	—		—	—	—	—	+	—	—
Dzegužzes puķe (sveķenes) — Lychnis flos cuculis	—	+	+	+	1,5	0,5		—	+	+	—	0,5	1	—
Pēteņa puķe — Campanula glomerata	—	—	0,5	—	+	+		1	0,5	—	+	+	—	0,5
Vidriekši — Sium latifolium	—	—	—	2	0,5	—		1	—	—	—	0,5	1,5	0,5
Retēji — Potentilla tormentilla	—	—	—	—	—	—		—	—	—	—	—	—	—
Baltvēdere — Potentilla anserina	—	—	—	—	—	—		—	—	—	—	—	—	—
Deguma zāle — Lysimachia nummullaria	—	+	+	+	+	—		—	—	—	+	+	+	+
Zaļšu zāle — Polygonum bistorta	—	0,5	—	—	0,5	0,5		—	+	—	—	—	—	1
Sierene — Thalictrum flavum	—	—	—	—	—	—		—	—	—	—	0,5	—	—
Baltā puķe — Chrisanthemum leucant.	—	—	—	—	—	—		0,5	—	—	—	—	—	—
Vīgrieznes — Ulmaria pentapetala	—	+	—	0,5	—	—		—	—	—	—	+	+	+
Pļavas naudulis — Alectrolophus major	—	—	—	—	—	—		—	—	—	—	—	—	—
Brūngalvīte — Brunella vulgaris	—	—	+	—	—	—		—	—	—	+	—	—	0,5
Ziepene — Polygala amara	—	—	—	+	—	—		—	—	—	—	—	—	—
Jāņa zāle — Galium boreale	—	—	—	—	—	—		—	—	—	—	—	—	—
Skostas — Equisetum spec.	—	+	—	—	—	—		—	—	—	—	—	—	—
Sugu skaits — Artenzahl	26	29	27	28	29	26		25	27	23	25	31	26	28

	1923.	1924.	1925.	1926.	1927.	1928.	1929.	1923.	1924.	1925.	1926.	1927.	1928.	1929.
	3. lauciņš III. Parzelle							4. lauciņš IV. Parzelle						
Sarkanais āboliņš — Trifolium pratense	1	3	3,5	1,5	2	+	—	+	1,5	5,5	2	5	3	6,5
Baltais āboliņš — Trifolium repens	+	0,5	+	0,5	+	+	—	+	+	+	1	1	0,5	+
Dedestiņi — Lathyrus pratensis	9	6	4,5	5	5	6,5	5	8	8,5	4	4.5	3	5	2,5
Vanagzirņi — Vicia cracca	+	0,5	2	3	3	3,5	5	2	+	0,5	2,5	1	1,5	1
Vanagnadziņi — Lotus corniculatus	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Pļavas auzene — Festuca pratensis	1,5	2	2	2,5	2,5	3	3	0,5	1,5	2	2	4	4	2
Timotiņš — Phleum pratense	1	1,5	0,5	0,5	1,5	1	1	1,5	2	1	2	0,5	1	1
Pļavas skarene — Poa pratensis	3,5	2	5	3,5	3	3	2,5	4	1,5	5	3	3	3	2,5
Parastā skarene — Poa trivialis	4	4,5	2,5	3,5	3	3	3,5	4	5	2	3	2,5	2	4
Baltā smilga — Agrostis alba	+	+	—	—	—	—	—	+	+	—	—	—	—	0,5
Sarkanā auzene — Festuca rubra	10	8	7,5	9	6,5	8,5	10	9	8,5	7,5	7,5	5	4,5	8
Trīsuļi — Briza media	+	2	2,5	1	3,5	1,5	—	1	1,5	2,5	2,5	5	5,5	2
Ciņu zāle — Aira caespitosa	9	7	7	7,5	6,5	7,5	9,5	10	7,5	6	8	5,5	6,5	10
Zaķu auza — Avena pubescens	1	3	3	2,5	3,5	2,5	0,5	—	2,5	4	2	4,5	3,5	+
Grīšļaugi — Carex spec.	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Dzelzenes — Centaurea jacea	—	1,5	0,5	0,5	0,5	—	2	1,5	+	0,5	0,5	0,5	+	0,5
Skābenes — Rumex acetosa	1	1	2,5	1,5	1	1	+	1,5	1,5	2	1	3	1	—
Bitenes — Geum rivale	0,5	0,5	0,5	0,5	1	1	+	0,5	0,5	0,5	0,5	+	1	0,5
Ķimenes — Carum carvi	3	2,5	1	1,5	1,5	2,5	—	2,5	1	0,5	0,5	2	1	+
Madaras — Galium mollugo	1	0,5	2	2	1	1,5	2	1,5	1,5	1	2,5	2	0,5	2
Rasas krēsliņš — Alchemilla vulgaris	+	+	+	+	+	+	—	+	+	—	+	+	0,5	+
Radzene — Cerastium triviale	+	+	+	—	0,5	1	1	+	+	+	—	+	1	1
Pļavas mauragas — Hieracium pratense	+	+	—	—	—	—	+	+	0,5	+	+	+	—	0,5
Pienenes — Taraxacum officinale	2	0,5	+	+	+	—	—	+	1	0,5	+	+	+	+
Pļavas ķērsa — Cardamine pratensis	—	+	+	—	—	—	—	+	+	1	+	—	—	—
Kodīgā gundega — Ranunculus acer	2	3	2,5	2,5	1	1	3,5	2,5	3	3,5	1,5	1	1	2
Purva madaras — Galium palustre	—	+	+	—	+	—	—	+	+	+	—	—	—	—
Dzeguzes puķe (sveķenes) — Lychnis flos cuculis	+	+	1	1	1	2	1	+	0,5	0,5	0,5	0,5	2	+
Pēteņa puķe — Campanula glomerata	0,5	0,5	—	+	+	—	—	+	+	—	—	—	—	+
Vidriekši — Sium latifolium	—	—	—	—	—	—	—	—	+	—	—	—	—	1
Retēji — Potentilla tormentilla	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Baltvēdere — Potentilla anserina	+	—	—	—	—	—	—	+	—	—	—	—	—	—
Deguma zāle — Lysimachia nummullaria	+	—	+	+	+	—	—	+	—	—	+	+	—	+
Zalšu zāle — Polygonum bistorta	—	—	+	—	1,5	—	—	—	—	+	1	—	1	2
Sierene — Thalictrum flavum	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Baltā puķe — Chrisanthemum leucant.	—	—	—	—	—	—	—	+	—	—	—	+	—	—
Vigrieznes — Ulmaria pentapetala	+	—	—	0,5	0,5	+	0,5	+	—	—	2	1	1	0,5
Pļavas naudulis — Alectrolophus major	—	—	—	—	—	—	—	+	—	—	—	—	—	—
Brūngalvīte — Brunella vulgaris	—	—	—	—	—	—	—	—	—	—	—	—	—	+
Ziepene — Polygala amara	—	—	—	+	+	—	—	—	—	—	—	—	—	—
Jāņa zāle — Galium boreale	—	—	—	—	0,5	—	—	—	—	—	—	—	—	—
Skostas — Equisetum spec.	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sugu skaits — Artenzahl	28	28	27	26	30	22	19	32	29	26	27	27	25	30

	1923.	1924.	1925.	1926.	1927.	1928.	1929.	1923.	1924.	1925.	1926.	1927.	1928.	1929.
	5. lauciņš. V. Parzelle							6. lauciņš. VI Parzelle						
Sarkanais āboliņš — Trifolium pratense	3,5	2,5	2	4,5	5,5	2,5	4	1,5	2	1,5	1,5	1,5	—	3
Baltais āboliņš — Trifolium repens	+	+	+	0,5	—	+	+	+	+	+	+	+	0,5	+
Dedestiņi — Lathyrus pratensis	4,5	7	8	3,5	2	3	2	8	8	8,5	8,5	7,5	7	4,5
Vanagzirņi — Vicia cracca	2	0,5	+	1,5	2,5	4,5	4	0,5	+	+	—	1	2,5	2,5
Vanagnadziņi — Lotus corniculatus	—	+	—	—	—	—	—	—	+	—	—	—	—	—
Pļavas auzene — Festuca pratensis	2	2,5	2	3,5	4	2,5	1,5	1	1,5	1,5	3	4,5	1	3
Timotiņš — Phleum pratense	0,5	1	1	0,5	0,5	2	1	0,5	1,5	1	1	0,5	—	1
Pļavas skarene — Poa pratensis	4	2	5	3	3	3	2	4	1,5	5,5	3	2,5	4	3
Parastā skarene — Poa trivialis	3,5	4,5	2	3	2,5	2,5	5	4,5	5	2	3	2,5	5	2,5
Baltā smilga — Agrostis alba	+	+	—	—	+	—	0,5	+	0,5	—	—	—	—	0,5
Sarkanā auzene — Festuca rubra	8,5	7,5	8	8,5	3,5	2,5	7	9,5	10	9,5	9,5	9	10	10
Trisuļi — Briza media	1,5	2,5	2	1,5	6,5	7,5	3	0,5	+	0,5	0,5	1	—	—
Ciņu zāle — Aira caespitosa	9,5	7,5	8,5	6,5	6	6	10	7	7	6	5	6,5	5,5	6	9,5
Zaķu auza — Avena pubescens	0,5	2,5	1,5	3,5	4	4	+	3	3	3,5	3,5	4,5	4	0,5
Grīšļaugi — Carex spec.	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Dzelzenes — Centaurea jacea	1	0,5	+	1,5	1	0,5	1	2,5	0,5	+	3,5	3,5	—	—
Skābenes — Rumex acetosa	2	1	1	1	2	0,5	—	1,5	0,5	2	0,5	0,5	—	—
Bitenes — Geum rivale	1	+	+	+	1	1	0,5	—	+	+	—	0,5	—	1
Ķimenes — Carum carvi	1,5	3	2	3	2	1,5	+	0,5	3,5	2,5	3	2	3	1,5
Madaras — Galium mollugo	1	1	1,5	2	1,5	1	2,5	0,5	0,5	2	0,5	1	3	3
Rasas krēsliņš — Alchemilla vulgaris	+	+	—	+	+	+	—	—	+	+	+	+	0,5	+
Radzene — Cerastium triviale	+	+	—	—	0,5	1	1	+	+	+	—	+	1	+
Pļavas mauragas — Hieracium pratense	+	0,5	—	+	—	—	+	—	0,5	+	—	—	—	—
Pienenes — Taraxacum officinale	0,5	+	+	+	+	—	+	1	0,5	0,5	0,5	0,5	—	0,5
Pļavas ķērsa — Cardamine pratensis	—	+	0,5	—	—	—	—	—	+	+	—	—	—	+
Kodīgā gundega — Ranunculus acer	1	3,5	3,5	1,5	0,5	1	3,5	3	3	3	2	0,5	0,5	2,5
Purva madaras — Galium palustre	—	+	—	—	+	—	—	—	+	—	—	+	—	—
Dzeguzes puķe (sveķenes) — Lychnis flos cuculis	0,5	0,5	1,5	0,5	0,5	1,5	1,5	—	+	+	+	—	—	+
Pēteŗa puķe — Campanula glomerata	1	+	—	—	0,5	—	—	—	—	—	—	—	—	—
Vidriekši — Sium latifolium	—	+	—	+	+	2	—	—	0,5	—	+	0,5	2	1,5
Retēji — Potentilla tormentilla	—	+	—	—	—	—	—	—	+	—	—	—	—	—
Baltvēdere — Potentilla anserina	0,5	+	—	—	—	—	+	+	—	—	—	—	—	—
Deguma zāle — Lysimachia nummullaria	+	+	—	+	+	—	—	+	+	—	+	+	+	+
Zalšu zāle — Polygonum bistorta	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sierene — Thalictrum flavum	—	—	—	+	—	—	—	0,5	—	—	—	—	—	—
Baltā puķe — Chrisanthemum leucant.	—	—	—	—	+	+	—	—	—	—	+	—	—	—
Vīgrieznes — Ulmaria pentapetala	+	—	—	0,5	0,5	+	—	+	—	—	—	0,5	—	—
Pļavas naudulis — Alectrolophus major	—	—	—	—	—	—	—	0,5	—	—	—	—	—	—
Brūngalvīte — Brunella vulgaris	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Ziepene — Polygala amara	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Jāņa zāle — Galium boreale	—	—	—	—	—	—	—	—	—	—	—	0,5	—	—
Skostas — Equisetum spec.	—	—	—	—	—	—	—	—	+	—	—	—	—	—
Sugu skaits — Artenzahl	29	33	22	27	29	25	24	26	32	25	23	27	17	24

	1923.	1924.	1925.	1926.	1927.	1628.	1929.	1923.	1924.	1925.	1926.	1927.	1928.	1929.
	7. lauciņš. VII. Parzelle							8. lauciņš. VIII. Parzelle						
Sarkanais āboliņš — Trifolium pratense	1	3,5	5,5	1,5	2	—	1	1	3	5	3	2,5	2	1
Baltais āboliņš — Trifolium repens	+	+	+	0,5	—	—	+	+	+	+	+	+	+	+
Dedestiņi — Lathyrus pratensis	7	6,5	4	4	5	2,5	3	9	7	5	6	6,5	6	4,5
Vanagzirņi — Vicia cracca	2	+	0,5	4	3	7,5	6	+	+	+	1	1	2	4,5
Vanagnadziņi — Lotus corniculatus	—	+	—	—	—	—	—	—	—	—	—	—	—	—
Pļavas auzene — Festuca pratensis	2	1	1,5	2,5	2,5	5	4	1	2	4	4	2,5	2,5	3
Timotiņš — Phleum pratense	1	1	1	0,5	0,5	—	+	1	1	1	0,5	1	1	0,5
Pļavas skarene — Poa pratensis	4	2	6	3,5	3,5	2,5	2,5	4	2	4	2,5	3	3,5	2,5
Parastā skarene — Poa trivialis	3	5,5	1,5	3,5	3,5	2,5	3,5	4	5	1	3	3,5	4	3,5
Baltā smilga — Agrostis alba	—	0,5	—	—	—	—	+	+	—	—	—	—	—	0,5
Sarkanā auzene — Festuca rubra	10	9	10	10	8	8,5	10	10	10	10	10	10	10	10
Trīsuļi — Briza media	+	1	+	+	2	1,5	—	—	+	+	+	—	—	—
Ciņu zāle — Aira caespitosa	8,5	7,5	4	7	5,5	4,5	10	10	7	5	7,5	4,5	3,5	9,5
Zaķu auza — Avena pubescens	1,5	2,5	6	3	4,5	5,5	+	—	3	5	2,5	5,5	6,5	0,5
Grīšļaugi — Carex spec.	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Dzelzenes — Centaurea jacea	1,5	2,5	0,5	1,5	1,5	—	0,5	—	1	0,5	1	0,5	—	1
Skābenes — Rumex acetosa	1	0,5	1,5	+	+	—	—	1,5	1,5	2	1	1,5	+	—
Bitenes — Geum rivale	+	+	—	+	—	+	—	0,5	+	0,5	0,5	+	—	+
Ķimenes — Carum carvi	3,5	2,5	3	4,5	3,5	6	0,5	3	4	1,5	2	4,5	5	1,5
Madaras — Galium mollugo	0,5	1	0,5	1	1,5	1	1,5	1,5	0,5	+	1	1,5	2	1
Rasas krēsliņš — Alchemilla vulgaris	+	—	—	+	+	1	+	+	—	+	+	1	1	+
Radzene — Cerastium triviale	—	+	+	—	0,5	0,5	0,5	—	—	—	—	+	1	0,5
Pļavas mauragas — Hieracium pratense	—	+	—	—	—	—	—	—	—	—	—	—	—	—
Pienenes — Taraxacum officinale	+	+	—	+	—	—	+	—	—	1	+	+	—	+
Pļavas ķērsa — Cardamine pratensis	—	+	—	—	—	—	—	—	0,5	+	—	—	—	0,5
Kodīgā gundega — Ranunculus acer	1,5	3	3,5	2,5	1,5	1	5,5	3	2,5	2,5	2,5	0,5	0,5	4
Purva madaras — Galium palustre	—	—	—	—		—		—	—	—	—	+	—	—
Dzegūzes puķe (sveķenes) — Lychnis flos cuculis	—	0,5	+	0,5	1	—	0,5	0,5	+	+	1	—	+	+
Pēteņa puķe — Campanula glomerata	1,5	—	—	—	+	—	—	—	—	+	1	—	—	—
Vidriekši — Sium latifolium	—	—	1	—	—	0,5	+	—	—	1	+	0,5	—	1
Retēji — Potentilla tormentilla	—	+	—	—	—	—	—	—	—	+	—	—	—	—
Baltvēdere — Potentilla anserina	+	+	—	—	+	—	—	+	—	—	—	—	—	—
Deguma zāle — Lysimachia nummullaria	+	+	—	+	+	+	+	+	—	—	+	+	0,5	+
Zaļšu zāle — Polygonum bistorta	—	—	—	—	—	—	—	—	—	1	—	—	—	—
Sierene — Thalictrum flavum	+	—	—	—	—	—	—	—	—	—	—	—	—	—
Baltā puķe — Chrisanthemum leucant.	—	—	—	—	—	—	—	—	—	—	—	—	+	—
Vīgrieznes — Ulmaria pentapetala	0,5	—	—	—	0,5	—	1	—	—	—	—	+	—	0,5
Pļavas naudulis — Alectrolophus major	+	—	—	—	—	—	—	+	—	—	—	—	—	—
Brūngalvīte — Brunella vulgaris	—	—	—	—	—	—	—	—	—	—	+	—	—	+
Ziepene — Polygala amara	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Jāņa zāle — Galium boreale	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Skostas — Equisetum spec.	—	+	+	—	—	—	—	—	+	—	—	—	—	—
Sugu skaits — Artenzahl	27	30	22	23	24	18	24	22	22	27	26	25	21	27

	1923.	1924.	1925.	1926.	1927.	1928.	1929.	1923.	1924.	1925.	1926.	1927.	1928.	1929.
	9. lauciņš IX. Parzelle							10. lauciņš X. Parzelle						
Sarkanais āboliņš — Trifolium pratense	2,5	4	2,5	2	2	0,5	2	5	3,5	5,5	2,5	3	4,5	2,5
Baltais āboliņš — Trifolium repens	+	+	+	+	—	—	+	+	+	+	+	—	+	+
Dedestiņi — Lathyrus pratensis	7,5	6	7,5	8	7	6,5	7	5	6,5	4,5	7,5	7	5,5	7,5
Vanagzirņi — Vicia cracca	+	+	+	—	1	3	1	+	+	+	—	+	—	—
Vanagnadziņi — Lotus corniculatus	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Pļavas auzene — Festuca pratensis	1	2,5	3	3,5	2	1,5	2,5	2	2	3	1	1,5	3	2
Timotiņš — Phleum pratense	2	1	1	1	1	1	2	1,5	1	1	+	1	1	1
Pļavas skarene — Poa pratensis	3	2,5	4	2,5	3,5	3,5	2	3	2,5	4,5	5	4	3	1,5
Parastā skarene — Poa trivialis	4	4	2	3	3,5	3,5	3	3,5	4	1,5	4	3,5	3	5,5
Baltā smilga — Agrostis alba	—	+	—	—	—	—	0,5	—	0,5	—	—	+	—	+
Sarkanā auzene — Festuca rubra	10	10	10	10	10	10	10	8,5	9,5	10	10	8,5	10	10
Trīsuļi — Briza media	+	+	+	—	—	—	—	1,5	0,5	+	—	1,5	—	—
Ciņu zāle — Aira caespitosa	8,5	6,5	5	5,5	5	2,5	9,5	4	6	5	7	7	3	9
Zaķu auza — Avena pubescens	1,5	3,5	5	4,5	5	7,5	0,5	6	4	5	3	3	7	1
Grīšļaugi — Carex spec.	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Dzelzenes — Centaurea jacea	—	0,5	—	0,5	1,5	—	1	—	1	+	1	+	—	—
Skābenes — Rumex acetosa	2	1,5	2,5	1	3,5	—	1	2	1	1,5	2	3	0,5	0,5
Bitenes — Geum rivale	+	+	—	+	0,5	+	—	0,5	+	+	1	+	+	+
Ķimenes — Carum carvi	2	1,5	1,5	3,5	1	3	1	3,5	1	2,5	1,5	2	1,5	1,5
Madaras — Galium mollugo	1,5	+	1	0,5	1	1,5	1	1	1	1	0,5	2,5	1	1,5
Rasas krēsliņš — Alchemilla vulgaris	+	+	+	+	0,5	0,5	+	+	—	+	+	0,5	1	+
Radzene — Cerastium triviale	+	+	—	—	+	0,5	1	—	+	—	—	0,5	+	1
Pļavas mauragas — Hieracium pratense	+	—	—	—	—	—	—	+	+	—	+	—	—	—
Pienenes — Taraxacum officinale	1	1,5	1	+	+	+	0,5	0,5	0,5	1	+	+	+	+
Pļavas ķērsa — Cardamine pratensis	—	+	—	—	—	—	—	—	0,5	+	—	—	+	0·5
Kodīgā gundega — Ranunculus acer	2,5	4	2,5	2	1	3,5	4	2,5	3,5	2,5	3	0,5	3,5	3,5
Purva madaras — Galium palustre	—	—	—	+	—	—	—	—	—	—	—	+	1	—
Dzeguzes puķe (sveķenes) — Lychnis flos cuculis	—	1	0,5	0,5	0,5	0,5	0,5	—	+	+	1	0,5	+	0,5
Pēteņa puķe — Campanula glomerata	—	—	—	—	—	+	—	—	—	0,5	—	0,5	—	—
Vidriekši — Sium latifolium	—	—	1	1	0,5	+	+	—	1	+	+	—	—	1
Retēji — Potentilla tormentilla	—	+	—	—	—	—	—	—	—	—	—	—	—	—
Baltvēdere — Potentilla anserina	+	—	+	+	—	—	—	—	—	—	—	—	—	—
Deguma zāle — Lysimachia nummullaria	+	+	+	—	+	0,5	+	+	+	+	+	+	0,5	+
Zalšu zāle — Polygonum bistorta	1	—	—	—	—	—	—	—	—	1	—	—	—	—
Sierene — Thalictrum flavum	—	—	—	—	—	—	—	—	—	—	+	—	—	—
Baltā puķe — Chrisanthemum leucant.	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Vīgrieznes — Ulmaria pentapetala	—	—	—	—	—	—	+	—	—	—	+	+	1	—
Pļavas naudulis — Alectrolophus major	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Brūngalvīte — Brunella vulgaris	—	—	—	+	—	—	—	—	—	—	—	—	—	—
Ziepene — Polygala amara	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Jāņa zāle — Galium boreale	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Skostas — Equisetum spec.	—	+	—	—	—	—	—	—	+	—	—	—	—	—
Sugu skaits — Artenzahl	25	28	23	24	23	22	25	22	28	27	25	27	24	24

	1923.	1924.	1925.	1926.	1927.	1928.	1929.	1923.	1924.	1925.	1926.	1927.	1928.	1929.
	11. lauciņš XI. Parzelle							12. lauciņš XII. Parzelle						
Sarkanais āboliņš — Trifolium pratense	3	5,5	7	2	4	1	6	0,5	6	6,5	2,5	2,5	2	2,5
Baltais āboliņš — Trifolium repens	+	+	+	+	+	+	+	+	+	+	+	—	+	+
Dedestiņi — Lathyrus pratensis	6,5	4,5	3	8	5,5	8,5	3	9	3.5	3,5	5	5	5	5,5
Vanagzirņi — Vicia cracca	0,5	+	+	+	0,5	0,5	1	0,5	0,5	+	2,5	2,5	3	2
Vanagnadziņi — Lotus corniculatus	—	+	—	—	—	—	+	—	—	—	—	—	—	—
Timotiņš — Phleum pratense	2	2	3,5	3,5	4,5	2,5	3	1	2	2,5	3,5	1	4,5	1,5
Pļavas auzene — Festuca pratensis	1,5	1,5	1	0,5	0,5	2,5	1	1,5	1	1	+	1,5	0,5	0,5
Pļavas skarene — Poa pratensis	3,5	2	4	3	2,5	2,5	2	4	2	5	3,5	4	2,5	2
Parastā skarene — Poa trivialis	3	4,5	1,5	3	2,5	2,5	4	3,5	5	1,5	3	3,5	2,5	6
Baltā smilga — Agrostis alba	—	+	—	—	—	—	+	—	+	—	—	—	—	+
Sarkanā auzene — Festuca rubra	8,5	9	9,5	10	8	9	9.5	8,5	9	9	9	9	8,5	9
Trīsuļi — Briza media	1,5	1	0,5	+	2	1	0,5	1,5	1	1	1	1	1,5	1
Ciņu zāle — Aira caespitosa	7,5	7,5	6,5	7	7	5,5	9	9	8	4	8	5	5,5	6
Zaķu auza — Avena pubescens	2,5	2,5	3,5	3	3	4,5	1	1	2	6	2	5	4,5	4
Grīšļaugi — Carex spec.	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Dzelzenes — Centaurea jacea	3	1,5	1,5	1,5	1	—	1	—	1,5	—	0,5	+	—	0,5
Skābenes — Rumex acetosa	1	1	1,5	0,5	1	—	1	1	0,5	1,5	1,5	1	+	+
Bitenes — Geum rivale	+	+	—	+	+	—	—	0,5	0,5	+	+	1	0,5	+
Ķimenes — Carum carvi	3,5	3	1,5	2,5	2	4,5	0,5	1	0,5	1,5	1	1	2	+
Madaras — Galium mollugo	0.5	1	1,5	3	3,5	1,5	1	2	2	1,5	2	2,5	+	1,5
Rasas krēsliņš — Alchemilla vulgaris	+	+	+	+	+	+	+	+	+	—	+	+	0,5	+
Radzene — Cerastium triviale	+	+	—	—	1	1	0,5	+	0,5	+	—	1	0,5	+
Pļavas mauragas — Hieracium pratense	—	+	—	—	—	—	+	+	0,5	—	+	—	—	—
Pienenes — Taraxacum officinale	+	1	0.5	0,5	+	—	+	2	1,5	+	0.5	+	0,5	0,5
Pļavas ķērsa — Cardamine pratensis	—	+	—	+	—	—	—	—	+	+	—	—	—	0,5
Kodīgā gundega — Ranunculus acer	1	1,5	2	1,5	0,5	1,5	5	1,5	2	2,5	2,5	1,5	3	5
Purva madaras — Galium palustre	—	—	—	—	—	0,5	—	—	—	1	0,5	+	1	—
Dzegūzes puķe (sveķenes) — Lychnis flos cuculis	—	0,5	0,5	—	+	+	—	2	0,5	0,5	1	—	1	1,5
Pētera puķe — Campanula glomerata	—	+	—	0,5	+	+	0,5	+	+	—	—	1	1	—
Vidriekši — Sium latifolium	+	0,5	0,5	—	1	+	—	—	+	1,5	—	1	—	—
Retēji — Potentilla tormentilla	—	+	—	—	—	—	—	—	+	—	—	—	—	—
Baltvēdere — Potentilla anserina	—	—	—	—	—	—	—	+	—	—	—	—	—	—
Deguma zāle — Lysimachia nummullaria	+	+	+	+	+	+	—	+	+	—	+	+	+	+
Zaļšu zāle — Polygonum bistorta	1	—	—	—	—	—	0,5	—	—	—	—	—	+	—
Sierene — Thalictrum flavum	+	—	—	+	—	—	—	+	—	—	+	—	—	—
Baltā puķe — Chrisanthemum leucant.	—	—	+	—	+	—	—	—	—	—	—	—	—	+
Vīgrieznes — Ulmaria pentapetala	—	—	0,5	—	+	1	—	+	—	—	0,5	—	+	0,5
Pļavas naudulis — Alectrolophus major	—	—	—	—	—	—	—	+	—	—	—	—	—	—
Brūngalvīte — Brunella vulgaris	—	—	—	+	—	—	—	—	—	—	—	—	—	—
Ziepene — Polygala amara	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Jāņa zāle — Galium boreale	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Skostas — Equisetum spec.	—	—	—	—	—	—	—	—	+	+	—	—	—	—
Sugu skaits — Artenzahl	26	31	25	26	28	24	26	29	31	25	27	25	27	28

	1923.	1924.	1925.	1926.	1927.	1928.	1929.	1923.	1924.	1925.	1926.	1927.	1928.	1929.
	13. lauciņš XIII. Parzelle							14. lauciņš XIV. Parzelle						
Sarkanais āboliņš — Trifolium pratense	3	2,5	4	4	4,5		0,5	3,5	2	4,5	3	2		4
Baltais āboliņš — Trifolium repens	3,5	0,5	+	+	—		+	+	+	+	+	+		+
Dedestiņi — Lathyrus pratensis	1,5	7	4	4	5		5,5	4,5	8	4,5	4	4		5,5
Vanagzirņi — Vicia cracca	2	+	2	2	0,5		4	2	+	0,5	3	4		0,5
Vanagnadziņi — Lotus corniculatus	—	—	—	—	—		—	—	—	0,5	—	—		—
Pļavas auzene — Festuca pratensis	3,5	2,5	4,5	5,5	5,5		1	0,5	2,5	3	4	7		+
Timotiņš — Phleum pratense	1	2	0,5	+	+		—	0,5	1	0,5	1,5	0,5		1
Pļavas skarene — Poa pratensis	3	2	4	2,5	2,5		2	4,5	2	5	2,5	1,5		2
Parastā skarene — Poa trivialis	2,5	3,5	1	2	2		7	4,5	4,5	1,5	2	1		6
Baltā smilga — Agrostis alba	—	+	—	—	—		+	—	+	—	—	—		1
Sarkanā auzene — Festuca rubra	6,5	8,5	9	9	6.5		9,5	10	7,5	9	9	6,5		10
Trīsuļi — Briza media	3,5	1,5	1	1	3,5		0,5	+	2,5	1	1	3,5		+
Ciņu zāle — Aira caespitosa	10	9	9	8,5	6,5		9,5	9,5	9,5	8	8	7		10
Zaķu auza — Avena pubescens	—	1	1	1,5	3,5		0,5	0,5	0,5	2	2	3		+
Grišļaugi — Carex spec.	+	+	+	+	+		+	+	+	+	+	+		+
Dzelzenes — Centaurea jacea	0,5	—	—	0,5	0,5		—	—	—	—	1	0,5		—
Skābenes — Rumex acetosa	1	1,5	1,5	2,5	1,5		—	1	1	2,5	0,5	3,5		+
Bitenes — Geum rivale	0,5	—	—	+	+		1	+	+	—	+	+		0,5
Ķimenes — Carum carvi	0,5	0,5	+	0,5	2		—	1	1	0,5	3	1,5		—
Madaras — Galium mollugo	+	1	+	2	2		2	1	1	0,5	1	1		2
Rasas krēsliņš — Alchemilla vulgaris	+	+	—	+	+		—	—	—	—	+	+		—
Radzene — Cerastium triviale	0,5	+	+	—	0.5		+	+	+	+	—	1		+
Pļavas mauragas — Hieracium pratense	+	—	—	+	—		—	+	0,5	—	—	—		+
Pienenes — Taraxacum officinale	1,5	1	2	0,5	0,5		0,5	3	0,5	1	0,5	0,5		0,5
Pļavas ķērsa — Cardamine pratensis	—	0,5	—	—	—		—	—	+	—	—	—		+
Kodīgā gundega — Ranunculus acer	5	5	3,5	2,5	2		2,5	2,5	5,5	4,5	3	+		3,5
Purva madaras — Galium palustre	—	—	+	2,5	2		2,5	—	+	—	—	+		—
Dzegužes puķe (sveķenes) — Lychnis flos cuculis	—	0,5	—	1	1		1	1	0,5	—	1	1,5		2
Pēteņa puķe — Campanula glomerata	—	—	—	—	+		—	—	—	—	—	—		—
Vidriekši — Sium latifolium	—	—	—	—	—		—	—	—	—	—	+		—
Retēji — Potentilla tormentilla	—	—	—	—	—		—	—	—	—	—	—		—
Baltvēdere — Potentilla anserina	—	—	—	—	—		+	—	—	—	—	—		+
Deguma zāle — Lysimachia nummullaria	+	+	—	+	+		+	+	+	—	+	+		+
Zaļšu zāle — Polygonum bistorta	—	—	3	—	—		3	—	—	—	—	0,5		—
Sierene — Thalictrum flavum	—	—	—	—	+		—	—	—	—	+	—		—
Baltā puķe — Chrisanthemum leucant.	—	—	—	—	—		—	—	—	—	—	—		—
Vīgrieznes — Ulmaria pentapetala	0,5	—	—	—	—		—	—	—	1	—	+		1,5
Pļavas naudulis — Alectrolophus major	—	—	—	—	—		—	+	—	—	—	—		—
Brūngalvīte — Brunella vulgaris	—	—	—	—	—		—	—	—	—	—	—		—
Ziepene — Polygala amara	—	—	—	—	—		—	—	—	—	—	—		—
Jāņa zāle — Galium boreale	—	—	—	—	—		—	—	—	—	—	—		+
Skostas — Equisetum spec.	—	—	—	—	—		—	—	+	—	—	—		—
Sugu skaits — Artenzahl	24	24	21	25	26		23	24	27	20	24	28		26

	1923.	1924.	1925.	1926.	1927.	1928.	1929.
	15. lauciņš XV. Parzelle						
Sarkanais āboliņš — Trifolium pratense	0,5	3	4	1	2		1
Baltais āboliņš — Trifolium repens	0,5	+	+	+	—		+
Dedestiņi — Lathyrus pratensis	9	6,5	6	9	7,5		8
Vanagzirņi — Vicia cracca	+	0,5	+	—	0,5		1
Vanagnadziņi — Lotus corniculatus	—	—	—	—	—		—
Pļavas auzene — Festuca pratensis	1,5	2	3	5,5	4		1,5
Timotiņš — Phleum pratense	2	2	0,5	0,5	1		—
Pļavas skarene — Poa pratensis	3,5	2	5	2	2,5		2,5
Parastā skarene — Poa trivialis	3	4	1,5	2	2,5		5,5
Baltā smilga — Agrostis alba	—	+	—	—	—		0,5
Sarkanā auzene — Festuca rubra	8	8,5	8	10	9,5		10
Trīsuļi — Briza media	2	1,5	2	+	0,5		—
Ciņu zāle — Aira caespitosa	9	9,5	4	8	4,5		10
Zaķu auza — Avena pubescens	1	0,5	6	2	5,5		—
Grīšļaugi — Carex spec.	+	+	+	+	+		+
Dzelzenes — Centaurea jacea	1	—	—	—	1		—
Skābenes — Rumex acetosa	2	1,5	2	1,5	2		+
Bitenes — Geum rivale	0,5	+	—	—	—		—
Ķimenes — Carum carvi	1	1	2	3	0,5		—
Madaras — Galium mollugo	0,5	1	1	1,5	1,5		+
Rasas krēsliņš — Alchemilla vulgaris	+	—	—	+	+		—
Radzene — Cerastium triviale	+	+	+	—	0,5		0,5
Pļavas mauragas — Hieracium pratense	+	+	—	—	—		—
Pienenes — Taraxacum officinale	1,5	1,5	1	+	+		8,5
Pļavas ķērsa — Cardamine pratensis	—	+	—	—	—		0,5
Kodīgā gundega — Ranunculus acer	3,5	4	4	3,5	2		0,5
Purva madaras — Galium palustre	—	—	—	+	+		—
Dzegūzes puķe (sveķenes) — Lychnis flos cuculis	+	0,5	—	+	2,5		—
Pēteŗa puķe — Campanula glomerata	—	—	—	—	—		—
Vidriekši — Sium latifolium	—	—	—	—	—		+
Retēji — Potentilla tormentilla	—	—	—	—	—		—
Baltvēdere — Potentilla anserina	+	—	—	—	—		—
Deguma zāle — Lysimachia nummullaria	+	+	—	+	+		+
Zalšu zāle — Polygonum bistorta	—	—	—	+	—		—
Sierene — Thalictrum flavum	—	0,5	—	—	—		—
Baltā puķe — Chrisanthemum leucant.	—	—	—	—	—		—
Vīgrieznes — Ulmaria pentapetala	—	—	—	+	—		—
Pļavas naudulis — Alectrolophus major	—	—	—	—	—		—
Brūngalvīte — Brunella vulgaris	—	—	—	—	—		—
Ziepene — Polygala amara	—	—	—	—	—		—
Jāņa zāle — Galium boreale	—	—	—	—	—		—
Skostas — Equisetum spec.	—	+	—	—	—		—
Sugu skaits — Artenzahl	26	27	19	23	23		19

Der Einfluss der Düngung auf die Wiesenernte und die botanische Zusammensetzung des Heues

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Der Versuch begann im Jahre 1921 auf einer Wiese der Versuchsfarm Rāmava, unweit von Riga. Die Wiese befindet sich in einem alten Flussbette der Düna und wird zuweilen durch zurückflutendes Hochwasser der Düna überschwemmt. Der Boden besteht aus tiefgründigem, stellweise stark humosem, sandigem Lehm. Näheres über die Zusammensetzung des Bodens ist aus der Analyse Seite 179 ersichtlich. Wie die Analyse zeigt, ist der Boden kalkreich; die Bodenreaktion ist basisch. Im Jahre 1921. wurden 12 Doppelparzellen á 1 Ar angelegt, zu welchen im Jahre 1923 noch 3 Doppelparzellen hinzukamen. Die Art und Menge der Düngung ist auf S. 180 zu ersehen. Die Zeitangaben über Düngung und Ernte sind aus der Zusammenstellung auf S. 181 ersichtlich.

Die Ernte des ersten Schnittes wurde in allen Fällen als Heu gewogen; der zweite Schnitt aber bisweilen als grüne Masse gewogen und, nach Austrocknen kleinerer Porzionen, auf Heu berechnet. Wo Angaben über den II Schnitt fehlen, konnte ein solcher nicht genommen werden. Die Erntezahlen sind aus der Tabelle S. 187 ersichtlich.

Um die botanische Zusammensetzung des Heues zu ermitteln, wurden in den ersten Jahren auf den Parzellen Probeflächen von je 4□ Fuss gewählt, in späteren Jahren aber die Probe beim Mähen von der ganzen Parzelle in kleineren Porzionen genommen, um eine Mittelprobe, von ungefähr 1 kg grüne Masse, zu erhalten. Nach sorgfältigem Trocknen wurde das Heu im Laboratorium untersucht, wozu zwei kleinere Mittelproben von je ca 100 gr genommen wurden. Zur Analyse gelangten nur Proben des ersten Schnittes, da bei unseren Verhältnissen nur der erste Schnitt einen wesentlichen wirtschaftlichen Wert hat. Ausserdem ist in der Zusammensetzung des Heues des ersten und zweiten Schnittes kein wesentlicher Unter-

schied festzustellen, wie aus der Tabelle S. 183 ersichtlich ist. Aus derselben Tabelle sind auch die Pflanzengruppen und deren Bestandteile zu ersehen, welche bei der Heuanalyse berücksichtigt wurden.

Da auf den Pflanzenbestand und Pflanzenentwicklung ausser der Düngung auch die Niederschlagsmengen und Temperaturverhältnisse der betreffenden Jahre von wesentlicher Bedeutung sind, werden solche in den Tabellen auf S. 185 angegeben.

Der Einfluss der Düngung auf die Erntemenge ist aus der Tabelle S. 187 zu ersehen. In diesem Versuch fällt die günstige Wirkung des Kali auf; doch wird die höchste Ernte bei Zugabe von Phosphorsäure und Stickstoff erhalten. Die Verbindung Kali-Phosphorsäure wirkt günstiger, als die Düngung Kali-Stickstoff. Wenn auch die Höchsternte durch die Düngung Kali-Phosphorsäure-Stickstoff erreicht wird, macht sich eine Düngung mit Kali-Phosphrsäure besser bezahlt. Die Wirkung der Kalkdüngung ist gering und in Verbindung mit anderen Düngemittel sogar ungünstig.

Bei genügender Düngung bleibt die Ernte im Laufe der bisherigen 9 Jahre auf bedeutender Höhe, wobei eine stätig bessere Zusammensetzung des Heues zu beobachten ist. Im allgemeinen nimmt auf den besser gedüngten Parzellen die Menge, von wertvollen Wiesengräsern zu.

Der Einfluss der Düngung auf die Veränderung der Pflanzengenossenschaft auf einzelnen Parzellen im Laufe 9, resp. 7 Jahren ist in den entsprechenden Tabellen SS. 189—193 angeführt. Dieselben Zahlen sind in einer andern Gruppierung in Bezug auf Pflanzengruppen in den Tabellen auf SS. 194—196 angegeben. Aus letztgenannten Tabellen sind folgende Schlüsse zu ziehen:

I. Pflanzengruppe der Schmetterlingsblütler:
   a) Auf die Gruppe der Schmetterlingsblütler scheint eine jede Düngung in den ersten Jahren günstig zu wirken.
   b) Stickstoff und Stallmist wirken in den folgenden Jahren ungünstig, was besonders aus den in der letzten Kolonne angeführten Durchschniteszahlen zu ersehen ist.
   c) Einseitige Kalidüngung wirkt besser auf die Schmetterlingsblütler, als andere einseitige Düngemittel.
   d) Kali-Phosphorsäuredüngung wirkt auf die Entwicklung der Schmetterlingsblütler am günstigsten.

e) 40% Kalisalz scheinen die Schmetterlingsblütler in diesem Versuch dem Kainit vorzuziehen.

f) Die Wirkung der angewandten Stickstoffdünger: Chilesalpeter und schwefelsaures Ammoniak scheint gleich zu sein.

g) Der Rückgang der Schmetterlingsblütler in den Jahren 1928 und 1929 ist auf schlechte Witterungsverhältnisse zurückzuführen.

II. Pflanzengruppe der guten Gräser:

a) Die guten Gräser sind dankbar für jede Stickstoffdüngung.

b) Chilesalpeter und schwefelsaures Ammoniak üben die gleiche Düngewirkung aus.

c) Eine jegliche einseitige Düngung ist für die guten Gräser ohne wesentliche Bedeutung.

III. Pflanzengruppe der mittelguten Gräser:

a) Die mittelguten Gräser scheinen durch Düngung weniger beeinflusst zu werden.

b) Sie sind auch unempfindlicher gegen ungünstige klimatische Verhältnisse (1928 und 1929).

c) Die mittelguten Gräser scheinen den Chilesalpeter dem schwefelsauren Ammoniak und Kainit dem 40% Kalisalz vorzuziehen.

IV. Pflanzengruppe der minderwertigen Gräser:

a) Das Verhalten der minderwertigen Gräser zu Düngung ist noch indifferenter, als das der mittelguten Gräser.

b) Sie breiten sich bei ungünstigen klimatischen Verhältnissen auf Kosten der besseren Gräser aus.

V. Pflanzengruppe der Riedgräser:

a) Auf den Parzellen ist eine verhältnismässig geringe Menge von Riedgräser vorhanden.

b) Volldüngung (Parzellen 8, 9 und 10) ist für die Riedgräser ungünstig.

VI. Pflanzengruppe der Kräuter:

a) Die Kräuter sind auf den Versuchsparzellen in erheblicher Menge anzutreffen.

b) Die reichste Entwicklung von Kräuter ist auf den ungedüngten und mit Stickstoff und Stallmist gedüngten Parzellen festzustellen.

c) Kali-Phosphorsäuredüngung ist ihrer Entwicklung nicht bekömmlich.

Die Sporenpflanzen sind in ganz geringer Menge anzutreffen und fehlen in der Heuprobe manches Jahr überhaupt.

In der Tabelle S. 198 sind die Durchschnittszahlen für 9 resp. 7 Jahre pro Parzelle angegeben, wobei in der letzten Kolonne die drei ersten wertvollsten Pflanzengruppen zusammengezählt sind. Die letztgenannten Zahlen heben besonders den günstigen Eindruck einer zweckentsprechenden Düngung auf die Zunahme der besten Bestandteile des Heues hervor.

In den auf SS. 200—202 folgenden Tabellen ist die Ernte der einzelnen Pflanzengruppen pro Parzelle in kg angegeben, um zu übersehen, ob, in Abhängigkeit von der Düngung, die Menge der einzelnen Pflanzengruppen nach Gewicht zu- oder abnimmt.

In den auf SS. 203—206 folgenden Tabellen sind dieselben Zahlen nach Parzellen und Pflanzengruppen für die ganze Versuchszeit geordnet und Durchschnittszahlen berechnet worden. Letztere Durchschnittszahlen sind der besseren Uebersicht wegen in der Tabelle S. 207 zusammengestellt worden.

Auch die Zahlen der letzten Gruppierungen nach dem Gewichte lassen dieselben Schlussfolgerungen zu, die schon oben, bei der Bewertung nach den prozentualen Ergebnissen, gemacht worden sind.

In der letzten Tabellenserie SS. 209—216 ist die vorhandene Menge einzelner Pflanzen schätzungsweise nach dem Zehnpunktsystem ermittelt worden. Die vorliegenden Ergebnisse zeigen, dass manche Pflanzen auf der Versuchswiese ständig anzutreffen sind, andere dagegen in Abhängigketi von Witterungsverhältnissen zufällig auftreten.

LATVIJAS UNIVERSITĀTES RAKSTI
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LAUKSAIMNIECĪBAS FAKULTĀTES SERIJA I. 11.

Aerobic soil bacteria that decompose cellulose

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I. Aerobic bacteria that decompose cellulose.

Cellulose constitutes from one third to one half of plant residues and is therefore one of the main sources of energy for the soil microflora. According to Waksman and Starkey (1), fungi play the main role in the decomposition of cellulose in the soil, whereas bacteria and actinomycetes are less important. The results of other workers, e. g. Scales (2) and Murray (3), show that fungi are more prominent in the decomposition of pure cellulose, though when plant materials (such as straw etc.) are added to the soil, the bacteria multiply to a much greater extent than the fungi. There is no doubt that the aerobic bacteria are important in the decomposition of cellulose under field conditions, but bacterial activity is more difficult to follow in soil, than that of the fungi.

Little work has been done with pure cultures of aerobic cellulose bacteria. The earliest work on aerobic cellulose bacteria is that of Van Iterson (4); several years later Merker (5) showed decomposition in *Elodea*. Neither of the workers obtained pures cultures. The first pure cultures were isolated by Kellerman and his associates (6, 7), who introduced the method of cellulose agar plates. Their work has been critised by Omeliansky (8), on the ground that the only evidence of cellulose decomposition was the formation of clear zones round the colonies of bacteria on the

cellulose agar plates. McBeth (9) later isolated 25 species by the same method and showed that the organisms actually decomposed filter paper in liquid media. Pringsheim (10, 11) admits that the bacteria really decompose cellulose on cellulose agar plates; but found it impossible to isolate pure cultures. He also tested the following bacteria isolated by Kellerman: *Bacillus subalbus*, *Bacterium fimi*, *Bacillus flavigenum*, *Bacterium udum*, but none of them decomposed cellulose. While working at Rothamsted, the author tested the following bacteria isolated by Kellerman and his associates: *Bacterium fimi*, *Bacillus amylolyticus*, *Bacillus bibulus*, *Pseudomonas perlurida and Bacillus cellaseus*. All of them, except *Bacillus amylolyticus*, decomposed cellulose; *Bacillus bibulus* and *Ps. perlurida* did so only with peptone as a source of nitrogen. Löhnis and Lochead (12) also failed to isolate cellulose decomposing bacteria in pure culture. Meanwhile Hutchinson and Clayton (13) at Rothamsted isolated an interesting organism, *Spirochaeta cytophaga*, which, unlike Kellerman's bacteria, grew only on cellulose. This organism resembles in many respects those observed by Van Iterson, Merker (5) and Gescher (14). Recently one more organism, *Microspira agarliquefaciens*, which grows on the usual routine media and has the power of "decomposing" agar, has been isolated at Rothamsted by Gray and Chalmers (15). Another agar liquefying organism, which resembles *Microspira agarliquefaciens* and also decomposes cellulose, has been isolated lately by Kluyver at Delft, who kindly sent a culture to Rothamsted for comparison. Sack (16) describes four new cellulose bacteria isolated on nutrient agar. He (17) claims further that his four nitrate producing organisms also attack cellulose.

The role of all these bacteria in field conditions still needs inveestigation. *Spirochaeta cytophaga* at least seems to take part in the decomposition of cellulose in natural conditions, as owing to its remarkable form, it has easily been distinguished on filter paper buried in the soil. It is the only organism known among aerobic cellulose bacteria that cannot attack other organic compounds except cellulose.

A search for aerobic bacteria which would grow only on cellulose, was begun by the author some years ago. Several such strains were isolated, but they all belonged to the species *Spirochaeta cytophaga*. The isolation of cellulose bacteria from Rothamsted and other English soils showed that *Spirochaeta cytophaga* is by no means

the most widely spread cellulose destroying organism in those soils, and that motile bacteria, similar to *Microspira agarliquefaciens* are more abundant. Many strains have been isolated from the above soils, and their role in the decomposition of cellulose in field conditions are being studied. This work deals mainly with the isolation, description and classification of the organisms isolated.

II. Isolation of cellulose bacteria from soil.

For the isolation of cellulose bacteria several methods were used. But the principle of all these methods is that of elective culture, the mixed bacterial flora being supplied with cellulose as the sole source of energy and carbon.

The following variations of this method were used. About one gram of soil was introduced into small Erlenmeyer flasks containing the following mineral salt solution:

K_2HPO_4	1,0 gm.
$MgSO_4 . 7H_2O$	0,2 „
$CaCl_2$	0,1 „
NaCl	0,1 „
$FeCl_3$	0,02 „
$NaNO_3$	2,0 „
or $(NH_4)_2SO_4$	1,0 „
Distilled water	1000 c.c.

The flasks contained a layer of solution about 1 cm. deep in which a strip of filter paper was partially immersed. Wide test tubes with 8 to 10 c.c. of the same solution and a strip of filter paper proved to be just as good. After 2 to 5 days at 25° C., decomposition of the cellulose began. Subcultures were then made into fresh tubes or flasks of the same medium. Platings were usually made from the second subculture. Sometimes it was necessary to make successive subcultures, in order to get rid of molds and obtain cleaner crude cultures. It was found that the accumulation of cellulose bacteria was more quickly obtained by using as inoculum a suspension of soil instead of a rather large amount of soil, which introduces undesirable sources of energy. In many cases platings were made straight from the first cultures.

A second method was to prepare silica plates according to Winogradsky (18). The surface of these was covered with a suspension of precipitated cellulose and dissolved nutrient salts. The excess of water was afterwards evaporated in an incubator, minute soil particles were placed in rows at regular distances on the moist surface. When transparent zones appeared around the soil particles, transplants were made from them into the nutrient salt solution, with filter paper as described above. One entire sheet of filter paper can also be used in place of precipitated cellulose. In such cases the filter paper was coloured yellowish after 2 to 3 days.

This method proved to be neither quick, nor very successful. Molds often multiplied luxuriantly, before the bacterial action began. Winogradsky (19) points out in a recent note that the right proportion of nitrate to cellulose is important, because excess of nitrate stimulates the multiplication of molds.

The third method in use was similar to that introduced by Christensen (20) for testing the cellulose decomposing power of soil. Soil placed in petri dishes was moistened with nutrient salt solution, and narrow pieces of filter paper were placed on the surface of the soil. Good contact of the paper with the soil was secured by pressing simultaneously both ends of the paper with flamed forceps. The plates were incubated at 25° C. and were protected from drying out under belljars. After 1 to 2 weeks the cellulose was attacked, usually turning a greenish-yellow or orange colour; in some cases being blackened. The spots free from molds were transplanted into tubes containing nitrate mineral salt solution, with a strip of filter paper. This method gives comparatively clean crude cultures, but is slow.

As a modification of this method, pieces of filter paper were buried 15 to 20 cm. deep into the soil on several fields for two weeks. By this time greenish or pink spots appeared on the paper. Small pieces of these spots transplanted into the tubes as above gave usually very clean crude cultures of cellulose bacteria. Very few molds appeared on this buried paper, though later in summer when the soil was much drier, more actinomycetes appeared.

The first method was chiefly used, since it yielded pure cultures most rapidly.

Isolation of pure cultures.

Pure cultures were isolated from these crude cultures by the use of cellulose silica or cellulose agar plates.

The precipitated cellulose was prepared for the above plates either by the method of Northrup (21) or that of Scales (22). The cupriammonium method, requiring thorough washing of the precipitated cellulose from copper chloride, is more laborious and longer. The simplest of these methods is that of Scales, and with small alterations it was mainly used throughout the work. The method is as follows: 100 c.c. of concentrated sulphuric acid is diluted with 60 c.c. of distilled water. The acid is added gently to the water in a 500 c.c. Erlenmeyer flask, which is kept under the tap during the process of mixing. The diluted acid is then poured into a two-liter flask with a wide neck. Five grams of moist cellulose (Whatman's filter paper No. 41) cut into strips are added to the acid which should have a temperature of 60° to 65° C. The flask is at once shaken vigorously, until the cellulose is dissolved, but not for longer than 20 seconds. The flask is then filled as quickly as possible with cold tap water which causes the cellulose to precipitate. The time of one minute used by Scales in his method proved to be too long, as the cellulose hydrolyses and does not precipitate on the addition of cold water. It was found easier to separate the precipitate from the dilute acid by allowing the cellulose to settle over night in a large volume of water (10 liters). The water is then syphoned off and the precipitate washed on a wide Buchner filter, until all traces of acid are removed. The amount recovered is usually 55 to 65 per cent. of the original cellulose. The stock suspension was prepared so as to contain 5 grams of cellulose in 100 c.c. of water. Cellulose agar when prepared contained 4 grams of precipitated cellulose per liter. The same concentration was used in silica plates.

The Preparation of Silica Sol.

Silica sol was prepared by the method of Bojanowsky (23), a few details being changed. The method used was as follows. Hydrochloric acid of specific gravtiy 1.195 was prepared from the usual laboratory acid (sp. gravity 1.16), by passing hydrochloric gas through it, keeping the receiver cooled. Sodium silicate solution of specific gravity 1.056 was prepared by dissolving syrupy sodium silicate in

distilled water. 235 c.c. of this solution were poured into 100 c.c. of the hydrochloric acid, and gently shaken. After five minutes the mixture was poured into a bag of parchment paper which was then partially sunk in a three liter glass vessel containing distilled water, until the levels of both liquids were at the same height. The bag was previously prepared by folding wet parchment paper around the bottom of a bottle, the paper being folded umbrella-like, bound with a string and then dried in a warm place. When dry, it was removed from the bottle and was ready for use. Three strings were attached to the rim for hanging. During the first hour of dialysis the water was removed twice, and up to five hours it was changed every hour. The water was then renewed at two hourly intervals for 4 to 5 hours. Then, after 10 to 11 hours of dialysis, the bag was left over night in a large volume (10 liters) of distilled water. The dialysed sol should finally have a reaction of from pH 2.5 to 3.0 which will give a yellow colour with both thymol blue and brom-phenol blue. This reaction is usually attained the following morning. If the acidity is less than that mentioned, it is too far dialysed, and solidification during the sterilisation may occur. The final quantity obtained is usually about 350 c.c. with the specific gravity 1.0145. The sol is tubed in 10 c.c. portions and sterilised. When the pressure of half an atmosphere (= 110° C.) is reached in the autoclave, the heating is stopped. The tubes are removed as soon as the pressure drops to normal, the whole process taking about 15 minutes. Care must be taken that the heat is not too high, or too long. The sol prepared in this way does not solidify during the sterilisation, and can be kept in the laboratory for about two weeks. After two weeks the sol begins to gel.

Silica sol is more satisfactorily obtained, if the process of dialysis can be hastened by using a continuous stream of tap water, a method used by the author in Riga. Bojanowsky also uses tap water. The tap water at Rothamsted however contained too much lime to be used for this purpose.

The use of silica for the isolation of pure cultures is as follows:

1.5 c.c. sterile nutrient medium of the following composition is poured into a sterile petri dish:

100 c.c. of 5% cellulose suspension (as prepared above)
50 c.c. mineral salt solution containing:

$MgSO_4 . 7H_2O$	—	0.24 grams
NaCl	—	0.12 „
$CaCl_2$	—	0.12 „
$FeCl_3$	—	0.024 „
$NaNO_3$	—	2.4 „

To 10 c.c. of silica sol 0.1 c.c. sterile 12% dibasic potassium phosphate solution is added, then it is inoculated with 1 to 2 loopfuls of diluted crude culture. On a plate there are poured 1.5 c.c. of saturated solution of calcium hydroxide ($Ca(OH)_2$), which does not need sterilisation. Calcium hydroxide solution is not allowed to mix with the mineral salt solution before adding the silica solution. When the silica solution is poured the whole is thoroughly mixed in the dish. The silica solution solidifies in 15 minutes to two hours, owing to the combined action of calcium hydroxide and mineral salts.

After four to seven days of incubation clear zones of the decomposed cellulose appear around the colonies, which are then isolated into cellulose nutrient salt solution. The isolated colonies were often impure at the first isolation. In such cases replatings were made. The silica gel plates gave more satisfactory results in the isolation of pure cultures of cellulose bacteria, than agar plates, but their preparation was too laborious to be applied to many platings. The silica plates were used only in the beginning of the isolation work, cellulose agar being used in all later isolations. Pure cultures were usually obtained after the second plating, though sometimes the plating had to be repeated several times, until pure cultures were isolated. Every colony to be isolated was cut out of the medium and transplanted into the nitrate mineral salt solution containing a strip of filter paper. When the cellulose in tubes was attacked, the plating was repeated. This was continued until only one type of colony was present. The purity of cultures was tested by microscopic observation. It was found that the majority of strains isolated did not grow when plated on dextrose nutrient agar. Barren platings on this medium thus indicated that the respective cultures were pure.

About two hundred strains of bacteria have been isolated from 28 soil samples, from different parts of England. The frequent occurrence of these bacteria suggests that they are common soil inhabitants. It is peculiar that in English soils *Spirochaeta cytophaga* was not the most frequently found organism. Using the same method of isolation

in Latvia, the spirochaeta was most commonly found. It seems that this organism is more common in such less fertile soils, as occur in Latvia. According to Krūmiņš (24) pH range in soils of Latvia is from 3,0 to 8,5. The main type of Latvian soils is either podsol or peat with a pH below 6,0.

The morphological and physiological characters of 48 strains have been studied. Some already known cellulose organisms have been used for comparison with the strains isolated during the course of investigation. The following species have been used for this purpose: *Bact. fimi*, *Bac. bibulus*, *Ps. perlurida* and *Bac. cellaseus*; Gray's *Microspira agarliquefaciens* and a similar organism isolated by Kluyver, at Delft. As the result of these investigations a provisional classification has been attempted.

III. Classification and description of the isolated bacteria.

A. Nutrient media used in studying the isolated strains.

The mineral salt solution of the folowing composition was used throughout the work as basis for different media:

K_2HPO_4	—	1	gram
$CaCl_2$	—	0.1	„
$MgSO_4.7H_2O$	—	0.2	„
NaCl	—	0.1	„
$FeCl_3$	—	0.02	„
Distilled water		1000	c.c.

This solution, referred to throughout as "mineral salt solution", was kept at tenfold concentration and diluted for use.

1. Cellulose "broth".

	$NaNO_3$	—	2	grams
or	$(NH_4)_2SO_4$	—	1	„
„	Asparagine	—	1	„
„	Peptone	—	5	„
„	Lemco	—	5	„

A strip of filter paper (Whatman's No 41) partly immersed in the nutrient solution, was added to each tube or flask.

2. Cellulose agar.

	Mineral salt solution	1000	c.c.
	$NaNO_3$	2	grams
or	peptone	5	„
	Precipitated cellulose	4	„
	Agar	12	„

3. Nutrient broth.

Peptone	5	grams
Lemco	3	„
Distilled water	1000	c.c.

4. Nutrient agar.

Nutrient broth	1000	c.c.
Agar	12	grams

5. Starch agar.

Nutrient broth	1000	c.c.
Soluble starch	3	grams
Agar	12	„

6. Dextrose agar.

Nutrient broth	1000	c.c.
Dextrose	10	grams
Agar	12	„

7. Nutrient gelatine.

Nutrient broth	1000	c.c.
Gelatine	140	grams
NaCl	3	„

8. Dextrose gelatine.

Nutrient gelatine	1000	c.c.
Dextrose	10	grams

9. Nitrate broth.

Nutrient broth	1000	c.c.
KNO_3	1	grams

10. Peptone water.

Mineral salt solution	1000	c.c.
Peptone	10	grams

11. Carbohydrate broth.

	Mineral salt solution	— 1000	c.c.
	Peptone	— 5	grams
or	$NaNO_3$	— 2	„

and one of the following carbon compounds:

Dextrose	— 10	grams
Sucrose	— 10	„
Lactose	— 10	„
Maltose	— 10	„
Soluble starch	— 10	„
Inulin	— 10	„
Dextrine	— 10	„
Arabinose	— 3	„
Xylose	— 3	„
Glycerol	— 10	„
Mannitol	— 10	„
Ca-formate	— 10	„
Ca-acetate	— 10	„
Ca-propionate	— 10	„
Ca-butyrate	— 10	„
Ca-lactate	— 10	„
Ca-citrate	— 10	„
Ca-malate	— 10	„

The initial reaction of culture media was adjusted before sterilisation to pH 7.3. All sterilisations were made at 1 atmosphere pressure for 15 minutes, except sugar media which were sterilised at 0.5 atm. for 30 minutes. Gelatine media were sterilised in the steamer for 20 minutes on each of 3 successive days, and afterwards incubated to test their sterility.

B. Methods employed in studying the bacteria.

The incubation temperature used throughout the work was 25° C. except when otherwise mentioned. Stock cultures were kept in nitrate cellulose broth, sterilised soil, or in sealed tubes of starch agar. Inoculations were usually made from nitrate cellulose broth cultures 5 to 10 days old. For the study of morphology 2 days old cultures on starch agar were used. For some strains which do not grow

on this medium, three days old dextrose agar slopes were employed. All of the strains stain well with diluted Ziehl's carbol-fuchsin. The colouration of bacteria in the middle part is usually more intense, the stainable matter being distributed in bands. Cell measurements were made on bacteria stained *intra vitam* with weak methylene blue, using 3, or sometimes 4 to 5 day cultures on nitrate cellulose broth. Flagella were stained by Gray's method (25) using 2 day old growth on starch agar slopes. Atkins's (26) modification for Gram staining was used. The appearance of colonies was observed on dextrose gelatine plates (20 to 30 days), on cellulose agar (7 to 14 days), and on starch agar (5 to 10 days). For streak cultures, slopes of dextrose gelatine, nutrient gelatine, dextrose and starch agar were used.

Reduction of nitrates was tested with Griess reagent (1. alpha-naphthylamine, 2. sulphanilic acid). Cultures in "nitrate-carbohydrate broth" with or without peptone were used for this purpose since growth in nitrate broth alone was weak.

Nessler's reagent was used for the detection of ammonia production in peptone cellulose medium.

Acid production from carbohydrates was tested in mineral salt medium with addition of the appropriate carbohydrate and with peptone or sodium nitrate as a nitrogen source. The changes of reaction were measured colorimetrically or electrometrically using a quinhydrone electrode (Biilmann) (27).

Diastatic activity was determined from 7 days old growth on starch agar. To make the tests, the surface of petri dish cultures was flooded with saturated solution of iodine in 50 per cent. alcohol.

C. Classification of the bacteria isolated.

The bacteria studied differ greatly, in respect to their physiological characters. These properties do not seem sufficiently distinct to form a basis for classification. Such a classification would involve the formation of at least 35 species. It seems more reasonable to base the classification on morphological differences and on the character of growth on gelatine and agar media. The typical cell shape has been used for dividing the organisms into the following three genera: *Bacterium* (Cohn emend. Hüppe), *Vibrio* (Müller emend. Winslow et al.) and *Bacillus* (Cohn emend. Zopf). The type of colony formed

on dextrose gelatine has been chiefly used as a specific character, the great majority of strains not producing colonies on nutrient or dextrose agar. The characteristics of growth on dextrose gelatine slopes and on dextrose agar slopes were also used for this purpose. The liquefaction or non-liquefaction of gelatine was the only physiological character used for differentiation of species. All other biochemical properties such as nitrate reduction, ammonia production from peptone, acid production from carbohydrates, diastatic action etc., have been taken into account only for characterisation of strains.

The characteristics of the strains have been compared with the descriptions of the known cellulose bacteria, but none of them could be identified with any formerly described.

Morphologically the Vibrio type resembles *Microspira agarliquefaciens* and Kluyver's agarliquefying organism. But the growth on gelatine and appearance on other solid media makes it impossible to identify the species of this genus with Gray's and Kluyver's agarliquefying vibrios.

The strains resemble in biochemical characters some of those described by Kellerman and his associates, but differ morphologically in their size and different arrangement of flagella.

The organisms here described have been classified provisionally into 17 species, 12 of which belong to genus Vibrio, 4 to genus Bacterium, and one strain to genus Bacillus.

D. Description of the strains.

Vibrio xylitica (4 strains).

Origin: Soils from Rothamsted experimental plots (Broadbolk manured) and glasshouse soil from Harpenden, Herts.

Morphology: Curved rods; in cellulose broth 1,5 μ to 2,5 μ long by 0,3 μ broad. In starch agar slopes 2 μ to 4 μ long by 0,6 μ to 0,8 μ broad. Motile.

Flagella: Polar, single, undulate. (See pl. I, fig. 1.)

Spores: No endospores observed.

Gram: Negative.

Cultural characteristics.

Dextrose gelatine slope: Shape: Filiform. Elevation: convex. Colour: buff. Surface: smooth, shining. Edge: entire. Two strains (viz. 31. and 33.) produce black pigment inside the stroke; the gelatine is darkened.

Dextrose gelatine colonies (12 days). Size: 1,5 to 2 mm. Shape: round or irregularly round. Elevation: convex or flat with raised border. Colour: whitish to buff. Surface: smooth, shining or resinous; opaque; translucent border. Edge: undulate, erose. (21. days). Irregularly round; flat to concave (due to partial liquefaction); buff; smooth or rugose. Edge: diffuse, partially liquefied, surrounded by satellite colonies. One strain (31.) liquefies dextrose gelatine.

Dextrose gelatine stab: Nailhead erose; the line of stab filiform. Two strains (31., 33.) blacken the gelatine, the nailhead being blackish-brown.

Nutrient gelatine stab: The growth forms a saccate or crateriform hollow, 3 to 8 mm deep. The line of stab below the hollow is filiform.

Nutrient gelatine slope: Liquefied. Two strains (31 and 33) produce only slight liquefaction.

Nitrate cellulose agar colonies. (See pl. V, fig. 1): Size: 2 to 3 mm. Clear zone: 0,5 mm. Shape: round and irregularly round. Elevation: concave. Colour: watery-white. Surface: smooth, resinous or granular; opaque centre, border translucent. Edge: erose. Those of one strain (No. 9.) are 2,0 mm; Clear zone: 0,5 mm; round, flat to umbonate; white; smooth; resinous; border radiate; edge undulate.

Peptone cellulose agar colonies. Size: 2,0 mm. Clear zone: 0,2 mm. Shape: round. Elevation: flat to concave. Colour: whitish transparent. Surface: smooth, resinous; white margin. Edge: erose.

Dextrose agar slope: Filiform; convex; whitish buff; rugose; resinous; edge erose.

Dextrose agar plate: No colonies formed.

Starch agar slope: Filiform; flat; greyish white; smooth, shining, viscid; edge entire.

Starch agar plate: No colonies formed.

Nutrient agar slope: Filiform; convex; whitish buff; smooth, shining; edge erose.

Nutrient broth: Cloudy.

Peptone broth: Cloudy growth produced by two strains (9 and 36).

Glycerol broth: No growth.

Mannitol broth: Slight cloudiness produced by two strains (viz. 9. and 36.).

Carbohydrate broth: Mucous scum or ring is formed in dextrose, lactose, starch, dextrine and arabinose broths; no cloudiness is produced, except in arabinose broth. One strain (No. 9) produces cloudy growth without scum production in lactose, saccharose and arabinose broths. In xylose broth cloudiness (pinkish) is produced only by one strain (33.).

Cellulose broth: Cellulose is visibly disintegrated in 4 to 5 days by three strains. One strain (No. 9) attacks cellulose after 2 to 3 days' incubation. A layer of sediment is formed by the disintegrated cellulose fibre at the bottom of the tube. The liquid becomes cloudy, except with one strain (36). After 10 days' incubation, by slight shaking of the test tube, the paper easily breaks down in a pulpy mass.

Biochemical characteristics:

Starch: Diastase is produced.

Nitrate: Reduced to nitrite.

Peptone: No ammonia produced.

Carbohydrates: One strain (viz. 9.) produces acid in dextrose medium. Other strains do not produce acid.

pH influence on cellulose decomposition.

Cellulose is decomposed in the range of pH 7,0 to 8,0.

Temperature influence on cellulose decomposition.

Two strains (viz. 9 and 36) are active at 29° C., but not at 31° C.; the remainder (31 and 33) are active at 27° C., but not at 29° C.

Vibrio prima (2 strains).

Origin: Garden soil from Harpenden, Herts, and hedge soil from Rothamsted Park.

Morphology: Cells are curved; in cellulose broth they measure 1 μ to 2,5 μ long by 0,3 μ broad. In starch agar slopes 2 μ to 4 μ by 0,7 μ broad. Motile.

Flagella: Polar, single. (See pl. I, fig. 3.)

Spores: No endospores observed.

Gram: Negative.

Cultural characteristics.

Dextrose gelatine slope. Shape: Filiform. Elevation: flat to concave. Colour: buff. Surface: smooth, resinous (or shining). Edge: entire. Gelatine slightly liquefied after 2 months.

Dextrose gelatine colonies. Size: 1,5 to 2 mm. Shape: round. Elevation: flat to convex with raised centre. Colour: white to whitish buff. Surface: smooth, resinous. Edge entire or erose, due to slight liquefaction. There are many large crystals inside the colonies.

Dextrose gelatine stab: Nailhead very concave; the line of stab filiform.

Nutrient gelatine stab: The growth forms a hollow — 15 mm deep. Below the hollow the line of stab is filiform.

Nutrient gelatine slope: Strong liquefaction by one strain, a slight one by another.

Nitrate cellulose agar colonies. Size: 1,5 to 3 mm. Clear zone: 0,5 to 1 mm; those of one strain 0,2 mm. Shape: round Elevation: concave. Colour: white. Surface: smooth, resinous. Edge: undulate, erose.

Peptone cellulose agar colonies. Size: 2 mm. Clear zone: 0,5 mm. One strain (viz. 25.) produces wide clear zones, about 2 mm. around deep colonies, but no zones round surface colonies. Shape: round. Elevation: concave. Colour: white. Surface: smooth, granular or resinous. Edge: erose.

Dextrose agar slope: Filiform; convex; whitish buff; smoth, shining; edge entire.

Dextrose agar colonies: Those of strain 25 are 1 to 2 mm.; round; flat; white; smooth; resinous; edge entire. Those of strain 27 are 2 mm. wide; round; convex; buff; smooth, shining; edge entire.

Starch agar slope: Filiform, convex; buff; smoth; resinous; edge entire.

Starch agar colonies: Size: 3 to 5 mm. Shape: convex to umbonate; colour: whitish buff. Surface: smooth or ringed, resinous; opaque; translucent border. Edge: undulate, entire.

Nutrient agar slope: Filiform; convex; whitish buff; smooth, shining; edge erose.

Nutrient broth: Cloudy.
Peptone broth: No growth.
Glycerol broth: No growth.
Mannitol broth: No growth.

Carbohydrate broths: Growth is cloudy with formation of scum in dextrose, saccharose, starch, dextrine and arabinose. Maltose broth is cloudy, no surface growth. In lactose and xylose broths growth is cloudy, scum formed by one strain (viz. 25). In inulin broth one strain grows; scum is produced, fluid clear.

Cellulose broth: Cellulose disintegration commenced by one strain (27) in 2 to 3 days, by the other (25) in 4 days. The first one breaks the paper in 10 days; fluid is cloudy; the latter produces, on paper just below the surface of liquid, a thin transparent area of decomposed cellulose. The fluid is clear. Slight yellow colouration of paper above the surface of liquid is produced by one strain (27).

Biochemical characteristics.

Starch: Diastase is produced.
Nitrates: Reduced to nitrites.

Peptone: Slight production of ammonia in peptone cellulose and peptone dextrine broths.

Carbohydrates: Strong acid production from dextrose, lactose and dextrine. Slight change of pH to the acid side in saccharose and starch broths.

pH influence on cellulose decomposition.

One strain (27) attacks cellulose at pH 7,0 to 9,0; the other (viz. 25) at 7,0 to 8,0.

Temperature influence on cellulose decomposition.

Strain 25 attacks cellulose at 29° C., not at 31° C.
Strain 27 attacks cellulose at 34° C., not at 37,5° C.

Vibrio bulbosa (5 strains).

Origin: Cloverfield soil from Rothamsted; soils from Gloucestershire, Cheshire and Lincolnshire.

Morphology: Curved rods; in cellulose broth cells measure 1 to 3 μ long by 0,3 to 0,4 μ broad; the majority about 1,0 to 2,0 μ long. In starch agar slope cells are 3—4 μ long by 0,7 to 1,0 μ broad. Two strains (viz. 56 and 58) form also coccoid cells 1,0 μ by 0,5—0,8 μ. Motile.

Flagella: Polar, single, undulate. (See pl. I, fig. 5.)

Spores: No endospores observed.

Gram: Negative.

Cultural characteristics.

Dextrose gelatine slope: Shape: Filiform. Elevation: convex. Colour: buff. Surface: smooth, resinous. Edge: entire.

Dextrose gelatine colonies: Size: 1 to 2,5 mm. Shape: round. Elevation: spheres or hemispheres up to 1—1,5 mm. high. Colour: whitish buff to brownish. Surface: smooth, resinous. Edge: undulate or lobate.

Dextrose gelatine stab: Nailhead erose; the growth forms a narrow hollow in upper part of stab. The line of stab in deeper part is beaded.

Nutrient gelatine stab: The growth forms a crateriform hollow 4 to 6 mm. deep. The line of stab deeper is filiform.

Nutrient gelatine slope: Liquefied.

Nitrate cellulose agar colonies (See pl. V, fig. 2): Size: 2,5 to 3,5 mm. Clear zone 0,3 to 0,5 mm. Shape: round. Elevation: flat to umbonate. Colour: white. Surface: resinous, smooth

centre, radiate border. Edge: undulate, erose. Two strains (viz. 56 and 58) produce colonies 4 to 5 mm. large; clear zone: 1 to 1,5 mm.; amoeboid, umbonate; whitish buff; resinous; radiate; edge undulate.

Peptone cellulose agar colonies. Size: 2 to 3 mm. Clear zone: 0,2 mm. Shape: round. Elevation: convex or flat with raised middle. Colour: whitish. Surface: smooth, resinous; opaque; translucent margin. Edge: undulate, erose. Two strains (viz. 56 and 58) produce colonies 5 to 6 mm. large; clear zone 1 mm.; amoeboid or irregular; umbonate; buff; resinous; smooth centre, border radiate; edge undulate.

Dextrose agar slope: Filiform; convex; whitish buff to buff; smooth, shining; viscid; edge entire.

Dextrose agar plate: No colonies formed.

Starch agar slope: Filiform; convex; white to buff; smooth, shining; edge entire. The growth of two strains (viz. 56 and 58) is filiform; flat; brownish; smooth, resinous or granular; edge entire.

Starch agar colonies: Size: 3 to 5 mm. Shape: round. Elevation: convex to hemisphere. Colour: watery white. Surface: smooth, resinous. Edge: entire or erose.

Nutrient agar slope: Filiform; convex; white; smooth, shining, edge lobate, erose.

Nutrient broth: Cloudy.

Peptone broth: One strain cloudy, remainder clear.

Glycerol broth: No growth.

Mannitol broth: One strain produces slight cloudiness; remainder do not grow.

Carbohydrate broths: The growth is cloudy with scum or ring formation in dextrose, saccharose, lactose, maltose, starch, dextrine and arabinose broths. Two strains (viz. 17 and 19) grow in xylose broth; these strains produce ring or scum only in dextrine, starch and maltose broths. No growth in inulin broth.

Cellulose broth (See pl. VII, fig. 15 b): Cellulose is disintegrated in 3 to 4 days. Fluid slightly cloudy. Cellulose is attacked in a wide area above and below the surface of the liquid; at slight agitation it breaks in two. The paper colours yellow or brownish, and on the upper part of it, above the surface of the liquid, there appear yellowish buff and slightly transparent spots. Two strains (viz. 17 and 19) do not produce pigment. They attack the paper in

a very narrow part just on the air-liquid level; the paper is cut in two along a rather straight line.

Biochemical characteristics.

Starch: Diastase is produced.

Nitrates: Nitrates are not reduced to nitrites.

Peptone: No ammonia produced.

Carbohydrates: Slight acid production from dextrose, lactose, dextrine and starch.

pH influence on cellulose decomposition.

Cellulose is attacked at pH 7,0 to 8,0.

Temperature influence on cellulose decomposition.

One strain attacks cellulose at 34° C., the remainder at 31° C.

Vibrio stationis (1 strain).

Origin: Soil from common by Rothamsted.

Morphology: Cells curved; in cellulose broth 1 to 2,5 μ long by 0,4 μ broad; the majority about 1,5 to 2 μ long; on starch agar slopes 2 to 3 μ long by 0,7 μ broad. Motile.

Flagella: One polar flagellum, curved or undulate (See pl. I, fig. 2).

Spores: No endospores observed.

Gram: Negative.

Cultural characteristics.

Dextrose gelatine slope: Shape: filiform. Elevation: convex. Colour: whitish-buff. On two weeks old slopes there appear blue spots; gradually all the stroke becomes bluish. Surface: wrinkled, resinous. Edge: deep lobate.

Dextrose gelatine colonies: Size: 2,5 mm. Shape: irregularly round. Elevation: flat with raised edge. Colour: buff. Surface: wrinkled, resinous. Edge: lobate, slightly cleft, erose. On three weeks old plates majority of colonies blue.

Dextrose gelatine stab: Filiform; erose; nailhead in several places with bluish spots.

Nutrient gelatine slope: Slight liquefaction.

Nutrient gelatine stab: Liquefaction crateriform, 10 mm. deep. Deep growth filiform.

Nitrate cellulose agar colonies: Size: 2 to 2,5 mm. Clear zone 0,3 mm. Shape: round. Elevation: concave. Colour: whitish. Surface: resinous, granular. Edge: undulate, erose.

Peptone cellulose agar colonies: Size: 2,0 mm. Clear zone: 0,2 mm. Shape: round. Elevation: concave. Colour: white. Surface: resinous, radiate, granular. Edge: undulate, erose.

Dextrose agar slope: Shape: filiform. Elevation: convex. Colour: greyish. Surface: resinous, wrinkled. Edge: erose. Two weeks old stroke: bluish.

Dextrose agar colonies: Size: 4 to 5 mm. Shape: round. Elevation: flat. Colour: whitish-buff; some colonies with bluish central part. Surface: smooth, resinous. Edge: undulate, entire.

Starch agar slopes: Shape: filiform. Elevation: flat. Colour: yellow. Surface: resinous, granular. Edge: slightly erose.

Starch agar colonies: Size: 3 to 4 mm. Shape: round (and irregularly round). Elevation: convex with raised border. Colour: brownish; some colonies are blue. Surface: resinous, wrinkled. Edge: lobate.

Nutrient broth: No growth.
Peptone broth: No growth.
Glycerol broth: No growth.
Mannitol broth: No growth.

Carbohydrate broths: Forms pellicle on the surface; liquid clear, except saccharose broth, which is cloudy. No surface growth in lactose broth, but only flocculent masses. No growth in arabinose, xylose and inulin broths.

Cellulose broth (see pl. VII, fig. 16b.): Disintegration of cellulose begins in 3 days; the liquid is slightly opalescent. After 10 days the paper, though thin at the surface level, is not yet broken in two. A layer of disintegrated cellulose is formed (at the bottom). Cellulose is less decomposed, when nitrogen is supplied in the form of ammonium. In ammonium nitrate cellulose medium bluish pigment is formed on the filter paper above the liquid level.

Biochemical characteristics.

Starch: Diastase is produced.

Nitrates: Not reduced to nitrates.

Peptone: Slight production of ammonia in peptone cellulose and peptone dextrine broths.

Carbohydrates: Acid produced from dextrose, saccharose, lactose, starch and dextrine.

pH influence on cellulose decomposition.

Cellulose attacked at pH 7,0; 8,0; 9,0.

Temperature influence on cellulose decomposition.

Cellulose is disintegrated at 34° C., but not at 37,5° C.

Vibrio castra (3 strains).

Origin: Glasshouse soil from Harpenden, Herts; parkland of Rothamsted; soil from common (Dunstable).

Morphology: Curved rods; in cellulose broth cells measure 1,5 to 2 μ long by 0,4 μ broad. In starch agar slopes 2 to 4μ long by 0,8 to 1 μ broad. Motile.

Elagella: Polar, single. (See pl. I, fig. 6.)

Spores: No endospores observed.

Gram: Negative.

Cultural characteristics.

Dextrose gelatine slope: Shape: filiform. Elevation: flat to convex. Colour: whitish buff. Surface smooth, resinous. Edge: lobate. One strain (viz. 50) liquefies dextrose gelatine.

Dextrose gelatine colonies: Size: 1,5 to 2,5 mm. Shape: round. Elevation: flat to umbonate. Colour: white to buff. Surface: smooth, matt. Edge: erose. Colonies of one strain (viz. 50) are 1 to 1,5 mm. large, irregularly round; flat to concave; whitish buff; resinous with smooth centre and rugose border; edge lobate or cleft.

Dextrose gelatine stab: Nailhead concave, erose; line of stab filiform.

Nutrient gelatine stab: Crateriform hollow, about 5 mm. deep; the deeper growth is filiform.

Nutrient gelatine slope: Liquefied; strain 37 shows a slight liquefaction.

Nitrate cellulose agar colonies: Size 1,5 to 2,5 mm. Clear zone: 0,2 mm.; those of strain 50 do not form clear zone round the surface colonies. Shape: round. Elevation: flat to concave with raised centre. Colour: watery white. Surface: resinous, centre smooth, border radiate. Edge: undulate, erose.

Peptone cellulose agar colonies: Size: 1,5 to 2,5 mm. Clear zone: 0,2 mm.; no clear zone round the colonies of strain 50. Shape: round and irregularly round. Elevation: flat to concave. Colour: whitish-transparent. Surface: smooth, resinous. Edge: undulate, erose.

Dextrose agar slope: Filiform; convex; buff; smooth, shining; edge entire. The growth of one strain (viz. 50) is whitish; wrinkled, with lobate edges.

Dextrose agar colonies: Formed only by one strain (viz. 50). Size: 2 mm. Shape: irregularly round. Elevation: flat to umbonate. Colour: buff. Surface: resinous, smooth centre, border rugose. Edge: cleft.

Starch agar colonies: 3 to 5 mm.; round; flat to umbonate; whitish buff; resinous, smooth and ringed; edge erose.

Starch agar slope: Filiform; convex; whitisch buff; smooth, resinous; edge entire.

Nutrient agar slope: Filiform; convex; whitish buff; smooth, shining; edge erose.

Nutrient broth: Slightly cloudy.
Peptone broth: No growth.
Glycerol broth: No growth.
Mannitol broth: No growth.

Carbohydrate broths: Growth is cloudy in dextrose, lactose, saccharose, maltose, starch and dextrine broths. Scum or ring is produced by one strain (viz. 50) in lactose and xylose broths; the same strain forms cloudy growth in inulin and arabinose broths.

Cellulose broth: Cellulose disintegration begins in 2 to 3 days; fluid cloudy with two strains, clear with one (viz. 22). After 10 days the paper is broken in two by 2 strains; one strain (viz.

22) is less active in cellulose disintegration process, though making the paper transparent.

Biochemical characteristics.

Starch: Diastase produced.

Nitrate: Reduced to nitrate by one strain (viz. 37), not reduced by two strains.

Peptone: No ammonia produced.

Carbohydrates: Two strains produce acid from dextrose, lactose, maltose, starch and dextrine. Acid is produced from saccharose by one strain. One strain does not produce acid at all.

pH influence on cellulose decomposition.

Cellulose decomposed in neutral and alkaline media only. Two strains are active in media with pH from 7,0 to 9,0; one strain (viz. 37) — from 7,0 to 8,0.

Temperature influence on cellulose decomposition.

Cellulose is decomposed by two strains at 34° C., but not at 37,5° C. One strain is active at 27° C., but not at 29° C.

Vibrio cucumis (1 strain).

Origin: Glasshouse soil from Harpenden, Herts.

Morphology: Curved rods; in cellulose broth 1,5 μ to 2,5 μ long by 0,4 μ broad. In starch agar slopes 3μ to 4 μ long by 0,7 μ to 0,9 μ broad. Motile.

Flagella: Some cells partly have a single flagellum, some 2 to 8 peritrichous flagella. (See pl. I, fig. 4.)

Spores: No endospores observed.

Gram: Negative.

Cultural characteristics.

Dextrose gelatine slope: Shape: filiform. Elevation: convex. Colour: buff. Surface: smooth, resinous. Edge: lobate.

Dextrose gelatine colonies: Size: 1,5 to 2 mm. Shape: irregularly round. Elevation: convex with depressed centre. Colour:

watery white with darker centre. Surface: smooth, resinous. Edge: undulate or cleft. Inside and around the colonies there are crystals.

Dextrose gelatine stab: Nailhead; whitish buff; the line of stab erose.

Nutrient gelatine stab: The growth forms a crateriform hollow.

Nutrient gelatine slope: Slight liquefaction.

Nitrate cellulose agar colonies: Size: 4 mm. Clear zone 0,3 to 0,5 mm. Shape: irregularly round. Elevation: flat to concave. Colour: whitish-transparent, border white; surface: resinous, smooth centre, radiate border. Edge: undulate. Deep colonies are lens shaped, with wide white border and white central point.

Peptone cellulose agar colonies: Size: 3 mm. No clear zone round surface colonies. Shape: round or elongated. Elevation: flat to concave. Colour: colourless to whitish. Surface: resinous or granular, smoot. Edge very erose. Deep colonies round; in translucent light show white centre and margin; clear zones formed by deep colonies are 0,5 mm. wide.

Dextrose agar slope: Filiform; convex; white; smooth, shining; edge entire.

Dextrose agar plate: No colonies formed.

Starch agar slope: Filiform; convex; whitish; smooth, shining; edge entire.

Starch agar colonies: Size: 3 to 5 mm. Shape: round. Elevation: convex, with flat or depressed centre. Colour: white to white-buff, opaque; translucent border. Surface: smooth, shining. Edge: entire.

Nutrient agar slope: Filiform; flat; pale buff; smooth, shining; edge lobate.

Nutrient broth: Slightly cloudy.

Peptone broth: Growth is cloudy.

Glycerol broth: Cloudy.

Mannitol broth: Slightly cloudy.

Carbohydrate broths: The growth is cloudy in saccharose and maltose broths. Scum is produced in dextrose, lactose, starch and dextrine broths; fluid clear.

Cellulose broth: The strip of filter paper commences

to disintegrate after 5 to 6 days' incubation. After 10 days it breaks in two on shaking.

Biochemical characteristics.

Starch: Diastase is produced.

Nitrate: Reduced to nitrite.

Peptone: No ammonia produced in cellulose peptone or dextrine peptone broths.

Carbohydrates: Acid produced from dextrose, lactose, starch and dextrine.

pH influence on cellulose decomposition.

Active in cellulose decomposition when reaction of medium is pH 7,0 to 8,0. Cellulose is not attacked at PH 6,0, or at 9,0.

Temperature influence on cellulose decomposition.

Cellulose is disintegrated at 31° C., but not at 34° C.

Vibrio synthetica (6 strains).

Origin: Garden soil from Rothamsted; artificial manure (Adco) heap; soil from pot experiments with lucerne (Rothamsted).

Morphology: Curved rods; in cellulose broth 1,5 μ to 2μ long by 0,3 μ to 0,4 μ broad. On starch agar slope 2 μ to 4 μ long by 0,6 μ to 0,8μ broad. Motile.

Flagella: Polar, single.

Spores: No endospores observed. (See pl. II, fig. 7. and 8.)

Gram: Negative.

Cultural characteristics.

Dextrose gelatine slope: Shape: filiform. Elevation: convex. Colour: white. Surface: rugose, resinous. Edge: erose. The growth of strain 30 is filiform; depressed; white; smooth, shining; edge diffuse, partly liquefied. That of strain 45 is blackish-brown, rugose, matt. Dextrose gelatine is liquefied by one strain (No. 23).

Dextrose gelatine colonies. Size: 2 to 3 mm. Shape: round. Elevation: flat to convex, with raised border. Colour: white

to buff. Surface: smooth, shining; opaque, translucent margin. Edge: entire. Those of one strain (45) are brownish-black; resinous, with smoot centre, rugose border; edge cleft. Strain 23 produces larger colonies, due to partial liquefaction, from 3 to 4 mm.; concave; white; smooth or wrinkled, shining; edge diffuse.

Dextrose gelatine stab: Nail head; line of stab filiform. The growth of one strain (viz. 45) forms a napiform hollow inside the gelatine, 3 cm. deep by 1,2 cm. wide, the neck of the hollow is 0,7 cm. wide. Black colouration of gelatine is produced by this strain (45.).

Nutrient gelatine stab: The growth forms a saccate hollow.

Nutrient gelatine slope: Liquefied.

Nitrate cellulose agar colonies. (See pl. V, fig. 3. and 4.) Size: 4 to 5 mm. Clear zone: 0,0 to 0,2 mm. Shape: round or irregularly round. Elevation: flat to concave. Colour: whitish. Surface: resinous or granular, centre smooth, border radiate. Edge: erose or cleft.

Peptone cellulose agar colonies: Size: 3 to 3,5 mm. Clear zone: 0,2 mm. Shape: round. Elevation: concave. Colour: whitish. Surface: resinous, ringed and radiate; translucent. Edge: erose or cleft.

Dextrose agar slope: Filiform; convex; white; rugose, shining; edge erose. One strain produces blackish pigment.

Dextrose agar plate: Colonies are formed by two strains (23 and 29). They are 3 to 4 mm. wide; round or irregularly round; convex; white; edge undulate, erose. Those of strain 23 are smooth, shining. Those of strain 29 are rugose, resinous.

Starch agar slope: Filiform; convex; whitish-buff; smooth, shining; edge erose. One strain (viz. 45) produces rugose growth, with black pigment formation.

Starch agar colonies. Size: 3 to 5 mm. Shape: round. Elevation: convex. Colour: white to buff. Surface: smooth, resinous or granular. Edge: undulate, entire.

Nutrient agar slope: Filiform; convex; white; smooth, shining; edge lobate or erose.

Nutrient broth: Cloudy.

Peptone broth: Slight cloudiness produced by four strains.

Glycerol broth: Slight cloudiness produced by four strains. Two strains (viz. 23 and 45) do not grow.

Mannitol broth: Slight growth, cloudy. One strain (viz. 45) does not grow.

Carbohydrate broths: Thick scum or mucous ring is produced in starch, dextrine, dextrose and lactose; fluid is clear, except that of two strains (viz. 5 and 11), which produce cloudiness in dextrose broth. The growth in arabinose and xylose is cloudy, or flocculent, with formation of scum or ring. Sucrose broth is cloudy, without surface growth. Scum without cloudiness is produced in sucrose broth by one strain (viz. 45). Cloudiness in inulin broth is observed for two strains (viz. 23 and 45), the latter with scum formation.

Cellulose broth: Cellulose disintegration commences in 3 days (strain 45 in 4 to 5 days). After 10 days the paper becomes transparent above the surface of the fluid, and easi breaks in two when agitated. Two strains (viz. 11 and 29), though making the paper transparent, do not disintegrate it in separate fibres, so that the pape: holds together even at slight agitation.

Biochemical characteristics.

Starch: Diastase is produced.

Nitrates: Reduced to nitrites.

Peptone: Ammonia produced by two strains (viz. 23 and 29).

Carbohydrates: Slight acid production from dextrose and lactose.

pH influence on cellulose decomposition.

Cellulose is attacked at pH 7,0 to 8,0 by five strains. One strain (viz. 29) decomposes cellulose at pH 6,0 to 9,0.

Temperature influence on cellulose decomposition.

Strain	Cellulose attacked at °C	but not at °C
5	34	37,5
11	29	31
23	34	37,5
29	31	34
30	34	37,5
45	27	29

Vibrio ranicula (2 strains).

Origin: Ditch soil from Rothamsted (Broadbalk); soil from Cheshire.

Morphology: Cells curved, in cellulose broth 2μ to 2,5 μ long by 0,4 μ broad. On starch agar slopes 2,5 μ to 3,5 μ long by 0,8 μ broad. Motile.

Flagella: Polar, single. (See pl. II, fig. 12.)

Spores: No endospores observed.

Gram: Negative.

Cultural characteristics.

Dextrose gelatine slope: Shape: filiform. Elevation: convex. Colour: white to buff. Surface: matt, wrinkled or smooth. Edge: lobate, erose.

Dextrose gelatine colonies: Size: 1,5 to 2,5 mm. Shape: round or irregularly round. Elevation: flat to convex with raised border. Colour: whitish; those of strain 43 brown. Surface: smooth, resinous or granular. Edge: lobate, entire.

Dextrose gelatine stab: Nail head concave; white; matt; wrinkled; lobate. The line of stab filiform.

Nutrient gelatine stab: Growth filiform, no liquefaction.

Nutrient gelatine slope: Filiform; flat; greyish transparent; smooth, resinous; edge entire. The growth is very slight.

Nitrate cellulose agar colonies. (See pl. V, fig. 5.) Size: 3—4 mm. Clear zone: 1,5 mm.; those of strain 43 without zone. Shape: round. Elevation: flat to concave with raised centre. Colour: white to buff. Surface: smooth, resinous or granular. Edge: undulate, erose.

Peptone cellulose agar colonies. Size: 3 to 5 mm. Clear zone: 1 mm.; those of strain 43 without zone. Shape: round or irregular. Elevation: flat to concave. Colour: white to buff. Surface: smooth, resinous or granular. Edge: undulate, erose.

Dextrose agar slope: Filiform; convex; buff; wrinkled, resinous; edge erose.

Dextrose agar plate: No colonies formed.

Starch agar slope: Filiform; convex; buff (strain 43 orange), smooth, shining; edge erose.

Starch agar colonies: Size: 5 to 8 mm. Shape: round. Elevation: flat to convex. Colour: brownish. Surface: smooth, shining. Edge: erose.

Nutrient agar slope: Filiform (wide); convex; whitish buff; smooth, shining; edge erose.

Nutrient broth: Slightly cloudy.

Peptone broth: No growth.

Glycerol broth: Slightly cloudy.

Mannitol broth: No growth.

Carbohydrate broths: Growth is cloudy in dextrose, lactose, saccharose, maltose, starch, dextrine and arabinose broths. Strain 4 produces scum or ring in all these media except saccharose broth. With inulin growth is clear with a scum. Strain 43 forms scum in dextrose, maltose and dextrine broths. No growth in xylose broth.

Cellulose broth. (See pl. VII, fig. 16 c): Filter paper is attacked by strain 4 in 2 days; strain 43 disintegrates paper after 4 days, when yellow colouration appears and gradually spreads over the portion of the paper emerging out of the liquid; liquid becomes slightly yellow. All strains produce cloudiness. After 10 days the paper becomes very thin and transparent on the surface level of the liquid; when slightly agitated it breaks into a pulpy mass of disintegrated fibres.

Biochemical characteristics.

Starch: Diastase is produced.

Nitrate: No nitrite formed.

Peptone: Slight production of ammonia in cellulose peptone broth.

Carbohydrates: Acid produced from dextrose, lactose, starch and dextrine.

pH influence on cellulose decomposition.

Strain 43 is active at pH 7,0 to 9,0; strain 4 active at pH 7,0 to 8,0.

Temperature influence on cellulose decomposition.

Cellulose is attacked at 29° C., but not at 31° C.

Vibrio malamoria (5 strains).

Origin: Ditch soil from Oxfordshire; glasshouse soil from Cheshunt; soil from Rothamsted experimental plots (Broadbalk).

Morphology: Cells are curved; in cellulose broth they measure 1,5 μ to 2,5 μ, sometimes longer, by 0,3 μ broad. In starch agar slope 2 μ to 4 μ long by 0,7 μ to 0,9 μ broad. Motile.

Flagella: One polar flagellum, curved or undulate. (See pl. II, fig. 10 and 11.)

Spores: No endospores observed.

Gram: Negative.

Cultural characteristics.

Dextrose gelatine slope: Shape: filiform with beadlike swellings. Elevation: convex. Colour: buff. Surface: smooth, resinous. Edge: entire.

Dextrose gelatine colonies: Size: 1 to 2,5 mm. Shape: round. Elevation: convex. Colour: white to buff. Surface: smooth, resinous. Edge: undulate, erose. Crystals inside and around the colonies.

Dextrose gelatine stab: Nailhead pale buff, erose. The line of stab is filiform. (No pigment production).

Nutrient gelatine stab: Filiform; no liquefaction.

Nutrient gelatine slope: Filiform; flat; greyish; smooth, shining; edge entire. The growth is slight.

Nitrate cellulose agar colonies See pl. VI, figs. 7—9). Size: 2 to 4 mm. Clear zone 1 to 2 mm.; two strains (viz. 49 and 67) form clear zones only round deep colonies. Shape: round. Elevation: concave to flat with raised centre. Colour: white. Surface: resinous, smooth centre, radiate border. Edge: lobate, erose.

Peptone cellulose agar colonies: Size: 2 to 3 mm. Clear zone: 0,5 to 1,5 mm. Shape: round. Elevation: concave to umbonate. Colour: white to transparent. Surface: smooth, resinous. Edge: undulate, erose.

Dextrose agar slope: Filiform; convex; whitish-buff; smooth, resinous or shining; edge entire.

Dextrose agar colonies: Size: 2 to 3 mm. Shape: round or irregularly round. Elevation: flat to convex. Colour: whitish-buff. Surface: resinous or shining, smooth centre, border rugose or ringed. Edge: undulate, entire. Crystals are formed inside and around the colonies. No colonies formed by two strains (viz. 49 and 67).

Starch agar slope: Filiform; flat or slightly convex; pale buff; smooth, shining; edge undulate, entire.

Starch agar colonies: Size: 2 to 3 mm. Shape: round. Elevation: flat to convex. Colour: white to buff. Surface: smooth, shining. Edge: undulate, entire.

Nutrient agar slope: Filiform; convex; white; smooth, shining; edge entire or slightly erose.

Nutrient broth: Slightly cloudy.
Peptone broth: No growth.
Glycerol broth: No growth.
Mannitol broth: No growth.

Carbohydrate broths: The growth is cloudy with or without scum formation in dextrose, saccharose, maltose, lactose, dextrine, starch and arabinose broths. Scum is produced in dextrose by 4 strains, in starch by 3 strains, in saccharose by one strain, in arabinose by one strain. Three strains grow in inulin and xylose broths.

Cellulose broth. (See pl. VII, fig. 15-a). Disintegration of cellulose commences in 2 to 5 days (the time depending on strain) and is completed in 10 days. Thick layer of disintegrated cellulose is formed at the bottom of the tube. The liquid is opalescent.

Biochemical characteristics.

Starch: Diastase is produced.
Nitrate: Reduced to nitrate.
Peptone: Ammonia produced by two strains (viz. 48 and 51).
Carbohydrates: Acid produced from dextrose by four strains; from saccharose, lactose and maltose by 3 strains; from starch, dextrine and inulin by 2 strains.

pH and temperature influence on cellulose decomposition.

Strains	Active at pH.				Active at temperature			
	6,0	7,0	8,0	9,0	29° C	31° C	34° C	37,5° C
8	0	+	+	+	+	+	+	0
48	0	+	+	0	+	+	+	+
49	0	+	+	0	+	0	0	0
51	0	+	+	+	+	+	+	0
67	0	+	+	0	+	+	0	0

Vibrio napi (2 strains).

Origin: Soils of Rothamsted experimental plots, manured with rape cake (Broadbalk 19) and farmyard manure (Barnfield 1.).

Morphology: Cells curved, in cellulose broth 2 μ to 3 μ long by 0,4 μ broad. On starch agar slope cells measure 2 μ to 3,5μ long by 0,7 μ broad. Motile.

Flagella: Polar, single. (See pl. III, fig. 13.)

Spores: No endespores observed.

Gram: Negative.

Cultural characteristics.

Dextrose gelatine slope: Shape: filiform. Elevation: convex; yellowish brown; smooth (or slightly wrinkled), resinous; edge lobate.

Dextrose gelatine colonies: Size: 1 to 1,5 mm. Shape: round. Elevation: flat to umbonate. Colour: white or brown. Surface: smooth, resinous. Edge: undulate, entire. Colonies are surrounded by numerous very small crystals.

Dextrose gelatine stab: Nailhead concave; slightly brownish; smooth, shining; edge undulate. Line of stab filiform. Gelatine slightly buff.

Nutrient gelatine stab: Growth filiform, no liquefaction.

Nutrient gelatine slope: Filiform; flat; greyish; smooth, resinous or granular; edge entire.

Nitrate cellulose agar colonies. (See pl. V, fig. 6): Size: 2,5 mm. Clear zone: 0—0,2 mm. Shape: round or irregularly round. Elevation: concave, middle umbonate. Colour: white. Surface:

smooth, resinous; border transparent, slightly radiate. Edge: undulate, erose or cleft.

Peptone cellulose agar colonies: Size: 2 to 2,5 mm. Clear zone: 0,0 to 0,2 mm. Shape: round. Elevation: concave with raised centre. Colour: white to transparent-watery. Surface: smooth or slightly ringed; resinous. Edge: erose.

Dextrose agar slope: Filiform; convex; buff; smooth, shining; edge entire.

Dextrose agar colonies: Size: 3 to 4 mm. Shape: round. Elevation: convex to flat. Colour: buff. Surface: smooth, shining. Edge: undulate or cleft. Round the colonies there are many crystals.

Starch agar slope: Filiform; convex; buff; smooth, shining; edge entire.

Starch agar colonies: Size: 3 to 4 mm. Shape: round. Elevation: flat to convex. Colour: buff, centre brown. Surface: smooth (or ringed), resinous. Edge: undulate, entire.

Nutrient agar slope: Filiform; convex; whitish-buff; smooth, shining; edge entire.

Nutrient broth: Slight cloudiness.
Peptone broth: No growth.
Glycerol broth: No growth.
Mannitol broth: No growth.

Carbohydrate broths: Growth is cloudy in dextrose, lactose, maltose, saccharose, starch, dextrine and inulin broths. Scum or ring is produced by one strain (No. 6) in dextrose, xylose and arabinose broths.

Cellulose broth. (See pl. VII, fig. 15 c): Cellulose is attacked after 2 days' incubation. The liquid is cloudy. A yellow pigment is formed colouring the paper and the liquid. After 10 days the paper becomes transparent above the surface of the liquid.

Biochemical characteristics.

Starch: Diastase is produced.
Nitrate: Reduced to nitrite.

Peptone: Ammonia is produced in peptone cellulose and peptone dextrine broths.

Carbohydrates: Acid produced by both strains from dextrose, starch, dextrine; by one strain (No. 6) from lactose, maltose and saccharose. Strain 28 is a rather weak acid producer.

pH influence on cellulose decomposition.

One strain (No. 6) is active in the range of pH 6,0 to 9,0; the other (No. 28) has smaller range of activity, from 7,0 to 8,0.

Temperature influence on cellulose decomposition.

Strain 6 is active at 34° C., not at 37° C. Strain 28 is active at 29° C., not at 31° C.

Vibrio rigensis (1 strain).

Origin: Field soil (neutral) from Auce, Latvia.

Morphology: Cells curved, in cellulose broth 2μ to 3μ long by 0,4 μ broad. On starch agar slopes cells measure 2,5 μ to 3,5 μ long by 0,7 μ broad. Motile.

Flagella: Polar, single (curved or undulate). (See pl. III, fig. 14.)

Spores: No endospores observed.

Gram: Negative.

Cultural characteristics.

Dextrose gelatine slope: Shape: filiform. Elevation: convex. Colour: yellow. Surface: smooth, shining. Edge: entire.

Dextrose gelatine colonies: Size: 2 to 4 mm. Shape: round. Elevation: convex. Colour: buff. Surface: smooth or ringed, resinous. Structure: radiate. Edge: entire.

Dextrose gelatine stab: Nailhead flat; brown; smooth, resinous, edge entire. The line of stab erose.

Nutrient gelatine slope: Filiform, concave, greyish, smooth, resinous; edge erose.

Nutrient gelatine stab: Nailhead yellowish; the line of stab erose.

Nitrate gelatine agar colonies: Size: 2,5 to 3 mm. Clear zone: 3,0 to 0,5 mm. Shape: round. Elevation: concave (with

raised centre). Colour: white. Surface: resinous; centre smooth, border radiate. Edge: erose, cleft.

Peptone cellulose agar colonies: Size: 2,5 mm. Clear zone: 0,7 mm. Shape: round. Elevation: concave. Colour: white. Surface: resinous, radiate. Edge: undulate, slightly cleft.

Dextrose agar slope: Filiform; convex; buff; wrinkled, resinous; edge erose.

Dextrose agar plate: No colonies formed.

Starch agar slope: Filiform; convex; greyish, smooth, shining; edge entire.

Starch agar colonies: Size: 4 to 5 mm. Shape: round. Elevation: umbonate. Colour: yellowish. Surface: ringed, resinous. Edge: undulate, entire.

Nutrient agar slope: Filiform; convex; white; smooth, shining; edge entire.

Nutrient broth: Slightly cloudy.

Peptone broth: No growth.

Mannitol broth: No growth.

Glycerol broth: No growth.

Carbohydrate broths: Growth is cloudy in dextrose, saccharose, maltose, lactose, starch, dextrine, arabinose and xylose. Scum or ring is produced in dextrose, lactose, dextrine and starch broths. No growth in inulin broth.

Cellulose broth: Cellulose disintegration commences in 2 days and is completed in 10 days. The liquid is opalescent. (Cellulose decomposition less active with organic source of nitrogen).

Biochemical characteristics.

Starch: Diastase is produced.

Nitrates: Nitrates not reduced to nitrites.

Peptone: No ammonia produced.

Carbohydrates: Slight acid production from dextrose, saccharose, lactose, starch and dextrine.

pH influence on cellulose decomposition.

Active at pH 7,0 to 8,0.

Temperature influence on cellulose decomposition.

Cellulose is attacked at 29° C., but not at 31° C.

Vibrio pericoma (two strains).

Origin: Allotment soil from Rothamsted; garden soil from Harpenden, Herts.

Morphology: Cells curved; in cellulose broth 1 μ to 2 μ long by 0,3 μ broad; on starch agar slopes 3 μ to 4 μ long by 0,6 μ to 0,8 μ broad. Motile.

Flagella: Majority of cells have one polar flagellum, curved or undulate. About 5 to 10 per cent. of cells have 2 to 8 peritrichous flagella. (See pl. II, fig. 9.)

Spores: No endospores observed.

Gram: Negative.

Cultural characteristics.

Dextrose gelatine slope: Shape: filiform. Elevation: convex. Colour: white. Surface: resinous, centre rugose, border smooth. Edge: lobate.

Dextrose gelatine colonies: Size: 1 to 2 mm. Shape: round. Elevation: convex to umbonate. Colour: whitish-buff. Surface: smooth, resinous. Edge: entire.

Dextrose gelatine stab: Concave; white; rugose, resinous; line of stab filiform, erose.

Nutrient gelatine stab: Nailhead.

Nutrient gelatine slope: Filiform; concave; greyish; smooth, shining; edge entire.

Nitrate cellulose agar colonies: Size: 1,5 mm. Clear zone: 1,5 to 2 mm. Shape: round. Elevation: umbonate to flat. Colour: white. Surface: resinous, smooth centre, border radiate. Edge: undulate, very erose.

Peptone cellulose agar colonies. Size: 1,5 to 2,5 mm. Clear zone: 1 mm. Shape: round. Elevation: umbonate to flat. Colour: white. Surface: resinous, smooth centre, border radiate. Edge: undulate, very erose.

Dextrose agar slope: Filiform; convex; white; smooth; shining; edge lobate.

Dextrose agar plate: No colonies formed.

Starch agar slope: Filiform; flat, slightly depressed; greyish; smooth, shining; edge entire.

Starch agar colonies: Size: 3 to 4 mm. Shape: round. Elevation: umbonate to convex. Colour: white. Surface: resinous, centre smooth, border ringed. Edge: undulate, entire.

Nutrient agar slope: Filiform; convex; whitish; smooth, shining; edge lobate.

Nutrient broth: Cloudy.

Peptone broth: No growth.

Glycerol broth: No growth.

Mannitol broth: No growth.

Carbohydrate broths: Growth is cloudy in dextrose, maltose, lactose, saccharose, starch, dextrine, arabinose and xylose, clear with scum in inulin. Scum is also formed in arabinose.

Cellulose broth: No visible disintegration of cellulose before 5 days. The liquid is very cloudy. After 10 days the strip of paper is not broken in two.

Biochemical characteristics.

Starch: Diastase is produced.

Nitrates: Reduced to nitrites. (No gas produced).

Peptone: Slight production of ammonia in peptone cellulose and peptone dextrine broths.

Carbohydrates: Acid produced from dextrose, lactose, maltose, saccharose, starch, dextrine and inulin.

pH influence on cellulose decomposition.

Cellulose is attacked at pH 7,0 to 8,0. No growth at pH 6,0 and 9,0.

Temperature influence on cellulose decomposition.

Cellulose is decomposed by one strain at 31° C. (not at 34° C.); by the other at 29° C. (not at 31°C.).

Bacterium elaphorum (4 strains).

Origin: Soils from Rothamsted experimental plots (Barnfield); Rothamsted grass plot, limed; field soil from Wheathamsted.

Morphology: Straight rods; in cellulose broth 1,5 μ to 2,5 μ

long by 0,5 μ broad; on dextrose agar slope cells oval, 1,5 μ to 4 μ long by 1 μ to 1,5 μ broad. Motile.

Flagella: Polar, single, undulate or curved. (See pl. III, figs. 15 and 16.)

Spores: No endospores observed.

Gram: Negative.

Cultural characteristics.

Dextrose gelatine slope: Shape: filiform. Elevation: convex. Colour: buff. Surface: smooth, shining. Edge: entire.

Dextrose gelatine colonies: Size: 2 to 3 mm. Shape: round. Elevation: convex with depressed centre. Colour: white to buff. Surface: smooth, shining; transparent with opaque centre. Edge: entire. Those of strain 39 are 1 mm. large; yellow; translucent; edge erose.

Dextrose gelatine stab: Nailhead; very slight growth. Strain 38 forms large nailhead; the line of stab filiform, in upper part beaded.

Nutrient gelatine stab: Nailhead; slight growth.

Nutrient gelatine slope: Filiform; flat; smooth, shining, translucent. Very faint growth.

Nitrate cellulose agar colonies (See pl. VI, fig. 10): Size: 2 to 3 mm. Clear zone: 0,2 mm. Shape: round. Elevation: concave, or flat. Colour: whitish. Surface: resinous, smooth or ringed, with radiate border. Edge: undulate or cleft, erose.

Peptone cellulose agar colonies: Size: 2 to 3 mm. Clear zone: 0,3 mm. Shape: round. Elevation: concave. Colour: white. Surface: resinous, smooth centre, radiate border. Edge: erose. Those of strain 39 are flat or umbonate with cleft border; clear zone: 0,5 mm.

Dextrose agar slope: Filiform; convex; white; smooth, shining; entire. The growth on slopes is attained only when inoculum of fresh liquid cultures (2—3 days old) is used.

Dextrose agar plate: No colonies.

Starch agar slope: No growth.

Starch agar plate: No colonies.

Nutrient agar slope: Filiform; convex; whitish-grey;

smooth, matt; edge entire. Two strains (viz. 30 and 40) produce beaded growth.

Nutrient broth: Growth slight, cloudy.

Peptone broth: No growth.

Glycerol broth: No growth.

Mannitol broth: No growth.

Carbohydrate broths: Growth is cloudy in dextrose, lactose, maltose, saccharose and dextrine. Scum is produced in arabinose. Strain 39 produces scum or ring, additionally to cloudiness. No growth in starch, inulin and xylose (except one strain).

Cellulose broth: Cellulose is disintegrated at the surface level of the liquid in two days; on slight agitation the paper breaks in two. If kept unshaken, after 10 days the paper forms a transparent film just above the surface of the liquid. Two strains (38 and 40) form transparent, slightly buff spots. The liquid is slightly cloudy.

Biochemical characteristics.

Starch: No diastase produced.

Nitrate: Reduced to nitrite.

Peptone: No ammonia produced.

Carbohydrates: Slight acid production from dextrose, saccharose, lactose, maltose.

pH influence on cellulose decomposition.

Cellulose is attacked by all strains at pH 9,0; two strains (viz. 38 and 40) decompose cellulose at pH 6,0.

Temperature influence on cellulose decomposition.

Cellulose is decomposed by all strains at 37,5° C.

Bacterium bosporum (1 strain).

Origin: Field soil from Oxfordshire.

Morphology: Straight rods; in cellulose broth cells measure 1 μ to 1,5 μ long by 0,5 μ to 0,6 μ broad. Some coccoid forms 0,5 μ to 0,6 μ in diameter. On starch agar 1,5 μ to 2,5 μ long by 0,8 μ broad. Motile.

Flagella: Polar, single, straight or undulate. (See pl. III, fig. 17.)

Spores: No endospores observed.
Gram: Negative.

Cultural characteristics.

Dextrose gelatine slope: Shape: filiform. Elevation: flat. Colour: white. Surface: resinous, centre smooth, border wrinkled. Edge: lobate. Slight growth.

Dextrose gelatine colonies: Size: 1,5 mm. Shape: irregularly round. Elevation: convex. Colour: whitish. Surface: slightly wrinkled, resinous. Edge: deeply cleft.

Dextrose gelatine stab: Nailhead.

Nutrient gelatine stab: The growth forms a saccate hollow 15 mm. deep, 4 mm. wide; deeper, the growth is tapered.

Nutrient gelatine slope: Liquefied.

Nitrate cellulose agar colonies (See pl. VI, fig. 11): Size: 4 mm. Clear zone: 4 mm. Shape: amoeboid. Elevation: umbonate. Colour: whitish. Surface: smooth, resinous. Edge: undulate, erose.

Peptone cellulose agar colonies: Size: 2 to 2,5 mm. Clear zone: 2 mm. Shape: amoeboid. Elevation: umbonate. Colour: white. Surface: smooth, resinous; radiate structure. Edge: undulate, entire.

Dextrose agar slope: Filiform; convex; whitish; smooth, resinous; edge entire.

Dextrose agar plate: No colonies formed.

Starch agar slope: Filiform; convex; greyish; smooth, shining; translucent; edge entire. Consistence very slimy.

Starch agar colonies: Size: 3 mm. Shape: round. Elevation: convex. Colour: white. Surface: smooth, resinous. Edge: entire. Enzymic zone: 8 mm.

Nutrient agar slope: Filiform; flat; white; smooth, shining. Edge: echinulate. Slight growth.

Nutrient broth: Slight growth, cloudy.
Peptone broth: No growth.
Glycerol broth: No growth.
Mannitol broth: No growth.

Carbohydrate broths: Slight cloudiness produced in

dextrose, saccharose, maltose and arabinose broths. Scum or ring is formed in lactose, starch, dextrine, inulin and arabinose broths.

Cellulose broth: Disintegration of cellulose is visible after 5 to 6 days. Liquid slightly cloudy. After 10 days a pulpy sediment of disintegrated fibres is formed. Less active in cellulose decomposition with peptone or Lemco as the source of nitrogen.

Biochemical characteristics.

Starch: Diastase is produced.

Nitrate: No nitrite formed.

Peptone: Slight production of ammonia in peptone cellulose broth.

Carbohydrates: Acid produced from dextrose, lactose, saccharose, starch, dextrine and inulin.

pH influence on cellulose decomposition.

Cellulose is disintegrated at pH 7,0 and 8,0: cellulose is not attacked at pH 6,0 or 9,0.

Temperature influence on cellulose decomposition.

Active at 29° C., but not at 31° C.

Bacterium pusiolum (2 strains).

Origin: Soils from Rothamsted experimental plots, manured with farmyard manure (Broadbalk and Barnfield).

Morphology: Straight rods; in cellulose broth 2 μ to 2,5 μ long by 0,4 μ broad. On starch agar slopes 1,5 μ to 2,5 μ long by 0,5 μ broad. Often chains of 4 to 5 cells. Motile.

Flagella: One polar flagellum. (See pl. III, fig. 18.)

Spores: No endospores observed.

Gram: Negative.

Cultural characteristics.

Dextrose gelatine slope: Shape: filiform. Elevation of growth: raised. Colour: whitish-buff. Surface: smooth, resinous. Edge: entire.

Dextrose gelatine colonies: Size: 1 mm. Shape: round. Elevation: convex (half-sphere). Colour: whitish-buff. Surface: smooth, resinous. Edge: entire. Colonies are surrounded by small crystals.

Dextrose gelatine stab: Nail head concave; whitish buff; shining; line of stab filiform, erose.

Nutrient gelatine stab: Nail head.

Nutrient gelatine slope: Filiform; flat; whitish; granular, matt; edge entire.

Nitrate cellulose agar colonies (See pl. VI, fig. 12): Size. 2,5 to 4 mm. Clear zone: 2 to 3 mm. Shape: round. Elevation: concave, with raised centre. Colour: whitish. Surface: resinous, smooth. Edge: undulate, erose.

Peptone cellulose agar colonies: Size: 2,5 mm. Clear zone: 2,5 mm. Shape: round. Elevation: concave. Colour: whitish. Surface: resinous, smooth. Edge: very erose.

Dextrose agar slope: Filiform; convex; pale buff; smooth, shining or granular; edge entire or erose.

Dextrose agar plate: No colonies.

Starch agar slope: Filiform; convex; white to buff; smooth, shining or granular; edge entire or erose.

Starch agar colonies: Size 4 to 5 mm. Shape: round. Elevation: flat to convex. Colour: white to buff. Surface: smooth, shining, opaque; translucent margin. Edge: undulate, erose.

Nutrient agar slope: Filiform; depressed; white; smooth; shining; edge lobate.

Nutrient broth: One strain with cloudy growth.

Peptone broth: No growth.

Glycerol broth: No growth.

Mannitol broth: No growth.

Carbohydrate broths: Growth is cloudy with formation of scum or ring in dextrose, lactose, maltose, saccharose, starch, dextrine and arabinose. One strain (No. 12) does not produce scum.

Cellulose broth: Cellulose disintegration commences in 2 to 3 days; cellulose breaks in two after 5—6 days. The liquid is cloudy. After 10 days the broken up (immersed) portion of paper does not disintegrate into fibres on agitation of the tube.

Biochemical characteristics.

Starch: Diastase is produced.

Nitrate: Reduced to nitrite.

Peptone: No ammonia produced.

Carbohydrates: Strong acid production from dextrose, lactose, maltose, starch, dextrine and saccharose.

pH influence on cellulose decomposition.

Cellulose is attacked at the range of pH from 7,0 to 9,0.

Temperature influence on cellulose decomposition.

Cellulose is decomposed at 34° C., but not at 37,5° C.

Bacterium protozoides (6 strains).

Origin: Allotment soil from Rothamsted; ditch soil from Rothamsted experimental plots (Broadbalk); Woburn field soil, manured.

Morphology: Straight rods. In cellulose broth cells measure 1,0 μ to 12,0 μ long by 0,3 μ to 0,4 μ broad; the majority about 1 μ to 1,5 μ long; the cells taper towards the extremities. Coccoid cells 0,8 μ to 1,0 μ in diameter. Irregular forms (lemonlike) measure 1,5 μ × 0,8 μ to 4 μ × 1,5 μ. Motile, also the irregular cells. (See pl. IV, fig. 19.). On starch agar cells measure 2 μ to 4 μ long by 0,8 μ to 1,0 μ broad. Irregular forms, like those in cellulose broth, not observed.

Flagella: One polar flagellum, straight or curved. (See pl. IV, fig. 20.).

Spores: No endospores observed.

Gram: Negative.

Cultural characteristics.

Dextrose gelatine slope (7 days): Shape: filiform. Elevation of growth: depressed. Colour: whitish to buff. Surface: smooth, shining. Edge: entire.

30 days old slope: filiform; convex; buff; rugose, resinous; edge erose.

Dextrose gelatine colonies: Size: 1,5 to 3 mm. Shape: round or irregularly round. Elevation: convex with raised border. Colour: white to buff. Surface: centre smooth, border granular, resinous. Edge: lobate, entire.

Dextrose gelatine stab: The growth forms a saccate hollow 20 to 30 mm. deep; the line of stab in lower part filiform. No liquefaction observed.

Nutrient gelatine stab: Nailhead.

Nutrient gelatine slope: Filiform; concave; greyish, transparent, smooth, resinous; edge entire. Slight growth.

Nitrate cellulose agar colonies (See pl. VII, fig. 13): Size: 4 to 5 mm. Clear zone: 4 mm. Shape: round and amoeboid. Elevation: convex to umbonate, with raised border. Colour: white. Surface: smooth, shining or resinous. Edge: slightly undulate.

Peptone cellulose agar colonies: Size: 4 to 7 mm. Clear zone: 3 to 4 mm. Shape: round and amoeboid. Elevation: convex; amoeboid colonies concave. Colour: white to greyish-white. Surface: smooth or slightly ringed, shining to resinous. Edge: undulate, lobate, slightly erose.

Dextrose agar slope: Filiform; convex; whitish; smooth, shining; edge entire. Slight growth.

Dextrose agar plate: No colonies formed.

Starch agar slope: Filiform, convex; whitish; smooth, shining, viscid; edge entire.

Starch agar colonies: Size: 6 to 8 mm. Shape: round. Elevation: convex. Colour: whitish. Surface: smooth, shining. Edge: entire. Enzymic zone: 10 mm.

Nutrient agar slope: Filiform; convex; white; smooth, shining. Edge: lobate.

Nutrient broth: No growth. Slight cloudiness produced in nitrate broth.

Peptone broth: No growth.
Glycerol broth: No growth.
Mannitol broth: No growth.

Carbohydrate broths: Growth is very cloudy, with formation of scum or ring in dextrose, lactose, maltose, saccharose,

starch dextrine and inulin. Arabinose broth is very cloudy without scum formation. No growth in xylose broth.

Cellulose broth (See pl. VII, fig. 16a): Cellulose is attacked after 4 days. The liquid is cloudy. In 10 days old culture the cellulose disintegrates on slight agitation of the tube. When nitrogen is supplied in the form of ammonium salt, the paper above the surface of the liquid is covered with a thin layer of slime; the reaction of the liquid is acid (below pH 5,0), as the result of ammonium ion absorption by the bacteria.

Biochemical characteristics.

Starch: Diastase is produced.

Nitrate: No nitrites formed.

Peptone: No ammonia produced.

Carbohydrates: Strong acid production from dextrose, lactose, maltose, saccharose; moderate production from starch, dextrine and inulin.

pH influence on cellulose decomposition.

Cellulose is disintegrated in media with initial reaction of pH 6,0. At pH 9,0 cellulose is not attacked.

Temperature influence on cellulose decomposition.

All strains are active at 27° C., but not at 29° C.

Bacillus latvianus (1 strain).

Origin: Parkland of Rothamsted.

Morphology: Straight rods; in cellulose broth cells measure 5 μ to 15 μ long by 1 μ broad; majority about 6 μ to 8 μ long. In starch agar slopes and nutrient broth (2 days) 5 μ to 10 μ long by 1 μ broad. (See pl. IV, fig. 22). There are several very long threads, from 100 to 200 μ long. Motile.

Flagella: Peritrichous, about 20, very long, undulate. (See pl. IV, fig. 21.)

Spores: Endospores are formed; they are polar, 1,5 μ to 2,5 μ long by 1 μ to 1,5 μ broad (7 days starch agar slope).

Gram: Negative.

Cultural characteristics.

Dextrose gelatine slope: Shape: rhizoid (spreading). Elevation: flat; grows inside gelatine. Colour: white. Surface: smooth, resinous. Tendency to spread.

Dextrose gelatine colonies: Only deep colonies formed, 10 mm. large; brownish, deeply cleft and lobate.

Dextrose gelatine stab: Line of stab beaded, arborescent.

Nutrient gelatine stab: The growth forms a saccate or crateriform hollow, about 12 to 15 mm. deep. The line of stab is arborescent. Grows equally well in upper and lower parts of the stab.

Nutrient gelatine slope: Liquefied.

Nitrate cellulose agar colonies: Size: 1,5 mm. Clear zone: 0,2 to 0,4 mm. Shape: round. Elevation: convex to raised. Colour: greyish. Surface: resinous, smooth. Edge: undulate. Deep colonies are irregularly round, 0,5 mm. large, with clear zones 0,5 mm. wide.

Peptone cellulose agar colonies (See pl. VII, fig. 14.): Size: 5 to 7 mm. Clear zone: 5 mm. Shape: irregularly round. Elevation: flat to convex, with depressed centre. Colour: white. Surface: smooth, resinous. Edge: slightly undulate, entire. Deep colonies are irregularly round, 1 mm. large, with clear zones 3 mm. wide.

Dextrose agar slope: Ribbon (spreading); flat; greyish; smooth, resinous; edge very erose.

Dextrose agar colonies: Size: 3,5 mm. Shape: irregular. Elevation: flat. Colour: greyish. Surface: granular or resinous, smooth. Edge: curled.

Starch agar slope: Filiform (spreading); flat; white; smooth, resinous; edge erose.

Starch agar colonies: Size 4 to 6 mm. Shape: irregular. Elevation: flat. Colour: white. Surface: smooth, resinous. Edge; curled.

Nutrient agar slope: Filiform; convex; whitish; smooth, shining; edge very erose.

Nutrient broth: Cloudy.

Peptone broth: Cloudy.

Glycerol broth: Cloudy.

Mannitol broth: Cloudy.

Carbohydrate broths: No growth with nitrate as the source of nitrogen.

Peptone carbohydrate broth: The growth in dextrose, saccharose, maltose, lactose, starch, dextrine and inulin broths is slightly cloudy, or clear with granular suspension. The sediment is flocculent, voluminous, abundant.

Cellulose broth: With nitrate or ammonium salt as the source of nitrogen, the decomposition of cellulose is very slow. After two weeks' incubation at 25° C. cellulose disintegrates to a very small extent. In a month-old culture cellulose, when shaken, breaks down in fine cellulose fibre particles. The fluid is clear.

With peptone or asparagine the cellulose is vigorously attacked. After 2—3 days' incubation filter paper easily disintegrates on shaking. No sediment (from cellulose) is formed in the tube, if kept quiet, even after a lapse of a longer period of time (after 3—4 weeks' incubation).

Biochemical characteristics.

Starch: Diastase is produced.

Nitrate: Reduced to nitrite.

Peptone: Ammonia is produced in peptone water, nutrient broth, or carbohydrate peptone broths.

Carbohydrates: Acid is produced from dextrose, saccharose, maltose, lactose, starch, dextrine and inulin. The degree of acidity attained is that of pH 4,5 to 4,7. Acid is also produced in glycerol broth, but not in mannitol.

In peptone water the reaction is changed to alkaline, due to ammonia production.

Acid is produced in cellulose broth either with nitrate, asparagine, or peptone as the source of nitrogen.

pH influence on cellulose decomposition.

Cellulose is disintegrated, when the initial reaction of cellulose broth is that of pH 7,0 to 9,0. At pH 6,0 no cellulose is attacked.

Temperature influence on cellulose decomposition.

Cellulose is attacked at 34° C., but not at 37,5° C.

IV. Characteristics of the bacteria isolated.

Method of attacking cellulose.

When grown in cellulose broth bacteria rapidly disintegrate the strip of filter paper. The filter paper is first attacked at the level of the culture solution. The first sign of cellulose decomposition is very slight turbidity (opalescence) of the liquid medium. At this state of disintegration the cellulose fibres can be thrown down from attacked region by a slight shaking of the tube. With many strains cellulose is disintegrated rapidly in young cultures, when by slight agitation of the tube the strip of filter paper breaks easily in two pieces. But if kept unshaken for a longer period the filter paper strip holds together even after shaking. In such cases microscopical examination shows that the cellulose fibre has partially or entirely disappeared and has been replaced by bacterial growth which keeps the shape of the fibres. The macroscopical appearance of such growth is usually yellowish. In 2 to 3 months' old cultures, a loose layer of opalescent colloidal matter often accumulates at the bottom of the tube. Several strains (e. g. *Bacterium protozoides*) make the solution in such old cultures slightly viscid. Some strains give rise to yellow-brown or black pigment, whilst one strain (*Vibrio stationis*) produces blue colouration. After 3 to 4 years cultivation in laboratory the colouration of filter paper is less pronounced than just after the isolation of bacteria from soil.

Relation to sources of nitrogen.

The nitrogen requirements of the organisms studied were met by nitrates, ammonium salts, aminoacids, peptone and meat extract (Lemco). Generally the organic nitrogen substances are less suited as sources of nitrogen. Cellulose is attacked more slowly with peptone or Lemco than with nitrate. If nitrogen is given to the "cellulose broth" in form of nitrate, and ammonium salt simultaneously (0,1 per cent. of both salts), the bacteria use ammonium first, so that after 3 weeks of incubation at 25° C. there is no ammonium in the nutrient medium when tested with Nessler's reagent. Strains which do not reduce nitrates are more active in ammonium absorption than those which do so.

Relation to Sources of Energy and Carbon.

The scanty growth on nutrient agar and nutrient gelatine slopes shows that meat extract is a very poor source of carbon and energy for the organisms. Peptone is also unsuitable since in peptone broth only eight strains showed a scanty growth, producing very slight cloudiness.

The calcium salts of following organic acids were tested as sources of carbon: formic, acetic, propionic, butyric, lactic and malic. In mineral salt solution with 0,2 per cent. of sodium nitrate and 1 per cent. of these salts, none of the organisms showed any growth.

Glycerol and mannitol, were found to be entirely unsuitable as sources of carbon and energy. With peptone as a source of nitrogen, slight cloudiness was produced in glycerol broth by only 5 strains, and in mannitol broth by 8 strains. The organisms showing growth in these media are the same that produce growth in peptone broth.

Of the compounds tested, the only compounds well suited as sources of carbon are carbohydrates. The following have been tested: cellulose, dextrose, levulose, maltose, lactose, sucrose, dextrine, starch, inulin, arabinose and xylose. In liquid media containing these compounds the growth is usually cloudy with or without surface growth. In some cases scum production is not accompanied by the cloudiness in liquid. On agar or gelatine slopes the growth is good or abundant when to the routine medium sugar or starch is added. While the great majority of the organisms can use all of the carbohydrates tested, several strains cannot grow in media containing starch, inulin, arabinose or xylose as the sole source of energy and carbon. Starch and inulin, for example, are unsuitable nutrients for *Bacterium elaphorum*.

Acid production from carbohydrates.

Mineral salt solution with either 0,2 per cent. sodium nitrate or 0,5 per cent. peptone was used as basic medium for determination of changes in reaction produced by the organisms. To this was added 1% of the compound to be tested. Before sterilisation the reaction of media was adjusted to pH 7,3 to 7,4. After sterilisation, the reaction was usually about pH 7,1 to 7,3. Test tubes containing 10 c.c. of liquid medium were used. After sterilisation the tubes were in-

oculated with a loopful of fresh culture from cellulose broth, and incubated at 25° C. Determinations of H-ion concentration were carried out after 10 and 20 days incubation. In the early stages of this work the colorimetric method for pH determination was used, but the electrometric method with quinhydrone electrode proved to be quicker, and was used throughout the later work. The following carbohydrates were tested: dextrose, lactose, maltose, sucrose, dextrine, soluble starch, inulin, arabinose and xylose. The means of triplicate determinations are shown in the Table I. and II.

T a b l e I. Changes of reaction produced by studied strains in peptone carbohydrate broths. (Initial pH = 7,1—7,3).

		pH after 10 days							pH after 20 days						
Organism.	Strain.	Dextrose	Lactose	Maltose	Sucrose	Starch	Dextrine	Inulin	Dextrose	Lactose	Maltose	Sucrose	Starch	Dextrine	Inulin
Control		7.22	7.18	7.15	7.30	7.20	7.33	7.30	7.20	7.12	7.18	7.27	7.24	7.30	7.35
V. xylitica	9	6.51	6.68	6.59	7.27	6.65	7.20		6.29	6.60	6.62	7.30	6.19	6.63	
„	31	6.66	6.74	6.58	7.15	6.62	6.69		6.51	6.40	6.38	7.21	6.43	6.42	
„	33	6.74	6.58	6.66	7.21	6.83	6.88		6.62	6.36	6.32	7.32	6.51	6.71	
„	36	6.66	6.49	6.45	6.90	6.73	6.81		6.32	6.39	6.29	6.93	6.20	6.61	
V. prima	25	6.30	6.18	6.29	6.64	6.70	6.32		6.03	6.07	5.96	6.70	6.03	6.10	
„	27	6.52	6.16	5.73	6.70	6.76	6.50		5.69	5.62	5.51	5.90	5.91	5.87	
V. bulbosa	17	6.83	6.96	6.58	7.23	6.80	6.79		6.14	6.28	6.11	7.20	6.14	6.53	
„	19	7.11	6.95	6.56	7.25	6.30	6.27		6.07	6.39	6.23	6.72	6.08	6.50	
„	20	6.49	6.40	6.43	7.19	6.41	6.82		6.02	5.96	5.93	7.25	5.98	6.23	
„	56	6.51	6.95	6.45	6.83	6.66	6.62		6.19	6.90	6.40	6.30	6.31	6.43	
„	58	6.70	6.99	6.68	6.60	6.76	6.51		6.30	6.97	6.32	6.22	6.14	6.40	
V. stationis		6.47	6.60	6.22	6.97	6.59	6.50		5.95	6.20	5.97	6.12	6.16	6.04	
V. castra	22	6.69	6.38	6.05	6.49	6.22	6.41		5.93	5.82	5.80	5.93	5.90	6.29	
„	50	6.68	6.48	6.30	7.19	6.78	6.73	7.08	6.00	5.93	6.09	6.73	6.11	5.90	6.93
„	37	7.19	6.93	7.10	7.23	6.97	7.21		6.73	6.95	6.94	7.06	6.56	6.79	
V. cucumis	35	6.49	6.53	6.54	6.81	6.32	6.41		6.13	6.30	6.23	6.74	6.30	6.24	
Vibrio	5	6.76	6.83	6.77	6.99	7.02	6.91		6.70	6.81	6.82	6.73	6.31	6.73	
synthetica	11	6.75	6.61	6.57	7.25	6.76	6.77		6.37	6.42	6.56	7.22	6.24	6.50	
„	23	6.90	6.98	6.89	7.09	7.12	7.03	7.04	6.72	6.91	6.93	7.15	7.09	6.94	7.01
„	29	6.88	6.71	6.83	7.23	6.90	6.88		6.40	6.36	6.41	6.95	6.37	6.60	
„	30	6.88	6.67	7.09	7.19	6.87	6.90		6.48	6.39	6.92	7.07	6.30	6.50	
„	45	6.57	6.42	6.81	6.68	6.90	6.67	7.11	6.03	6.17	6.59	6.37	6.09	6.43	6.95

Organism.	Strain.	pH after 10 days							pH after 20 days						
		Dextrose	Lactose	Maltose	Sucrose	Starch	Dextrine	Inulin	Dextrose	Lactose	Maltose	Sucrose	Starch	Dextrine	Inulin
V. ranicula	4	6.14	6.20	6.42	6.44	6.51	6.41	6.82	5.83	6.03	6.03	6.11	5.97	5.90	6.77
„	43	6.54	6.48	6.43	6.91	6.36	6.37		5.97	6.12	6.33	6.46	6.13	6.17	
Vibrio	8	6.43	6.40	6.39	6.97	6.36	6.39	7.02	5.92	5.89	6.09	6.78	5.81	5.97	6.19
malamoria	48	5.70	5.82	5.81	5.93	6.38	6.27	7.05	5.21	5.38	5.24	5.29	5.63	5.46	6.93
„	49	6.31	6.36	6.25	6.83	6.43	6.31		5.94	6.02	5.97	6.40	6.10	5.93	
„	51	6.11	6.04	6.13	6.05	6.70	6.59	7.14	5.52	5.90	5.83	5.31	5.77	5.82	5.76
„	67	6.44	6.39	6.23	6.65	6.45	6.45		5.96	5.87	5.91	6.30	5.93	6.18	
V. napi	6	6.24	6.10	6.02	5.98	6.68	6.46	7.09	5.89	5.93	5.81	5.77	5.79	5.98	6.63
„	28	6.48	6.40	6.37	6.83	6.51	6.47		6.10	6.13	6.07	6.44	6.14	6.11	
V. rigensis	7	6.59	6.53	6.71	6.60	6.34	6.48		6.07	6.16	6.48	6.41	6.08	6.11	
V. pericoma	46	5.99	6.07	6.05	5.91	6.24	6.20	6.35	5.57	5.61	5.52	5.40	5.87	5.87	5.79
„	47	5.90	6.19	5.93	5.87	6.43	6.20	6.27	5.41	5.56	5.46	5.37	6.12	6.04	6.01
B. elaphorum	38	6.52	6.33	6.32	6.52	7.48	7.58		6.03	5.97	6.05	6.32	7.88	7.32	
„	39	6.66	6.41	6.40	6.76	7.41	7.48		6.31	6.30	6.14	6.51	7.61	7.27	
„	40	6.44	6.58	6.01	6.91	7.41	7.44		5.84	6.08	5.76	6.38	7.53	7.04	
„	40a	6.52	6.40	6.20	6.86	7.36	7.40		6.01	5.93	5.93	6.45	7.66	7.42	
B. bosporum	48a	5.94	6.15	6.54	6.22	6.55	6.48	6.86	5.54	5.60	5.52	5.75	5.70	6.18	5.92
B. pusiolum	12	6.08	5.93	5.91	6.41	6.32	6.10		5.53	5.69	5.57	5.97	5.78	5.95	
„	14	6.22	5.90	5.82	6.63	6.30	6.31		5.91	5.77	5.50	6.03	6.00	6.06	
B. proto-	52	6.22	5.81	5.96	5.68	6.93	7.00	6.95	5.06	4.89	5.06	4.88	6.14	6.19	6.11
zoides	53	5.43	5.67	5.78	5.78	6.45	6.34	6.60	4.93	4.87	5.10	4.88	6.07	5.89	5.82
„	54	6.23	5.47	5.81	5.89	6.84	6.77	6.95	4.97	5.02	5.20	4.93	6.17	6.07	6.14
„	61	5.86	5.34	5.27	6.05	7.00	6.63	6.91	5.02	4.95	4.81	4.78	6.03	6.23	5.87
„	63	5.21	5.29	6.31	5.55	6.92	7.03	6.84	4.56	5.09	5.47	4.75	6.23	6.19	6.22
„	68	5.69	5.30	6.06	6.60	6.58	6.92	6.78	4.95	4.90	5.33	5.03	5.94	5.79	5.83
Bac. latvianus	70	4.76	4.89	4.92	5.04	4.86	4.81	5.28	4.74	4.78	4.70	4.63	4.65	4.83	5.12
M. agarlique-faciens		6.71	6.68	6.54	6.90	6.94	6.93		6.23	6.09	6.30	6.78	6.27	6.58	
Kluyver's vibrio		6.26	6.21	6.09	6.53	6.74	6.71	7.06	5.49	5.83	5.91	6.23	5.88	5.37	6.63
B. fimi		4.65	5.27	4.89	4.99	5.01	5.02	7.84	4.61	5.21	4.80	4.75	4.93	4.93	7.94
Bac. cellaseus		5.20	4.89	4.95	5.15	5.33	5.32	5.67	5.26	4.94	5.15	5.18	5.28	5.11	5.51
Bac. bibulus		4.36	5.49	5.40	5.73	5.20	5.10	7.90	4.42	5.37	4.70	5.08	5.00	4.90	7.92

T a b l e II. The changes of pH in nitrate mineral salt media containing carbohydrates. (Initial pH = 7,1 — 7,3)

Organism	Strain	Dextrose	Lactose	Maltose	Sucrose	Starch	Dextrine	Inulin	Arabinose	Xylose
Control . . .		7.2	7.1	7.2	7.3	7.2	7.1	7.2	7.2	7.2
V. xylitica . .	9	6.0	7.0	6.9	6.9	7.2	6.0		6.4	
„	33	6.2	6.2	6.4	7.0	7.2	6.3		7.2	7.4
„	31	6.2	6.6	6.8	7.1	7.2	7.2		7.2	7.4
„	36	6.0	6.6	6.8	6.5	7.1	7.1	7.2	7.0	
V. prima . .	25	5.0	5.2	5.9	6.4	6.0	6.5	7.2	6.5	6.3
„	37	5.4	5.6	5.2	5.3	6.3	6.6	7.1	7.3	7.4
V. bulbosa . .	17	6.0	6.1	6.4	6.9	7.2	6.0			
„	19	6.2	6.0	6.2	6.7	6.8	6.1		7.4	7.3
„	20	6.0	6.5	6.3	6.6	6.7	6.6		7.0	
„	56	6.1	6.2	6.6	6.7	6.4	7.2		7.2	
„	58	6.0	6.5	6.4	6.6	7.0	7.2		7.3	
V. stationis .	1	5.9	6.5	6.5	7.5	6.4	6.4			
V. castra . .	22	5.8	6.4	6.0	6.4	6.7	7.2		7.2	
„	50	5.2	5.7	5.9	7.2	7.2	7.1	7.2	7.4	7.2
„	37	6.5	6.4	6.4	7.2	6.8	7.1			
V. cucumis .	35	5.7	6.2	6.1	6.6	6.5	6.4			6.3
V. synthetica	5	6.0	6.6	6.5	6.2	6.4	7.2		7.2	7.4
„	11	6.4	6.3	6.5	7.0	7.2	6.8		7.2	7.1
„	23	6.0	6.4	6.0	6.9	7.4	7.2	7.1	7.2	7.4
„	29	6.5	6.4	6.8	6.9	6.8	7.2		7.2	7.1
„	30	6.5	6.5	6.9	6.9	7.0	7.2		7.1	7.2
„	45	6.5	6.7	6.6	6.8	7.4	7.2	7.4	7.1	7.2
V. ranicula .	4	6.0	5.6	6.0	6.8	6.4	6.4	7.2	7.4	
„	43	5.9	6.0	7.0	7.0	6.1	6.2		7.2	
V. malamoria	8	5.0	6.3	5.3	6.2	7.2	7.0	7.0	7.4	7.4
„	48	5.4	6.0	5.3	5.5	7.0	6.6	7.4	7.4	7.3
„	49	6.0	6.4	7.0	6.7	7.0	6.4			
„	51	5.4	5.8	5.8	5.0	6.2	6.5	7.4	7.3	7.4
„	67	5.8	6.2	6.0	6.4	6.2	6.0		6.0	

Organism	Strain	Dextrose	Lactose	Maltose	Sucrose	Starch	Dextrine	Inulin	Arabinose	Xylose
V. napi . . .	6	5.0	5.7	5.4	6.0	5.4	6.0	7.4	7.2	7.4
„	28	6.0	6.2	6.0	6.3	6.2	6.1		6.0	
V. rigensis .	7	6.0	7.0	6.5	6.6	6.1	6.1		7.2	7.2
V. pericoma .	46	4.6	6.0	5.9	5.3	6.1	7.0	6.0	7.2	6.5
„	47	5.4	6.0	5.3	4.9	6.1	6.4	7.3	7.4	
B. elaphorum	38	6.0	6.0	6.1	6.9				6.5	
„	39	6.2	6.3	6.2	7.0				6.6	
„	40	5.6	6.1	5.7	7.0				6.4	
„	40a	5.0	6.0	5.6	7.0				6.5	6.5
B. bosporum .	48a	5.2	5.4	5.6	5.6	5.7	6.3	5.9	7.4	
B. pusiolum .	12	4.5	5.7	5.4	6.2	7.0	7.1			
„	14	4.6	5.9	5.8	6.3	7.0	6.9		7.0	
B. protozoides	52	5.0	5.1	5.4	5.0	5.9	6.1	6.0	7.4	
„	53	4.9	5.0	5.8	5.1	5.9	5.8	5.9	7.3	
„	54	5.1	5.2	5.0	5.0	5.6	5.5	6.2	7.2	
„	61	4.6	4.8	4.7	4.9	6.0	5.9	6.9	7.2	
„	63	5.0	4.9	4.9	5.0	5.4	5.3	5.8	7.2	
„	68	4.8	4.9	4.9	5.2	5.7	5.6	6.1	7.3	
Bac. latvianus	70	no growth.								
Microspira agar-liquefaciens . .		6.2	6.3	64	6.9	6.3	6.6	7.2	7.3	

The bacteria show great variation between species in respect of acid production from carbohydrates. The strains of the same species also differ in respect of acid production, though the difference is not so great as between different species.

The changes of reaction are greater, when nitrogen is supplied in the form of nitrate, than with the more highly buffered peptone media. Dextrose media generally produce the lowest pH, followed by lactose, maltose, starch and dextrine. Less acid is produced from sucrose; several strains even change the reaction to the alkaline side. Few strains produce acid from inulin. The reaction is made slightly

alkaline in starch media by *B. elaphorum* which grows weakly. Kellerman's organisms, which have been used for comparison, are strong acid producers (with peptone as N source); in this respect they resemble *Bac. latvianus* and *B. protozoides*. Among the agarliquefying organisms Kluyver's vibrio is also very active, whereas *Microspira agarliquefaciens* produced only slight changes of pH.

The changes of reaction in cellulose media.

Mineral salt solution was used as the basic medium. The following compounds as sources of nitrogen were added: sodium nitrate 0,2%, ammonium sulphate, 0,1%, ammonium phosphate 0,1%, asparagine 0,1%, peptone 0,5%. The reaction of media was adjusted before sterilisation to pH 7,3 to 7,4. A strip of filter paper was placed in each tube. The cultures were incubated at 25° C. for 25 days, when determination of H-ion concentration was carried out electrometrically (in duplicate). Table III. shows the results obtained.

An acid reaction is produced when nitrogen is supplied in the form of ammonium sulphate, (with ammonium phosphate the results obtained are very similar). With any of the other substances used as a source of nitrogen, the reaction was either neutral or alkaline. This seems to indicate that the change in reaction is not due to products resulting from cellulose decomposition, but due to the physiological absorption of nitrogen by the bacteria. In the case of ammonium salts this results in acid reaction, in the case of nitrate, — an alkaline reaction. With ammonium salts the resulting pH is about 5,0 to 6,0, depending, as the later investigations show, on the amount of cellulose decomposed. In this series of tests the lowest pH produced is 4,8 (by *Bact. protozoides*), but with better aeration, when the decomposition process was more active, the pH produced was as low as 3,29 (see p. 287, Table VII). The highest pH with nitrate as the source of nitrogen, (8,78.) was produced by *Bact. elaphorum*, the most active cellulose decomposer.

When nitrogen is supplied with both sodium nitrate and ammonium sulphate, the resulting reaction may be acid, neutral or alkaline, depending on the concentrations of the nitrogen compounds used, and on their ratio. With 0,1 per cent. $NaNO_3$ and 0,025 per cent. $(NH_4)_2SO_4$ (ratio 4 : 1) the reaction is acid. With 0,2% $NaNO_3$ and 0,2% $(NH_4)_2SO_4$ (ratio 10 : 1) the resulting reaction is alkaline.

Table III. Changes in reaction produced by bacteria in cellulose media with different sources of nitrogen, after 25 days incubation. (Initial reaction pH = 7,0 — 7,3.)

Organism	Strain	Sources of nitrogen			
		Sodium nitrate	Ammonium sulphate	Asparagine	Peptone
Control		7.07	6.89	7.24	7.30
Vibrio xylitica . .	9	7.37	5.98	6.97	7.16
„ „	31	7.89	5.99	7.04	7.34
„ „	33	7.51	5.89	7.14	7.17
„ „	36	7.84	6.08	7.33	7.19
Vibrio prima . . .	25	7.73	6.02	7.11	7.23
„ „	27	8.01	5.92	7.16	7.14
Vibrio bulbosa . .	17	7.80	5.89	7.08	7.34
„ „	19	7.70	5.94	7.10	7.29
„ „	20	7.77	6.00	7.13	7.19
„ „	56	7.84	6.04	7.08	7.26
„ „	58	7.59	6.20	7.04	7.30
Vibrio stationis . .	1	8.08	5.52	7.14	6.92
Vibrio castra . . .	22	8.03	5.96	7.10	7.20
„ „	50	7.97	5.81	7.12	7.37
„ „	37	7.63	6.08	7.02	7.26
Vibrio cucumis . .	35	7.84	6.16	7.26	7.35
Vibrio synthetica .	5	7.46	5.80	7.24	7.20
„ „	11	7.80	6.03	7.12	7.18
„ „	23	7.68	6.17	7.08	7.34
„ „	29	7.66	6.13	7.14	7.15
„ „	30	7.94	6.15	7.26	7.32
„ „	45	7.62	5.93	7.04	7.18
Vibrio ranicula . .	4	8.01	5.75	7.04	7.19
„ „	43	7.94	6.11	7.37	7.08
Vibrio malamoria .	8	7.89	5.92	7.03	7.21
„ „	48	7.91	5.81	7.20	7.15
„ „	49	7.73	6.09	7.22	7.35
„ „	51	8.05	5.92	7.12	7.38
„ „	67	8.10	6.03	7.35	7.28

Organism	Strain	Sources of nitrogen			
		Sodium nitrate	Ammonium sulphate	Asparagine	Peptone
Vibrio napi	6	8.22	5.31	7.04	6.86
„ „	28	8.08	5.92	7.18	6.95
Vibrio rigensis . .	7	7.46	5.93	7.24	6.93
Vibrio pericoma .	46	8.14	6.13	7.28	7.15
„ „	47	7.74	5.99	7.18	7.12
Bact. elaphorum .	38	8.51	5.78	7.21	7.07
„ „	39	8.14	5.71	7.18	7.10
„ „	40	8.17	5.85	7.24	7.22
„ „	40a	8.78	5.81	7.18	7.08
Bacterium bosporum	48a	7.91	5.55	6.62	7.08
Bacterium pusiolum	12	8.08	5.73	5.90	7.02
„ „	14	7.70	5.45	6.90	7.15
Bact. protozoides .	52	7.48	5.06	7.07	6.89
„ „	53	7.55	5.01	6.68	6.96
„ „	54	7.63	4.87	6.38	7.07
„ „	61	7.34	5.18	6.70	6.96
„ „	63	7.42	4.86	5.80	6.88
„ „	68	7.51	4.86	6.90	6.92
Bac. latvianus . .	70	6.43	6.12	6.44	5.37
Microspira agarliquefaciens		7.87	5.87	7.18	7.15
Kluyver's vibrio . .		7.68	5.81	7.26	7.25
Bact. fimi		6.50	6.36	6.72	5.23
Bac. cellaseus . .		7.12	6.51	6.34	5.93
Bac. bibulus . . .		6.20	6.62	6.63	4.92

The acid culture solutions resulting from the cellulose decomposition in the ammonium mineral salt medium were titrated potentiometrically. The character of titration curves thus obtained shows that the acid reaction of these solutions is due to a strong and not to a weak acid. (See fig. 1). This suggests that the acid reaction is due

to the setting free of sulphuric acid due to ammonium absorption by the organisms.

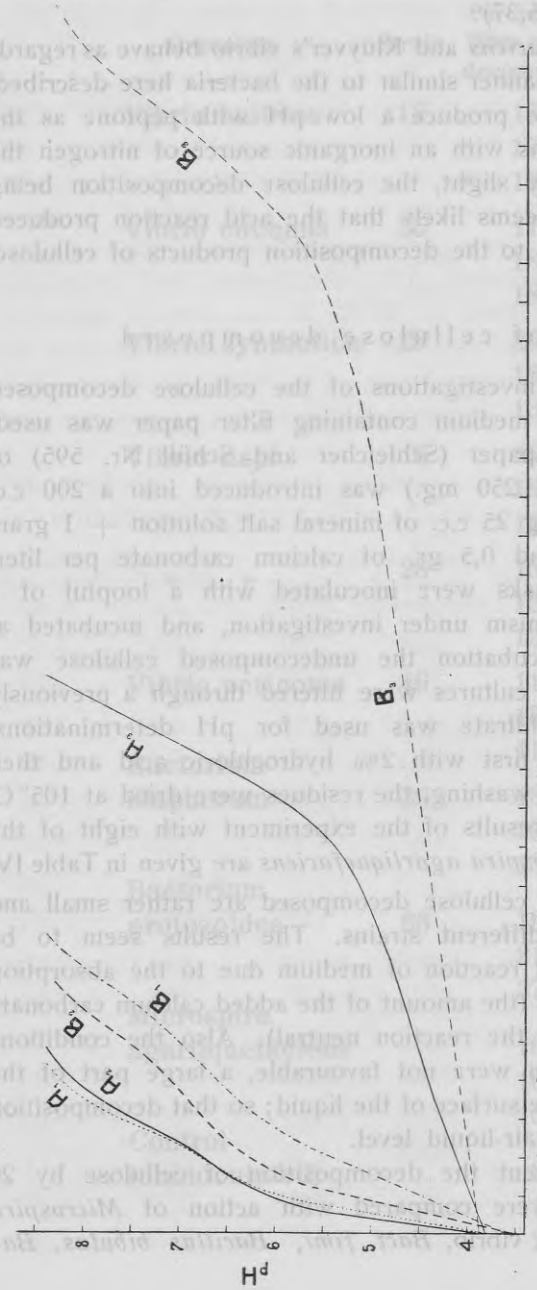

Fig. 1. Titration curves of culture solutions (mineral salts + 0,1% $(NH_4)_2SO_4$ + cellulose) acidified by the action of *Bact. protozoides* (see Table VII, p. 287) or by the addition of hydrochloric or acetic acids. Medium without $CaCO_3$: A_1 = *Bact. protozoides*, A_2 = control + HCl (3·8 milligram equivalents per liter), A_3 = control + acetic acid (26 mg. equivalents per liter). Medium with 0.06% of $CaCO_3$: B_1 = *Bact. protozoides*, B_2 = control + HCl (13 mg. equivalents per liter), B_3 = control + acetic acid (70 mg. equivalents per liter).

With peptone and asparagine there is a very slight change of reaction, generally to the acid side, *Bac. latvianus* being the only one that produces a low pH (5,37).

Microspira agarliquefaciens and Kluyver's vibrio behave as regards changes in reaction in a manner similar to the bacteria here described. Kellerman's organisms also produce a low pH with peptone as the source of nitrogen, whereas with an inorganic source of nitrogen the change of reaction is only slight, the cellulose decomposition being also very slight. It thus seems likely that the acid reaction produced by these organisms is due to the decomposition products of cellulose.

Quantities of cellulose decomposed.

For the quantitative investigations of the cellulose decomposed by the bacteria, a liquid medium containing filter paper was used. A folded sheet of filter paper (Schleicher and Schüll Nr. 595) of known dry weight (about 250 mg.) was introduced into a 200 c.c. Erlenmeyer flask containing 25 c.c. of mineral salt solution + 1 gram of ammonium sulphate and 0,5 gr. of calcium carbonate per liter. After sterilisation, the flasks were inoculated with a loopful of a fresh culture of the organism under investigation, and incubated at 25° C. After 14 days incubation the undecomposed cellulose was estimated as follows. The cultures were filtered through a previously tared filter paper. The filtrate was used for pH determinations. The residue was washed first with 2% hydrochloric acid and then with distilled water. After washing, the residues were dried at 105° C. to constant weight. The results of the experiment with eight of the new strains and with *Microspira agarliquefaciens* are given in Table IV.

The quantities of the cellulose decomposed are rather small and vary only slightly with different strains. The results seem to be partly affected by the acid reaction of medium due to the absorption of nitrogen by the bacteria (the amount of the added calcium carbonate being insufficient to keep the reaction neutral). Also the conditions for cellulose decomposition were not favourable, a large part of the filter paper being below the surface of the liquid; so that decomposition took place mainly at the air-liquid level.

In a further experiment the decomposition of cellulose by 29 strains of the bacteria were compared with action of *Microspira agarliquefaciens*, Kluyver's vibrio, *Bact. fimi*, *Bacillus bibulus*, *Ba-*

Table IV. Decomposition of cellulose in ammonium sulphate cellulose broth after 20 days incubation.

Organism	Strain	Per cent. of filter paper decomposed	pH after 20 days.
Vibrio bulbosa	17	17.3	5.95
		17.9	5.89
		18.9	6.07
Vibrio cucumis	35	17.3	5.45
		18.9	5.58
		18.3	5.52
Vibrio synthetica	29	20.4	5.53
		18.3	5.71
		13.4	5.83
Vibrio napi	6	19.7	5.56
		18.3	5.77
		16.6	5.89
„ „	28	15.7	5.45
		15.1	5.57
		12.4	5.45
Vibrio pericoma	46	11.9	6.11
		13.6	5,92
		11.1	6.15
Bacterium elaphorum	39	18.3	5.38
		19.4	5.47
		18.5	5,30
Bacterium protozoides	63	19.3	5.30
		21.2	5.19
		27.0	4.89
Microspira agarliquefaciens		16.2	6.01
		16.3	5.97
		15.6	6.26
Control (uninoculated)		2.1	7.23
		1.9	7.19
		2.0	7.31

cillus cellaseus and *Pseudomonas perlurida*. Mineral salt solution was used with addition either of 0,2% sodium nitrate or 0,3% peptone + 0,1%. Lemco as the source of nitrogen. To economise space, cultures were made in test tubes about 180 cm. long by 22 mm. wide containing 20 c.c. culture medium. A strip of filter paper 15 cm. long by 2,5 cm. broad and a piece of glass rod were introduced in each tube. The purpose of the glass rod was to support the filter paper and to prevent it from sticking to the wall of the tube, when the latter is placed in an inclined position, It was hoped that in this way better conditions for the cellulose decomposition would be secured. After sterilisation and inoculation the test tubes were incubated at 25° C. in an almost horizontal position, in 4 to 5 rows, one row on the other. After 20 days the amount of the paper decomposed was determined as above. The results of this experiment are shown in Table V.

Table V. Decomposition of cellulose in nitrate cellulose and peptone-lemco cellulose broths after 20 days incubation.

Organism	Strain	Nitrate as source of N		Peptone as source of nitrogen	
		Per cent. of filter paper lost	pH after 20 days	Per cent. of filter paper lost	pH after 20 days
Vibrio xylitica	31	18.9	7.60	31.8	7.62
		20.5	7.79	25.3	7.46
Vibrio prima	25	28.8	7.82	5.9	7.33
		28.1	7.53	7.0	7.40
„ „	27	31.8	7.70	13.7	7.96
		34.3	7.85	16.2	8.07
Vibrio bulbosa	17	32.3	7.87	19.0	7.95
		35.7	7.98	18.2	7.50
„ „	56	26.8	8.12	23.4	7.73
		28.5	8.05	22.8	7.56
Vibrio stationis	1	33.1	7.71	5.2	8.04
		31.6	7.60	6.3	7.89
Vibrio castra	22	35.6	7.61	27.2	7.87
		37.8	7.70	24.9	7.71
„ „	50	12.9	7.92	24.5	7.39
		18.7	8.07	21.2	7.34

Organism.	Strain.	Nitrate as source of N		Peptone as source of nitrogen	
		Per cent. of filter paper lost	pH after 20 days	Per cent. of filter paper lost	pH after 20 days
Vibrio castra	37	13.6	7.59	7.0	8.18
		11.3	7.40	6.2	7.91
Vibrio cucumis	35	30.0	8.35	19.0	8,01
		32.4	8.19	17.6	7.86
Vibrio synthetica	23	28.6	7.81	18.8	7.66
		26.3	7.69	20.3	7.81
„ „	29	27.8	7.66	14.6	7.37
		29.6	7.80	12.1	7.53
„ „	45	24.0	7.65	12.0	7.32
		25.2	7.76	10.9	7.47
Vibrio ranicula	4	34.6	7.73	11.5	7.71
		36.7	7.85	9.8	7.16
„ „	43	20.7	8.08	8.6	8.04
		22.3	7.98	9.4	7.91
Vibrio malamoria	8	25.3	8.04	18.7	7.41
		28.5	8.17	20.9	7.39
„ „	48	29.0	7.71	20.7	7.44
		30.6	7.86	19.1	7.33
„ „	49	29.5	7.62	12.3	7.36
		32.7	7.66	10.8	7.45
„ „	51	32.0	8.02	21.8	7.48
		27.8	7.84	18.6	7.41
„ „	67	29.2	8.33	9.7	7.16
		32.0	8.29	10.5	7.31
Vibrio napi	6	35.4	8.22	25.5	7.63
		38.1	8.31	24.6	7.50
„ „	28	25.1	8.04	15.5	7.60
		28.0	8.13	14.6	7.47
Vibrio rigensis	7	27.4	7.78	5.2	8.16
		26.9	7.91	6.6	8.01
Vibrio pericoma	46	19.7	7.94	15.4	7.57
		23.9	8.12	16.8	7.41

Organism.	Strain.	Nitrate as source of N		Peptone as source of nitrogen	
		Per cent. of filter paper lost	pH after 20 days	Per cent. of filter paper lost	pH after 20 days
Bacterium elaphorum	39	45.8	8.35	14.1	7.14
		49.3	8.28	18.7	7.28
Bacterium bosporum	48a	32.7	8.08	12.8	7.28
		34.8	7.92	14.4	7.40
Bacterium pusiolum	14	35.8	8.00	34.4	7.47
		38.4	8.10	33.7	7.39
Bacterium protozoides	63	23.0	7.94	9.3	7.29
		25.3	7.86	10.2	7.51
Bacillus latvianus	70	9.3	6.62	15.8	5.29
		11.4	6.49	13.2	5.13
Microspira agarliquefaciens		26.2	7.75	14.7	7.30
		24.8	7.60	12.1	7.36
Kluyver's vibrio		36.4	8.00	7.1	7.25
		32.1	7.89	8.2	7.32
Bacterium fimi			6.40	13.4	5.41
		9.7	6.59	14.6	5.30
Bac. cellaseus		5.2	7.12	7.5	5.78
		4.5	7.06	6.2	5.63
Bac. bibulus		5.8	6.69	9.8	5.03
		4.2	6.60	11.2	4.90
Pseudomonas perlurida		9.2	7.13	12.6	5.83
		8.3	7.20	13.9	5.92
Control		2.2	7.08	2.0	7.14
		1.9	7.17	1.5	7.20

Nitrate is usually superior to peptone + lemco as a source of nitrogen. Only *Bacillus latvianus*, *Vibrio pericoma*, *Vibrio xylitica* and a strain of *Vibrio castra* (No. 50) from among 29 strains decompose cellulose better with peptone + lemco than with sodium nitrate. Generally from one fourth to one third of the paper disappeared in 20 days when nitrogen was provided in the form of sodium nitrate. Some species are even more active, as for example *Bact.*

elaphorum which decomposes nearly a half of the filter paper (in 20 days). *Microspira agarliquefaciens* disintegrate about 25%, and Kluyver's vibrio about 34% of the paper. The bacteria isolated by Kellerman and his associates attack cellulose very slightly, when nitrogen is supplied in the form of a nitrate, but are more active with an organic source of nitrogen.

The products of the cellulose decomposition.

Hutchinson and Clayton (13) have found that volatile acids are produced in the course of action of *Spirochaeta cytophaga* on the cellulose. But, except one species, no volatile acids could be detected from cultures of bacteria under investigation. Very small quantities of volatile acids are produced by *Bac. latvianus*.

As the intermediate product of cellulose decomposition the formation of oxycellulose could be demonstrated with corresponding reagents, as with potassium hydroxide or basic aniline dyes. Methylene blue was mainly used. The partly decomposed filter paper was immersed for about one quarter of an hour into 0,05% solution of methylene blue. When washed with water for several hours, the paper attacked showed a more intensive colouration when compared with unattacked paper.

It was expected that products reducing Fehling solution would appear during the course of the cellulose disintegration. Many tests were carried out with all the strains in different media, and it was found that strains of two species, *Bact. protozoides* and *Bact. bosporum*, produce such products. The two species produce reducing compounds in ordinary conditions, with ammonium salts as the source of nitrogen. A more detailed study was made to see what were the conditions favouring the formation of such products. It was thought possible that sugarlike compounds were formed by all studied bacteria as intermediate products in cellulose decomposition, but that under ordinary conditions these products do not accumulate, being further oxidised. To hinder such oxidising processes and to accumulate the intermediate products of decomposition, two methods were followed: 1) sealing the test tubes with the cultures already in full action, thus limiting the supply of oxygen; 2) raising the incubation temperature so high, that the usual oxidation ceases.

The arrangement of the experiment was as follows. The test

tubes containing the usual strip of filter paper with the nutrient solution, were inoculated with *Bact. protozoides* (strain 63), and were incubated at 27° C. As the source of nitrogen, sodium nitrate, ammonium sulphate, peptone and asparagine were used. In order to obtain a better aeration, one set of tubes was kept in the incubator in a very inclined position. After 8 days, when the decomposition process was much advanced, some of the tubes were sealed with paraffin and replaced into the incubator. After 12 days some of the unsealed tubes were transferred into another incubator with the temperature of 37° to 38° C. Starting from the fifteenth day two tubes of each set were tested for products reducing Fehling solution. Where considerable amounts of such compounds were indicated, they were determined quantitatively. The results obtained are shown in the Table VI.

Appreciable amounts of reducing substances are produced in unsealed tubes at 27° C. when ammonium salts are given as the source of nitrogen. If incubated for a longer period (90 days), small quantities of such products are also formed in a medium containing nitrate as the source of nitrogen. They do not accumulate with peptone or asparagine. When oxygen supply is limited in sealed test tubes, they are found with each compound tested as the source of nitrogen. The quantities found under these conditions are even larger in media containing nitrate than in those with ammonium sulphate as the sole source of nitrogen. When nitrogen is supplied in the form of peptone or asparagine, there is only slight accumulation of reducing substances in sealed tubes.

The addition of calcium carbonate to media containing ammonium sulphate favours the accumulation of reducing bodies, but in tubes with nitrate as the sole source of nitrogen, the addition of calcium carbonate slightly depresses it.

Under well aerated conditions, as in the inclined tubes with large surface of culture solution, no reducing substances accumulate except when ammonium salt is used as the source of nitrogen. After three months' incubation they also appear in the tubes containing peptone or asparagine as the source of nitrogen only when no calcium carbonate is added.

When incubated at 37° to 38° C., slight accumulation of reducing bodies took place in all media.

Table VI. The influence of oxygen supply on the formation of reducing substances from cellulose by *Bact. protozoides* (with different sources of nitrogen) at 27° C.

Sources of nitrogen		$NaNO_3$ 0.2%		$(NH_4)_2SO_4$ 0.1%		$NaNO_3$ 0.1% and $(NH_4)_2SO_4$ 0.05%		Peptone 0.3%		Asparagine 0.1%	
Addition of $CaCO_3$		nil.	0.01%	nil.	0.01%	nil.	0.01%	nil.	0.01%	nil.	0.01%
Unsealed tubes	After 15 days	0	0	+	+	0	0	0	0	0	0
	„ 26 „	0	0	+	+	+	+	0	0	0	0
	„ 37 „	0	0	+	+	+	++	0	0	0	0
	„ 90 „	+	+								
Sealed tubes	After 26 days	++	+	+	+	++	++	+	0	+	0
	„ 37 „	++	++	+	++	++	+++	+	0	+	0
	„ 90 „	+++++	++++	++	+++						
Inclined tubes, (large surface)	After 26 days	0	0	+	+	+	+	0	0	0	0
	„ 37 „	0	0	+	++	+	++				
	„ 90 „	0	0	++	++	+	0	++	0	+	0
Reducing substances produced in unsealed tubes at 37 C											
	After 15 days	+			+	+	+	0	0	+	+
	„ 26 „	+			+	+	+	+	+	+	+

NOTE:

0 = no reducing compounds formed
\+ = less than 0.1 per cent.
++ = less than 0.2 per cent.
+++ = less than 0.3 per cent.
++++ = less than 0.5 per cent.
+++++ = more than 0.5 per cent.

The maximum concentration of reducing substances produced was about 0,5 per cent. (calculated as dextrose). This was in the sealed tubes with nitrate as the sole source of nitrogen.

A further quantitative study of the action of *Bact. protozoides* on cellulose was made principally to determine the nature of the substances reducing Fehling solution. The arrangement of this experiment was as follows. Eight glass tubes 4 cm. long and 1,5 cm. wide were placed horizontally on the bottom of 500 c.c. Erlenmeyer flask. A folded sheet of filter paper dried and weighed was introduced into the flask and placed on these tubes. To each flask were added 150 c.c. of mineral salt solution with the following sources of nitrogen: 1) sodium nitrate 0,2 per cent., 2) ammonium sulphate 0,1 per cent., 3) sodium nitrate 0,1 per cent. and ammonium sulphate 0,05 per cent., 4) peptone 0,3 per cent. One half of the flasks each received 0,1 gr. of calcium carbonate. After sterilisation the flasks were inoculated with a loopful of a fresh culture *Bact. protozoides* (strain 63), weighed and incubated at 25° C. After ten days two flasks of each set were sealed with paraffin wax. After 30 days incubation the flasks were weighed again, and then the cultures were filtered through a tared filter paper. The residues were washed and dried to the constant weight. The filtrates served for electrometric titration, and for the determination of pH, nitrates, ammonia and substances reducing Fehling solution. An attempt was also made to determine the nature of these substances. Nitrates were estimated by reducing them to ammonia (by means of Devarda alloy), and distilling into a known amount of acid. The substances reducing Fehling solution were determined iodimetrically using the modification of Schoorl's (28) method used in Germany for wine analysis (29). The quantities of reeducing bodies were calculated as dextrose. The results of this experiment are given in Table VII.

This experiment and the previous one give similar results with regard to the accumulation of reducing bodies. They are always produced by *Bact. protozoides*, in presence of ammonium sulphate. With nitrate as the source of nitrogen, they accumulate only when oxygen supply is limited, though in such conditions their accumulation is greater with nitrate than with ammonium sulphate.

The amount of cellulose decomposed depends on the reaction of the medium. As much as 38 to 71 per cent. of added cellulose was decomposed when the reaction was neutral or nearly neutral.

Table VII. Decomposition of cellulose by *Bact. protozoides* under different conditions of aeration.

Number of flasks	Oxygen supply	Source of nitrogen	Addition of $CaCO_3$	Filter paper used	Filter paper destroyed	per cent. destroyed	Reducing substances found calculated as dextrose	pH after 30 days	Nitrogen supplied: as nitrate N	Nitrogen supplied: as ammonia N	Nitrogen recovered: as nitrate N	Nitrogen recovered: as ammonia N
				mgs			mgs		milligrams			
1	Unsealed flasks	$NaNO_3$ 0.2%	+	1922	731	38.0	nil.	7.45	49.4		31.0	nil.
1a			+	2088	816	39.1	nil.	7.57	49.4		29.7	nil.
2			—	2024	846	48.5	nil.	7.82	49.4		25.3	nil.
2a			—	1835	932	50.8	nil.	7.86	49.4		25.2	nil.
3		$(NH_4)_2SO_4$ 0.1%	+	2056	1037	50.5	411	3.29		31.8		nil.
3a			+	2003	1085	54.2	442	3.41		31.8		nil.
4			—	2043	393	19.2	206	3.87		31.8		20.6
4a			—	1880	385	20.5	195	4.04		31.8		21.0
5		$NaNO_3$ 0.1% $(NH_4)_2SO_4$ 0.05%	+	2032	815	40.2	141	6.61	24.7	15.9	12.8	nil.
5a			+	1874	821	43.8	130	6.79	24.7	15.9	11.1	nil.
6			—	2062	354	17.1	116	3.84	24.7	15.9	19.9	nil.
6a			—	1806	334	18.5	99	4.01	24.7	15.9	19.5	nil.
7	Sealed flasks	$NaNO_3$ 0.2%	+	1895	1125	59.4	648	6.82	49.4		30.5	
7a			+	1940	1071	55.2	615	6.80	49.4		35.6	
8			—	1895	1330	70.2	764	6.87	49.4		29.2	
8a			—	1740	1151	66.2	753	6.98	49.4		32.8	
9		$(NH_4)_2SO_4$ 0.1%	+	2085	1413	70.1	856	3.38		31.8		nil.
9a			+	1958	1379	70.3	840	3.50		31.8		nil.
10			—	2082	375	18.0	193	3.95		31.8		19.3
10a			—	2133	337	15.6	175	4.14		31.8		20.0
11		$NaNO_3$ 0.1% $(NH_4)_2SO_4$ 0.05%	+	1890	1348	71.3	722	6.57	24.7	15.8	9.5	nil.
11a			+	infected by molds								
12			—	2100	408	19.4	162	3.73	24.7	15.8	19.6	nil.
12a			—	2095	451	21.7	176	3.89	24.7	15.8	18.9	nil.
13	Peptone 0.5% Unsealed flasks			1915	475	24.8	nil.	6.32				
13a				2043	345	16.9	nil.	6.40				
Control												
$NaNO_3$ 0.2%				1977	11	0.55			49.4		47.8	
$(NH_4)_2SO_4$ 0.1%				2147	10	0.17				31.8		25.1

When the reaction of medium became acid during decomposition (pH about 4,0 and lower), little cellulose was lost (about 15 to 20 per cent.).

The effect of sealing the flasks on the efficiency of cellulose decomposition was rather unexpected.

In one set of flasks, viz. in that with ammonium sulphate without additional $CaCO_3$, there is a little more cellulose decomposed in unsealed flasks than in the sealed ones. In all other cases sealing the flasks resulted in greater loss of cellulose. The organisms, although aerobic, decompose more cellulose with limited than with full oxygen supply. But in this case, although more cellulose has disappeared in sealed flasks, the breakdown of the cellulose has partly stopped at the formation of reducing compounds. When the amounts of these compounds is subtracted from the quantity of cellulose lost, the influence of oxygen supply becomes more evident. In Table VIII the amounts of reducing substances are expressed as dextrose, and in columns 5 and 9 it is assumed that 180 grams of dextrose are formed from 162 grams of cellulose according to equation

$$(C_6H_{10}O_5)x + xH_2O = x(C_6H_{12}O_6).$$

The columns 6 and 10 of this table show the amounts of cellulose which have undergone further changes. This is in all cases greater under conditions of better aeration showing that the bacteria have decomposed the cellulose more fully. Where air supply is limited, the full decomposition is arrested and more cellulose must be decomposed to provide an equivalent supply of energy.

The ratio of nitrogen lost to cellulose decomposed, can be calculated from the results obtained, where nitrate alone was used as a source of nitrogen. Where ammonium sulphate was present, loss of nitrogen during sterilisation vitiated the results. Table IX shows the data for flasks supplied with nitrate.

There is a good agreement between the ratios obtained for the series with unsealed flasks but less good in the case with sealed flasks. The latter also show much higher quantities of cellulose decomposed per unit of nitrogen absorbed (59,5 to 77,5). This again suggests that the bacteria, in building up a similar quantity of protein, require to decompose a greater quantity of cellulose where the process of decomposition is partially arrested at the stage of dextrose. Waksman's (30) figures are 50 to 55 mg. of cellulose decomposed per milligram of nitrogen absorbed.

Table VIII. The effect of oxygen supply on cellulose decomposition by *Bact. protozoides.*

		Sealed flasks				Unsealed flasks			
Source of nitrogen	Addition of $CaCO_3$	Cellulose lost mgs	Dextrose produced mgs	Cellulose converted into dextrose mgs	Cellulose not accounted for mgs	Cellulose lost mgs	Dextrose produced mgs	Cellulose converted into dextrose mgs	Cellulose not accounted for mgs
1	2	3	4	5	6	7	8	9	10
$NaNO_3$	+	1125	648	584	541	731	nil.		731
„	+	1071	615	554	456	816	nil.		816
„	—	1330	764	688	642	846	nil.		846
„	—	1151	753	678	473	932	nil.		932
$(NH_4)_2SO_4$	+	1413	856	770	643	1037	411	370	667
„	+	1379	840	756	623	1085	442	398	687
„	—	375	193	174	201	393	206	185	208
„	—	337	175	157	180	385	195	175	210
$NaNO_3$ and $(NH_4)_2SO_4$	+	1348	722	650	698	815	141	127	692
„	+					821	130	117	704
„	—	408	162	146	262	354	116	104	250
„	—	451	176	158	293	334	99	89	245

Table IX. The ratio of cellulose decomposed to nitrogen lost.

Flasks sealed with paraffin wax.			Flasks plugged with cotton wool.		
Cellulose decomposed mgs.	Nitrogen absorbed mgs.	Ratio	Cellulose decomposed mgs.	Nitrogen absorbed mgs.	Ratio
1125	18.9	59.5	731	18.4	39.7
1071	13.8	77.5	816	19.7	41.5
1330	20.2	65.8	846	24.1	35.1
1151	16.6	69.3	932	24.2	38.6

With ammonium sulphate as the source of nitrogen 26,5 to 27,4 mgs. of cellulose has been decomposed per milligram of nitrogen absorbed by the bacteria (assuming that the amount of ammonium nitrogen at the start was 25,1 mg. per flask, as shown by the control flask).

The amount of nitrogen absorbed by the bacteria during the process of cellulose decomposition is thus about 3 per cent. of the cellulose decomposed.

The Nature of Substances Reducing Fehling's solution.

The filtrates that reduce Fehling's solution give, with phenylhydrazine, tufts of needle-shaped yellow crystals identical with those formed by glucosephenylosazone. The crystals are soluble in hot alcohol, but not in water. The melting point of this phenylosazone determined on several occasions, varied from 204° to 206° C. These results indicate that the osazone formed is glucosephenylosazone. Though mannose and fructose produce the same osazone as dextrose, it is not probable that in the case of cellulose decomposition the formation of either fructose or mannose would take place. It therefore seems probable that the substance is glucose.

According to Pringsheim (31), cellobiose is also formed in the process of cellulose decomposition. During the work described here attempts were also made to isolate a cellobiososazone, but these attempts failed.

Further investigations with other species here described showed that reducing substances are formed by all strains. The simplest way to demonstrate this is to seal with paraffin the test tubes with 10-day old cultures and incubate them at 25° C. The medium most suited for this purpose is the usual mineral salt solution with nitrate and a strip of filter paper. After 20 days the culture solutions usually reduce Fehling's solution and form yellow needle-shaped crystals with phenylhydrazine.

When the tubes with cultures are kept sealed for several months or a year, the most active sugar producers, as for instance *Bact. bosporum*, dissolve all filter paper which is immersed in the culture solution. (See pl. VIII, fig. 17.). The dissolution of cellulose seems to be caused by an exo-enzyme, probably cellulase.

Growth in association with *Azotobacter chroococcum*.

The fact that sugars are formed, as intermediate products of cellulose decomposition, suggested that nitrogen-fixing organisms such as Azotobacter, could grow in cellulose media in association with the bacteria. This was proved to be the case, when Azotobacter was inoculated in tubes which had been sealed for a while and where

sugar produced from cellulose had accumulated. Under such conditions there was a good growth of Azotobacter producing a ring or scum on the surface of the liquid.

Good growth of the Azotobacter was also produced when inoculated together with cellulose bacteria into media containing mineral salt solution with a source of nitrogen ($NaNO_3$, $(NH_4)_2SO_4$, or peptone), and a strip of filter paper, but neither the growth of Azotobacter, nor the decomposition of cellulose occurred, when nitrogen compounds were omitted. When dextrose was added to such medium containing no nitrogen compounds, Azotobacter grew well forming a black ring on the surface of the liquid; but no cellulose decomposition, and no multiplication of cellulose bacteria took place. Azotobacter can thus profit from cellulose decomposition, deriving energy from the decomposition products, but the studied bacteria cannot get the nitrogen from Azotobacter.

Decomposition of Cellulose in Presence of Carbohydrates.

As a rule, the addition of 1 per cent. of dextrose to cellulose broth (medium No. 1) with sodium nitrate as the source of nitrogen does not prevent the bacteria from attacking cellulose, but less cellulose is decomposed. The strains of several species, such as those of *Bact. protozoides*, *Bact. bosporum*, *Vibrio bulbosa*, *Vibrio synthetica*, do not disintegrate filter paper at all in such conditions, although the growth produced is good, as shown by the scum or ring production on the surface of the medium. With 0,5 per cent. of dextrose the growth is less cloudy and surface growth is produced by 7 strains only, but cellulose is decomposed more energetically. A concentration of 0,1 per cent. of dextrose does not markedly affect the speed of the cellulose decomposition.

In the case with *Bact. elaphorum*, which does not grow in media containing either starch or inulin as the sole source of energy, the addition of these substances to the cellulose broth does not affect the intensity of the cellulose decomposition. But the addition of dextrose does affect it, although the growth in such case is more luxuriant.

In such dextrose-cellulose nitrate media no acid is produced, except by *Bac. latvianus*. The change of reaction usually goes towards the alkaline side, though when first isolated from soil, some strains pro-

duced acid in these media. The Kellerman's organisms, however, showed a marked production of acid in dextrose cellulose medium, *Bact. fimi* attaining pH 6.10, *Bac. cellaseus* 4.53, *Bac. bibulus* 4.82

The Effect of Reaction on Cellulose Decomposition.

When grown in ammonium salt cellulose broth, the bacteria change pH from 7.2 to 5.0, and even further. This suggested that some strains might attack cellulose under acid conditions. This, however, was not the case, as the following experiment shows. Cultures were grown in test tubes containing mineral salt solution with 0.2 per cent. sodium nitrate and a strip of filter paper. The basic potassium phosphate was replaced by acid phosphate. The initial pH of different sets of tubes was adjusted as follows: 5.0; 6.0; 6.5; 7.0; 7.5; 8.0 and 9.2. The cultures were incubated at 25° C. for 14 days. Series with pH = 9.2 were protected from absorbing carbon dioxide from the air. The results based on duplicate tubes are shown in Table X.

Table X. The influence of reaction on cellulose decomposition. The plus (+) sign means that cellulose decomposition took place; zero means that no cellulose was attacked.

Organism	Strain	Action on cellulose in medium with initial pH						
		5.0	6.0	6.5	7.0	7.5	8.0	9.2
Vibrio xylitica	9	0	0	+	+	+	+	0
„ „	33	0	0	+	+	+	+	0
„ „	31	0	0	+	+	+	+	0
„ „	36	0	0	0	+	+	+	0
Vibrio prima	25	0	0	+	+	+	+	0
„ „	27	0	0	+	+	+	+	+
Vibrio bulbosa	17	0	0	+	+	+	+	0
„ „	19	0	0	+	+	+	+	0
„ „	20	0	0	0	+	+	+	0
„ „	56	0	0	+	+	+	+	0
„ „	58	0	0	0	+	+	+	0
Vibrio stationis	1	0	0	+	+	+	+	+
Vibrio castra	22	0	0	+	+	+	+	+
„ „	50	0	0	+	+	+	+	+
„ „	37	0	0	0	+	+	+	0

Organism	Strain	Action on cellulose in medium with initial pH 5.0	6.0	6.5	7.0	7.5	8.0	9.2
Vibrio cucumis	35	0	0	0	+	+	+	0
Vibrio synthetica . . .	5	0	0	+	+	+	+	0
„ „	11	0	0	0	+	+	+	0
„ „	23	0	0	+	+	+	+	0
„ „	29	0	+	+	+	+	+	+
„ „	30	0	0	+	+	+	+	0
„ „	45	0	0	+	+	+	+	+
Vibrio ranicula	4	0	0	+	+	+	+	0
„ „	43	0	0	+	+	+	+	+
Vibrio malamoria . . .	8	0	0	+	+	+	+	+
„ „	48	0	0	+	+	+	+	+
„ „	49	0	0	0	+	+	+	0
„ „	51	0	0	+	+	+	+	+
„ „	67	0	0	+	+	+	+	0
Vibrio napi	6	0	+	+	+	+	+	+
„ „	28	0	0	+	+	+	+	0
Vibrio rigensis	7	0	0	+	+	+	+	+
Vibrio pericoma	46	0	0	0	+	+	+	0
„ „	47	0	0	+	+	+	+	0
Bacterium elaphorum .	38	0	+	+	+	+	+	+
„ „	39	0	0	+	+	+	+	0
„ „	40	0	0	+	+	+	+	0
„ „	40a	0	+	+	+	+	+	+
Bacterium bosporum . .	48a	0	0	+	+	+	+	0
Bacterium pusiolum . .	12	0	0	+	+	+	+	+
„ „	14	0	0	+	+	+	+	+
Bacterium protozoides .	52	0	+	+	+	+	+	0
„ „	53	0	+	+	+	+	+	0
„ „	54	0	+	+	+	+	+	0
„ „	61	0	+	+	+	+	+	0
„ „	63	0	+	+	+	+	+	0
„ „	68	0	+	+	+	+	+	0
Microspira agarliquefaciens		0	0	+	+	+	+	+
Kluyver's vibrio		0	0	+	+	+	+	+

No strain grew at pH 5.0, At pH 6.0 cellulose is attacked by *Bact. protozoides*, *Bact. elaphorum* (2 strains), *Vibrio napi* (one strain) and *Vibrio synthetica* (one strain). All but eight strains are active at pH 6.5. The slightly alkaline reaction was more suited for the cellulose decomposition, the optimum pH being about 7.5. All strains grew at pH 8.0, but only fifteen at pH 9.2. In all cases when the organisms grow at the initial pH of 9.2, slight change of the reaction to the acid side results (to about pH 8.5). The few organisms which grew at an initial pH of 6.0, changed the reaction to neutral or slightly alkaline.

Results similar to those of the above experiment were obtained when peptone was used as the source of nitrogen. Only nine strains (including *Bac. latvianus*) however, grew in a medium with the initial pH 9.0. The changes in reaction with this more highly buffered medium were less than with the nitrate medium in the case of all the organisms, except *Bac. latvianus*, which changed the reaction of the peptone medium to about pH 5.3.

Relation to temperature.

All the organisms attack cellulose at 18° C. The optimum temperature for cellulose decomposition for majority of strains was found to be from 25° to 27° C. Several strains, however, seem to be more active at higher temperature, viz. at 29° or 31° C.

The effect of different temperatures on the rate of cellulose decomposition has been studied with *Bact. protozoides* (strain 63). The arrangement of the experiment was similar to that mentioned on the page 286. In this experiment the filter papers were not folded, but about 1.2 grams were laid flat on the small supporting tubes. The medium used was mineral salt solution with 0.2 per cent. sodium nitrate and 0.05 per cent. calcium carbonate. After sterilisation the flasks were inoculated with a loopful of fresh culture and incubated at 18°, 22°, 26° and 30° C. Two uninoculated flasks were kept at the room temperature, as control flasks. After 30 days the undecomposed cellulose was determined. The culture was filtered through a dried and weighed filter. The residue was washed first with 2 per cent. hydrochloric acid and then with water. The filter containing the residual cellulose was then dissolved in 200 c.c. of the Schweitzer reagent *).

*) The Schweitzer reagent was prepared according the method of Barthel and Bengtsson (32).

The bottle was stoppered and the mixture shaken for an hour in a shaking machine. The cellulose was then precipitated by adding sufficent quantity of 7 per cent. hydrochloric acid. The precipitate was filtered through a Gooch crucible and after washing with 1 per cent. hydrochloric acid, followed by warm distilled water, until free from Cl′, was dried at 105° C. to constant weight. The results of this experiment are shown in Table XI. There was neither growth, nor decomposition of cellulose at 30° C.

T a b l e XI. Decomposition of cellulose by *Bact. protozoides* at different temperatures

Incubation temperature	18° C.		22° C.		26° C.		Control	
	a	b	a	b	a	b	a	b
Weight of paper at start in gms.	1.2848	1.2890	1.2912	1.2853	1.2882	1.2790	1.2740	1.2836
Loss	0.2328	0.2117	0.3580	0.3116	0.3640	0.3977	0.0156	0.0177
Cellulose lost (per cent.)	18,1	16,4	27,7	24,2	28,2	31,3	1,2	1,7

The most active cellulose disintegration took place at 26° C. Subsequent observations showed that cellulose is decomposed at 27° C. but not at 29° C. The optimum and maximum temperatures for cellulose decomposition are thus vere close.

The maximum temperatures for cellulose decomposition by each of the isolated strains was then determined. Test tubes containing a strip of filter paper and sodium nitrate mineral salt solution were inoculated with a loopful of fresh cultures and incubated for 14 days at 27°, 29°, 31°, 34° and 37.5° C. The results obtained are shown in the Table XII.

The thermal deathpoints of the organisms have not been determined, but none of them are killed at 37° C., when incubated for 20 days.

T a b l e XII. Maximum temperature of cellulose decomposition for different strains. The plus (+) sign signifies that the cellulose was decomposed, while zero signifies that the cellulose was not attacked

		Cellulose attacked at				
Organism	Strain	27° C.	29° C.	31° C.	34° C.	37,5° C.
Vibrio xylitica	9	+	+	0	0	0
„ „	33	+	0	0	0	0

Organism	Strain	Cellulose attacked at 27° C.	29° C.	31° C.	34° C.	37,5° C.
Vibrio xylitica	31	+	0	0	0	0
„ „	36	+	+	0	0	0
Vibrio prima	25	+	+	0	0	0
„ „	27	+	+	+	+	0
Vibrio bulbosa	17	+	+	+	0	0
„ „	19	+	+	+	0	0
„ „	20	+	+	+	+	0
„ „	56	+	+	+	0	0
„ „	58	+	+	+	0	0
Vibrio stationis	1	+	+	+	+	0
Vibrio castra	22	+	+	+	+	0
„ „	50	+	+	+	+	0
„ „	37	+	0	0	0	0
Vibrio cucumis	35	+	+	+	0	0
Vibrio synthetica . . .	5	+	+	+	+	0
„ „	11	+	+	0	0	0
„ „	23	+	+	+	+	0
„ „	29	+	+	+	0	0
„ „	30	+	+	+	+	0
„ „	45	+	0	0	0	0
Vibrio ranicula	4	+	+	0	0	0
„ „	43	+	+	0	0	0
Vibrio malamoria . . .	8	+	+	+	+	0
„ „	48	+	+	+	+	+
„ „	49	+	+	0	0	0
„ „	51	+	+	+	+	+
„ „	67	+	+	+	0	0
Vibrio napi	6	+	+	+	+	0
„ „	28	+	+	0	0	0
Vibrio rigensis	7	+	+	0	0	0
Vibrio pericoma	46	+	+	+	0	0
„ „	47	+	0	0	0	0

Organism	Strain	Cellulose attacked at 27° C.	29° C.	31° C.	34° C.	37,5° C
Bacterium elaphorum .	38	+	+	+	+	+
„ „	39	+	+	+	+	+
„ „	40	+	+	+	+	+
„ „	40a	+	+	+	+	+
Bacterium bosporum . .	48a	+	+	0	0	0
Bacterium pusiolum . .	12	+	+	+	+	0
„ „	14	+	+	+	+	0
Bacterium protozoides .	52	+	0	0	0	0
„ „	53	+	0	0	0	0
„ „	54	+	0	0	0	0
„ „	61	+	0	0	0	0
„ „	63	+	0	0	0	0
„ „	68	+	0	0	0	0
Bacillus latvianus . . .	70	+	+	+	+	0
Microspira agarliquefaciens		+	+	0	0	0
Kluyver's vibrio		+	+	+	+	+

Viability of studied organisms.

The organisms have been cultivated in laboratory for more than three years. During this time none of them have lost the power to decompose cellulose. Stock cultures have been kept in tubes with sterilised soil containing a strip of filter paper, or on starch agar slopes. The tubes with starch agar were sealed with paraffin wax, in order to protect the agar from drying. All strains were alive and active when kept in soil or on agar after one year, but several of them died when kept in such conditions for two years. In sealed tubes with nitrate cellulose broth the organisms were alive after two years. Even in open tubes, though the liquid had dried out to about one fifth of the initial volume, the cultures were alive after nine months' keeping.

V. Summary and Abstract.

1. A number of aerobic bacteria that decompose cellulose have been isolated from 28 samples of English soils by use of cellulose agar or cellulose silica plates.

2. The morphological, cultural and biochemical characters of 48 strains are described. They are all morphologically different from those of Kellerman and his associates. Some of the strains with curved rods morphologically resemble Gray's *Microspira agarliquefaciens* and Kluyver's vibrio, but none of them liquefy agar. The strains have been classified into three genera and 17 species. Twelve of the species belong to the genus *Vibrio*, four to the genus *Bacterium* and one to the genus *Bacillus*. In three of the Vibrio strains, some cells bear peritrichous flagella up to 8 in number.

3. The species described, with the exception of the Bacillus, are widely distributed in English soils.

4. The bacteria destroy cellulose only under aerobic conditions, except for one species (*Bac. latvianus*), which also shows slight cellulose disintegration under anaerobic conditions. Cellulose is disintegrated at the air-liquid level in 2 to 5 days. On cellulose agar or cellulose silica plates clear zones are formed around the colonies as the result of cellulose dissolution by an exo-enzyme.

5. The best sources of nitrogen are nitrates and ammonium salts. Nitrogen can be obtained also from organic substances, such as meat extract, peptone or aminoacids, but these are less efficient sources of nitrogen, as judged by the amount of cellulose decomposed. One species (*Bac. latvianus*) however prefers organic nitrogen compounds.

6. The growth in nutrient broth or nutrient agar is very slight. The organisms can derive energy from carbohydrates such as cellulose, dextrose, starch, maltose, lactose, sucrose, arabinose, xylose and inulin.

7. When grown in media containing these carbohydrates, the majority of strains increases H-ion concentration of the nutrient solution, but no acid is produced from cellulose.

8. The calcium salts of organic acids, glycerol and mannitol, do not supply energy to the organisms, except one species (*Bac. latvianus*), which can utilise glycerol and mannitol.

9. A compound reducing Fehling solution and producing glucosephenylosazone from phenylhydrazine, is formed as a product of cellulose decomposition. It is produced in quantities up to 30% of the added cellulose by *Bacterium protozoides*. Limitation of the oxygen supply increases the accumulation of this compound and under such conditions it can be detected in cultures of all the bacteria studied It has been shown that products formed during the cellulose decom-

position process, can serve as a source of energy for *Azotobacter chroococcum*.

10. Dextrose and starch hinder cellulose decomposition, if added to cellulose media in concentration of 1 per cent., though the growth produced by the bacteria is good. Very low concentration (0.1 per cent.) of these compounds do not affect cellulose decomposition.

11. For the majority of strains the optimum temperature for cellulose decomposition is in the region of 25° to 27° C. Two species decompose cellulose also at 37.5° C. The most suitable reaction for cellulose decomposition is in the region of pH 7.5.

12. The cellulose decomposition by the bacteria was well pronounced even after 3 years' cultivation in laboratory conditions.

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EXPLANATION OF PLATES I—VIII.

Plates I—IV.

Cells of studied bacteria grown on starch agar slope (2 days).
The figures 1 to 21 are made from preparations stained by Gray's method.

Plate I.

Fig. 1. Vibrio xylitica (strain 9).
„ 2. Vibrio stationis.
„ 3. Vibrio prima (strain 25).
„ 4. Vibrio cucumis.
„ 5. Vibrio bulbosa (strain 20).
„ 6. Vibrio castra (strain 50).

Plate II.

Fig. 7. Vibrio synthetica (strain 5).
„ 8. Vibrio synthetica (strain 23).
„ 9. Vibrio pericoma (strain 47).
„ 10. Vibrio malamoria (strain 67).
„ 11. Vibrio malamoria (strain 48).
„ 12. Vibrio ranicula (strain 43).

Plate III.

Fig. 13. Vibrio napi (strain 28).
„ 14. Vibrio rigensis.
„ 15. Bacterium elaphorum (strain 38).
„ 16. Bacterium elaphorum (strain 39).
„ 17. Bacterium bosporum.
„ 18. Bacterium pusiolum (strain 14).

Plate IV.

Fig. 19. Bacterium protozoides (strain 52). 7 days nitrate cellulose broth.
„ 20. Bacterium protozoides (strain 52).
„ 21. Bacillus latvianus. 20 hours starch agar slope.
„ 22. Bacillus latvianus. 7 days nutrient broth. Stained with carbol-fuchsin.

Plate V.

Colonies on cellulose agar plates (14 days).

Fig. 1. Vibrio xylitica (strain 31).
„ 2. Vibrio bulbosa (strain 58).
„ 3. Vibrio synthetica (strain 5).
„ 4. Vibrio synthetica (strain 30).
„ 5. Vibrio ranicula (strain 4).
„ 6. Vibrio napi (strain 28).

Plate VI.

Colonies on cellulose agar plates (14 days).

Fig. 7. Vibrio malamoria (strain 8).
„ 8. Vibrio malamoria (strain 49).
„ 9. Vibrio malamoria (strain 51).
„ 10. Bacterium elaphorum (strain 38).
„ 11. Bacterium bosporum.
„ 12. Bacterium pusiolum (strain 14).

Plate VII.

Fig. 13. Bact. protozoides (strain 54). Colonies on nitrate cellulose agar
„ 14. Bac. latvianus. Colonies on peptone cellulose agar (14 days).
„ 15. Cultures in nitrate cellulose broth (10 days).
a) Vibrio malamoria (strain 51).
b) Vibrio bulbosa (strain 58).
c) Vibrio napi (strain 6).
„ 16. Cultures in nitrate cellulose broth (10 days).
a) Bact. protozoides (strains 63).
b) Vibrio stationis.
c) Vibrio ranicula (strain 43).

Plate VIII.

Fig. 17. Cultures in nitrate cellulose broth, sealed with parafin wax after 10 days incubation at 25° C. 11 months old cultures at room temperature.
a) Bact. elaphorum (strain 39).
b) Bact. bosporum.
c) Bact. protozoides (strain 63).

Presented to the Faculty, January 31 st 1930.

Plate VI.

Colonies on cellulose agar plates (14 days).

Fig. 7. Vibrio malamoria (strain 3).
„ 8. Vibrio malamoria (strain 30).
„ 9. Vibrio malamoria (strain 31).
„ 10. Bacterium elaphorum (strain 39).
„ 11a. Bacterium bosporum.
„ 11b. Bacterium pusiolum (strain 14).

Plate VIII.

Fig. 13. Bact. protozoides (strain 52). Colonies on nitrate cellulose agar (14 days).
„ 14. Bac. latvianus. Colonies on peptone cellulose agar (14 days).
„ 15. Cultures in nitrate cellulose broth (10 days).
a) Vibrio malamoria (strain 31).
b) Vibrio bulbosa (strain 58).
c) Vibrio napi (strain 0).
„ 16. Cultures in nitrate cellulose broth (10 days).
a) Bact. protozoides (strains 03).
b) Vibrio stationis.
c) Vibrio ranicula (strain 15).

Plate VIIIb.

Fig. 17. Cultures in nitrate cellulose broth, sealed with paraffin wax after 10 days incubation at 25° C. 11 months old cultures at room temperature.
a) Bact. elaphorum (strain 39).
b) Bact. bosporum.
c) Bact. protozoides (strain 03).

Presented to the Faculty, January 31 st 1930.

EXPLANATION OF PLATES I—VIII.

Cells of studied bacteria grown on agar-agar (1 day).

The figures 1 to 21 are made from preparations stained by Gram's method.

Plate I.

Fig. 1. Vibrio xylitica (strain 33).
„ 2. Vibrio bulbosa (strain 58).
„ 3. Vibrio synthetica (strain 5).
„ 4. Vibrio synthetica (strain 30).
„ 5. Vibrio ranicula (strain 4).
„ 6. Vibrio napi (strain 28).
„ 7. Vibrio synthetica (strain 51).
„ 8. Vibrio synthetica (strain 57).
„ 9. Vibrio pericoma (strain 47).
„ 10. Vibrio malamoria (strain 31).
„ 11. Vibrio malamoria (strain 30).
„ 12. Vibrio napi (strain 0).

Plate III.

Fig. 13. Vibrio napi (strain 28).
„ 14. Vibrio rugosus.
„ 15. Bacterium elaphorum (strain 38).
„ 16. Bacterium elaphorum (strain 39).
„ 17. Bacterium bosporum.
„ 18. Bacterium pusiolum (strain 14).

Plate IV.

Fig. 19. Bacterium protozoides (strain 52). 7 days nitrate cellulose broth.
„ 20. Bacterium protozoides (strain 52).
„ 21. Bacillus latvianus. 20 hours starch agar slope.
„ 22. Bacillus latvianus. 7 days nutrient broth. Stained with carbol-fuchsin.

Plate V.

Colonies on cellulose agar plates (14 days).

Fig. 1. Vibrio xylitica (strain 33).
„ 2. Vibrio bulbosa (strain 58).
„ 3. Vibrio synthetica (strain 5).
„ 4. Vibrio synthetica (strain 30).
„ 5. Vibrio ranicula (strain 4).
„ 6. Vibrio napi (strain 28).

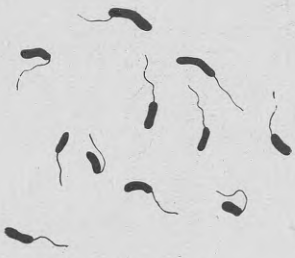


Fig. 1

Fig. 2

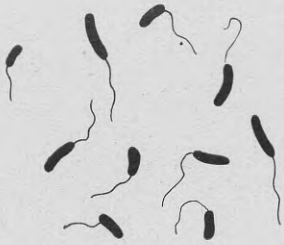


Fig. 3

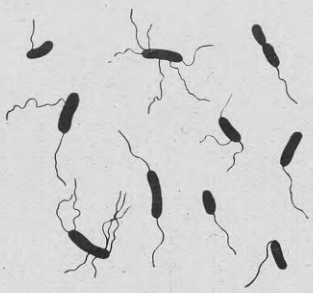
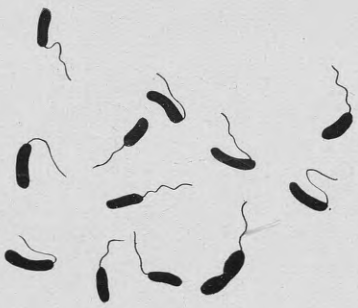


Fig. 4



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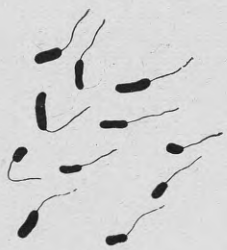
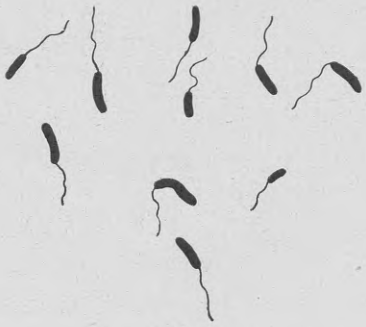


Fig. 6

5μ



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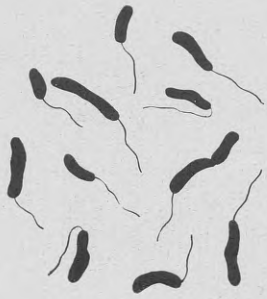

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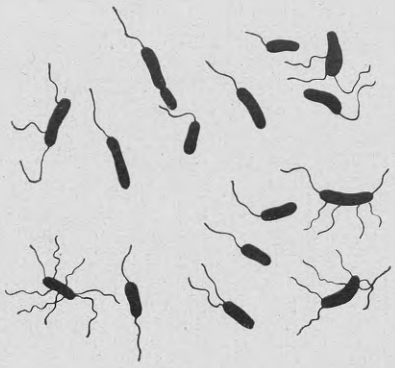

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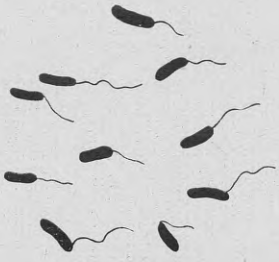

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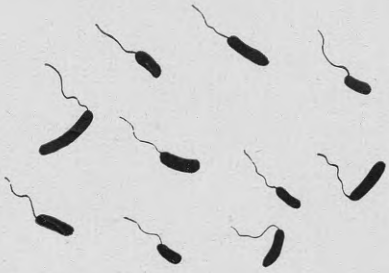

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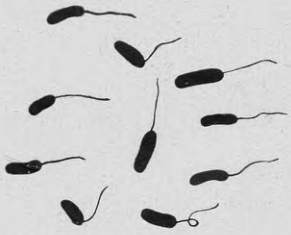
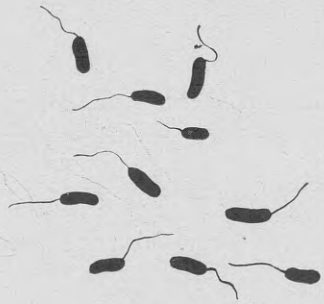


Fig. 12

5 μ



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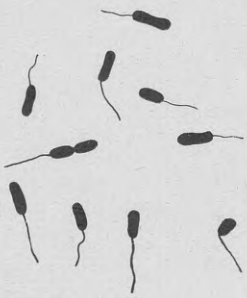

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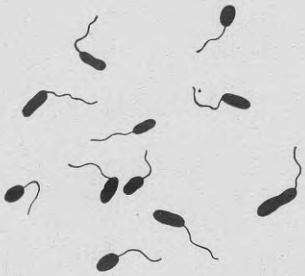

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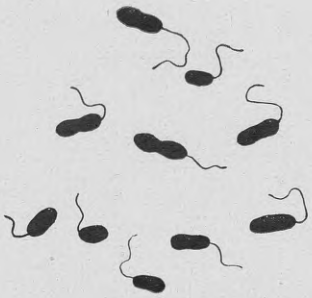

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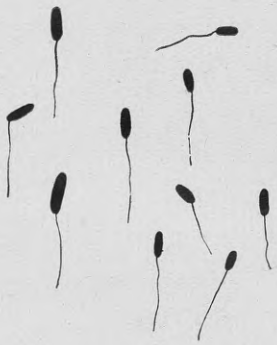

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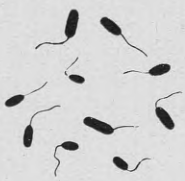
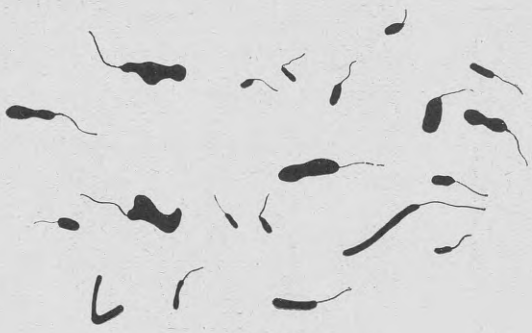


Fig. 18

5μ



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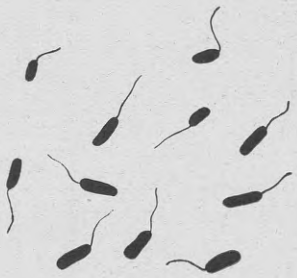

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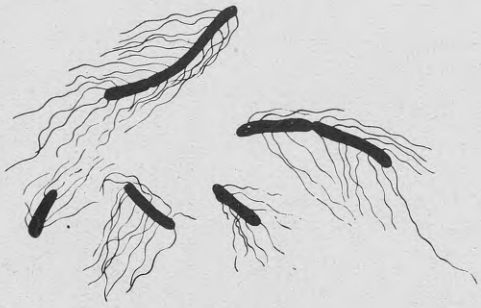

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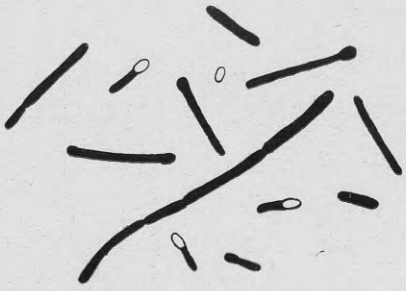


Fig. 22

10 μ

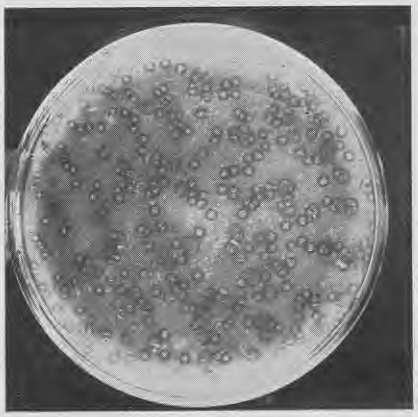


Fig. 1

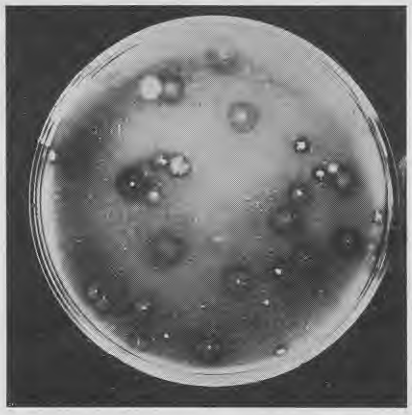
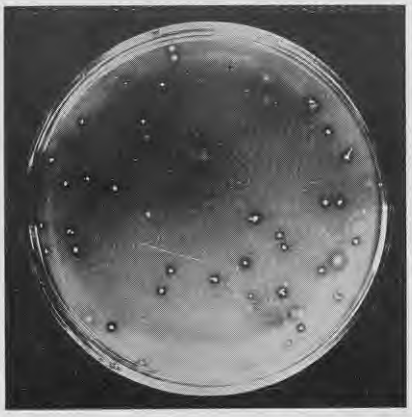


Fig. 2



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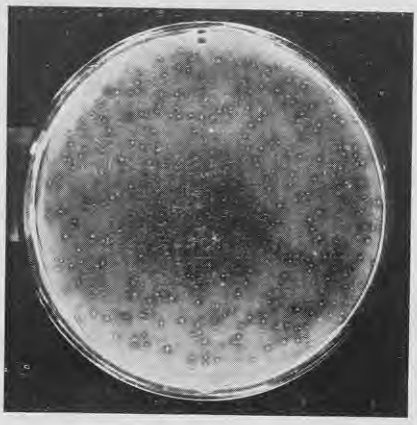

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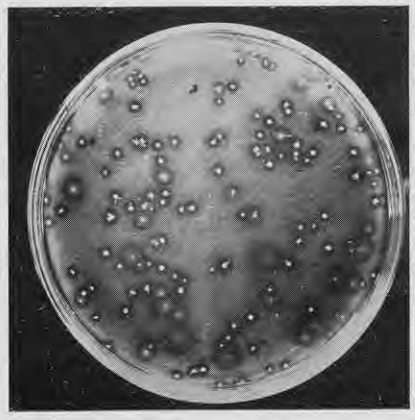

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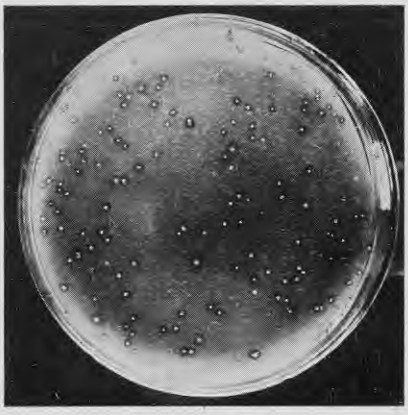

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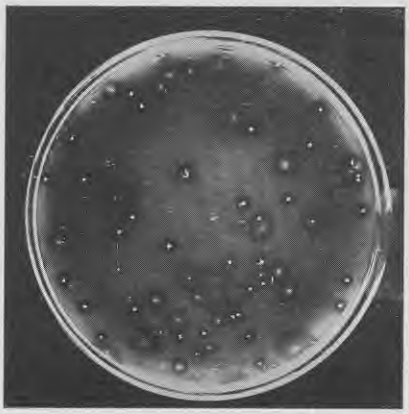

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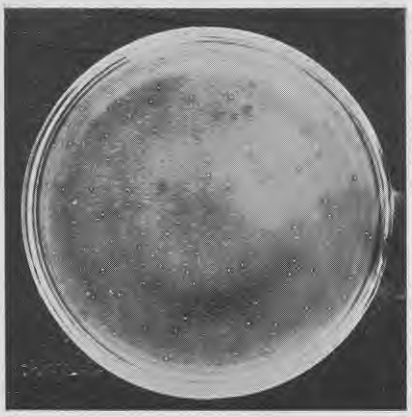

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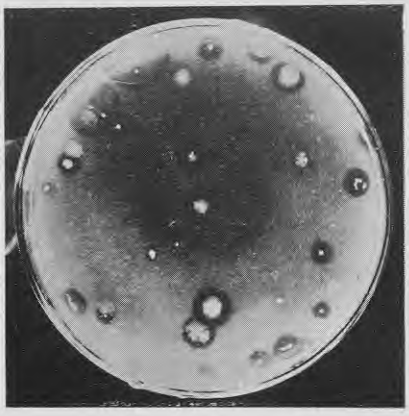

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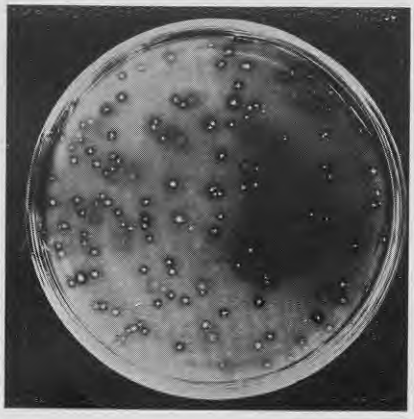

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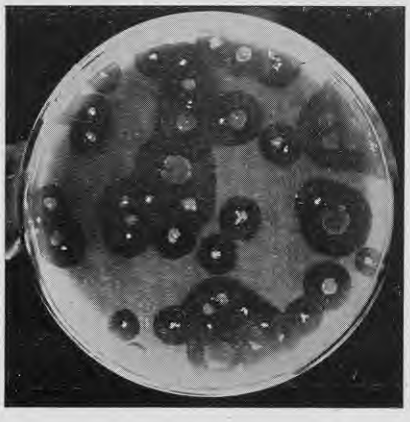

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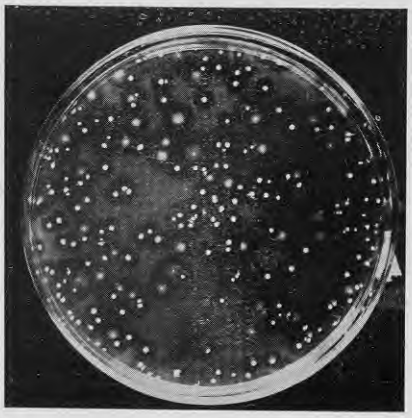

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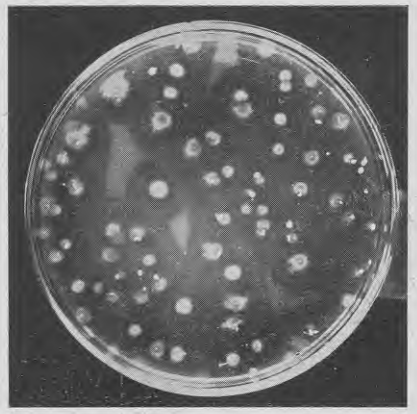

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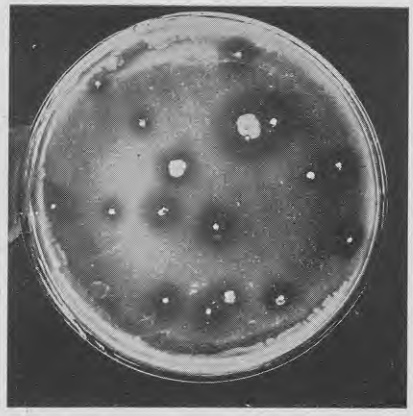

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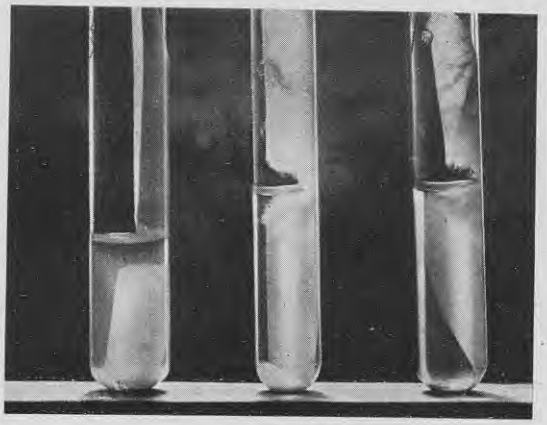
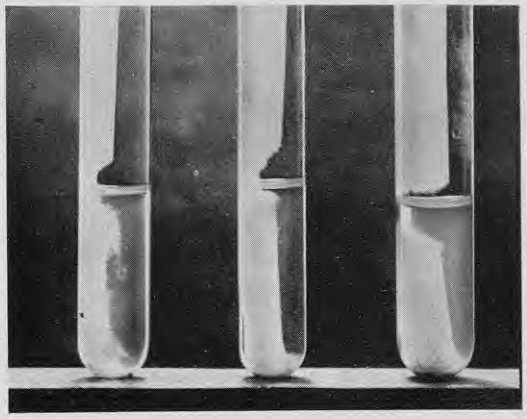


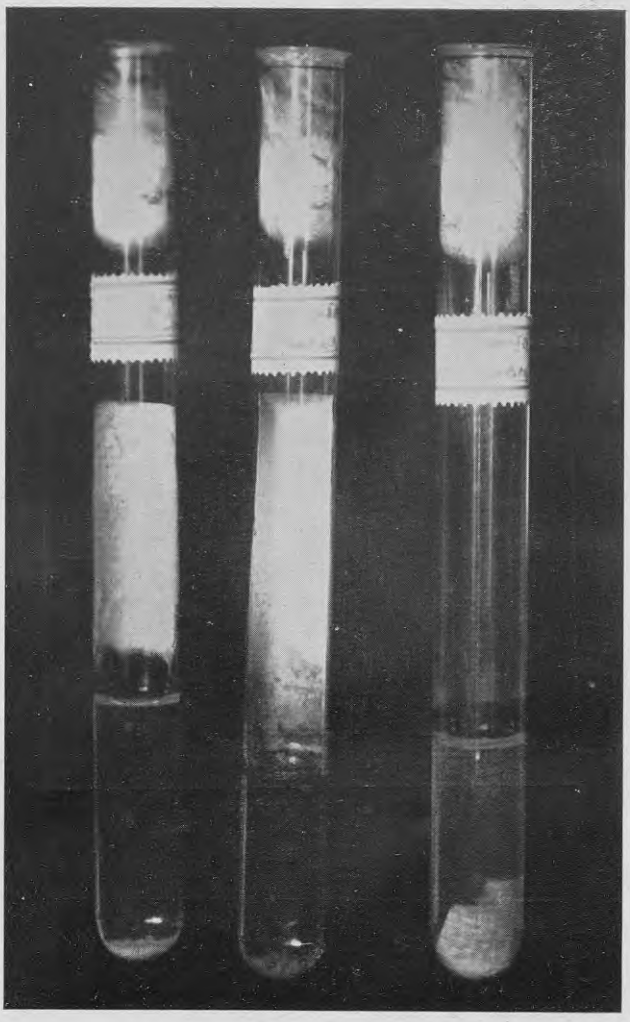
a b c

Fig. 15



a b c

Fig 16



a b c

Fig. 17

Zemes aerobas baktērijas, kas sadala cellulōzi

A. Kalniņš

(Rūgšanas un lauksaimniecības technoloģijas labōrātōrija, Latvijas Ūniversitātes Lauksaimniecības Fakultātē un Bakterioloģijas labōrātōrija, Rotamstedas Izmēģinājumu Stacija, Anglijā)

Kopsavilkums un beigu slēdzieni.

Starp organiskās vielas minerālizācijas procesiem dabā, cellulozes noārdīšanai piekrīt viena no svarīgākām vietām. Cellulozes saturs augu sausnē svārstās no 30 līdz 50 procentiem, tādēļ celluloze jāuzskata kā zemes sīkbūtņu galvenais enerģijas avots. Celluloze nodrošina šīm sīkbūtnēm arī vienmērīgāku enerģijas piegādāšanu, jo viņa ūdenī nešķīst un īpatnējās organismu grupas var viņu tik pamazām skaldīt un tādā kārtā darīt šo enerģijas avotu pieejamu visām pārējām zemes sīkbūtņu grupām.

Šiem īpatnējiem cellulozi sadalošiem organismiem līdz šim ir piegriezts pārāk maz vērības. Slāpekļa pārvērtības zemē, sevišķi nitrifikācijas procesi, kā zaļiem augiem svarīgākie, izpētīti jo plaši, lai gan sīkbūtnes, kas izsauc šīs norises, nesastāda ne simto daļu no visas zemes mikrofloras. Pirmos pētījumus par cellulozes noārdīšanu izdarīja Omeļjanskis un ar saviem klasiskiem darbiem par anaerobo cellulozes sadalīšanu novērsa uzmanību no daudz svarīgāka aerobā cellulozes noārdīšanas procesa. Pat līdz pēdējam laikam daži autori (piem. Pringsheim's) izceļ anaerobo cellulozes sadalīšanu kā svarīgāko, tādā kārtā pilnīgi ignorējot gaisa un ūdens apstākļus zemē. Līdzšinējie pētījumi par cellulozes noārdīšanu zemē, kaut gan vēl ir ļoti nepilnīgi, tomēr norāda, ka anaerobiem organismiem šeit nav nekāda iespaida. No zemes aerobām sīkbūtnēm trīs grupas ņem dalību cellulōzes sadalīššanā: baktērijas, sēnes un aktinomiceti. Daži pētnieki, kā Vaksmans un Starkey's, uzskata sēnes kā svarīgāko grupu nevien skābās meža, bet arī neutrālās aramzemēs. Citi, turpretī, kā Murray's, norāda, ka augu atliekas zemē sadala galvenā kārtā baktērijas un vienīgi tīru cellulozi noārda aktīvāki sēnes. Nav šaubu, ka aerobām baktērijām piekrīt svarīga nozīme cellulozes noārdīšanā, bet šo baktēriju radītie procesi zemē nav tik skaidri aptverami, jo viņu darbībai zemē ir grūtāki sekot, nekā sēnīšu darbībai. Pastāvošās metodes izceļ vairāk sēnīšu darbību cellulozes noārdīšanā, jo cellulozes baktērijas neaug parastās gaļas ekstrakta barības vidēs.

Maz ir strādāts arī ar aerobo cellulozes baktēriju tīrkultūrām. Van Iterson's (1904.) pirmais konstatēja aerobo baktēriju darbību cellulozes noārdīšanā. Dažus gadus vēlāk Merker's novēroja šo baktēriju darbību uz *Elodea* lapām. Tīrkultūras ne viens, ne otrs nav izolējis. Pirmās tīrkultūras ir ieguvuši Kellerman's un viņa līdzstrādnieki, lietojot jaunu metodi, cellulozes agāra plates. Viņu darbus nokritizēja Omeļjanskis, norādot, ka vienīgais pierādījums par šo baktēriju specifisko darbību ir caurspīdīgu zonu rašanās ap baktēriju kolonijām uz necaurspīdīgās cellulozes agāra plates. McBeth's, lietojot to pašu metodi, vēlāk izolēja 25 sugas. Pringsheim's gan piekrīt, ka caurspīdīgās zonas uz agāra ir cellulozes noārdīšanas sekas, bet uzsveŗ, ka tīrkultūras nav iespējams iegūt no šīm platēm. Pārbaudot dažus Kellerman'a izolētos organismus, viņš atrada, ka neviens no tiem nav spējīgs noārdīt cellulozi. Strādājot Rotamstedā, autors pārbaudīja piecu Kellerman'a izolēto sugu spējas sadalīt cellulozi. No tām tikai viena bija bezdarbīga, bet pārējās četras noārdīja cellulozi, starp tām arī viena suga, kuŗu Pringsheim's agrāki bija atzinis par nedarbīgu. Tīrkultūru izolēšanā nav sekmējies arī Löhnis'am un Lochhead'am. 1919. gadā Hutchinson's Rotamstedā izolēja jaunu cellulozes baktēriju — *Spirochaeta cytophaga*. Šis organisms daudzu pazīmju ziņā līdzinās Van Iterson'a, Merker'a un Gescher'a novērotām baktērijām. Pretēji Kellerman'a izolētiem organismiem, šis aug un darbojas vienīgi uz cellulozes. Vēlāk Gray's Rotamstedā izolēja vēl otru organismu — *Microspira agarliquefaciens*. Šī baktērija līdzīgi Kellerman'a izolētām aug parastās barības vidēs, bez tam viņa ir spējīga atšķidrināt agāru.

Minēto organismu nozīme cellulozes noārdīšanā zemes apstākļos vēl ir noskaidrojama. Kas attiecas uz *Spirochaeta cytophaga*, liekas, ka vismaz viņa ir darbīga cellulozes noārdītāja dabīgos apstākļos. Savas raksturīgās formas dēļ, viņa viegli atšķiŗama no pārējām sīkbūtnēm, kas savairojas uz zemē ieraktā filtra papīra. Šis ir vienīgais pazīstamais organisms starp aerobām cellulozes baktērijām, kuŗš neaizskar citus organiskus savienojumus, kā vien cellulozi.

Dažus gadus atpakaļ autors uzsāka aerobo cellulozes baktēriju izolēšanu no Latvijas zemēm, lietojot Kellerman'a cellulozes agāra plates. Visas izolētās rases bija viena tipa un vēlāk Rotamstedā izrādījās kā identiskas ar *Sp. cytophaga*. Turpretī, strādājot Rotamstedā, tika konstatēts, ka auglīgās Anglijas zemēs *Sp. cytophaga* nekādā ziņā nav visvairāk izplatītais cellulozi noārdošais organisms,

bet gan kustīgas baktērijas, līdzīgas *Microspira agarliquefaciens* ir stipri pārsvarā. Daudzas rases tika izolētas no šīm zemēm un viņu morfoloģiskās un fizioloģiskās īpašības pētītas.

Cellulozes baktēriju izolēšanai lietoja cellulozes kramskābes un cellulozes agāra plates. Pirms tam cellulozes baktērijas savairoja elektīvās barības vidēs, kuŗas saturēja cellulozi kā vienīgo organisko savienojumu. Baktēriju uzkrāšanu parasti izdarīja šķidrā elektīvā vidē vai arī uz cellulozes kramskābes platēm, ienesot tur nelielu daudzumu zemes. Labi panākumi tika gūti novietojot filtra papīri tieši uz mitras zemes virsas, jeb arī aprokot viņu zemē. Pēc vairākkārtīgas pārpotēšanas šķidrās elektīvās vidēs, cellulozes baktērijas tika pietiekošā mērā atbrīvotas no citiem sīkorganismiem, lai beidzot viņas izolētu kā tīrkultūras no cellulozes agāra vai cellulozes kramskābes platēm. Vairāk kā divi simti cellulozes baktēriju rases tika izolētas no dažādām Anglijas zemēm. Lielākā daļa no izolētām rasēm ir kustīgas baktērijas. 48 rasēm tika sīkāki pētītas viņu morfoloģiskās un fizioloģiskās īpašības, lietojot šim nolūkam 12 dažādas barības vides. Salīdzināšanai tika lietotas dažas, jau agrāki citu pētnieku izolētas, cellulozes baktēriju tīrkultūras, kā: *Bact. fimi*, *Ps. perlurida*, *Bac. bibulus* un *Bac. cellaseus* (Kellerman et. al.); *Microspira agarliquefaciens* (Gray et Chalmers) un kāds vibrions, kuŗu izolējis Kluyver's Delftā. Fizioloģisku īpašību ziņā, izolētās baktēriju rases atšķiŗas lielā mērā viena no otras. Lai gan šīs īpašības ir konstantas, tomēr viņas nevar uzskatīt par pietiekoši svarīgām, lai pamatotu uz tām šo organismu klasificēšanu. Klasificējot pēc fizioloģiskām īpašībām, iznāktu vismaz 35 īpatnējas grupas. Pareizāki ir grupēt šīs rases pēc viņu morfoloģiskām īpašībām, kā arī augšanas pazīmēm dažādās barības vidēs. Ņemot vērā morfoloģiskās atšķirības, organismi tika sagrupēti trijās ģintīs: *Bacterium* (Cohn emend. Hüppe), *Vibrio* (Müller emend. Winslow et al.) un *Bacillus* (Cohn emend. Zopf.). Sīkākam sadalījumam sugās, tika ņemtas vērā arī augšanas pazīmes dažādās barības vidēs un no fizioloģiskām īpašībām želatīna atšķidrināšana, jo šī īpašība iespaido lielā mērā koloniju raksturu uz želatīna. Visas pārējās fizioloģiskās īpašības, kā nitrātu redukcija, amonjaka ražošana no peptona, skābes ražošana no ogļhidrātiem, diastātiskā darbība u. c., tika ņemtas vērā vienīgi, lai raksturotu rases. Šinī darbā, pamatojoties uz iegūtiem rezultātiem, tiek aprakstītas 17 jaunas sugas un salīdzinātas ar jau pazīstamu cellulozes baktēriju aprakstiem. Šīs jaunās sugas ir sekošas: *Vibrio xylitica*, *V. prima*, *V. bulbosa*, *V.*

stationis, *V. castra*, *V. cucumis*, *V. synthetica*, *V. ranicula*, *V. malamoria*, *V. napi*, *V. rigensis*, *V. pericoma*, *Bacterium elaphorum*, *Bact. bosporum*, *Bact. pusiolum*, *Bact. protozoides* un *Bacillus latvianus*. Pielietotā izolēto baktēriju grupēšana nav domāta kā pastāvīga klasifikācija. Mūsu patreizējās zināšanas un metodes vēl nav pietiekošas, lai rastu baktērijām izsmeļošu klasificējumu. Tādēļ aprakstītais iedalījums jāuzskata kā pagaidu klasifikācija, kuŗas galvenais nolūks ir atvieglot orientēšanos un identificēšanu.

Visas aprakstītās baktērijas ir kustīgi stabiņi. Gandrīz visām sugām šūnas ir ar vienu polāru skropstiņu. Divām sugām, *V. pericoma* un *V. cucumis*, bez parastām vienskropstiņu šūnām arī šūnas, kuŗām skropstiņas piestiprinātas visapkārt (peritrichas). Baktēriju kustības ir ļoti intensīvas. Sporas rada tikai viena suga, *Bac. latvianus*. Šai sugai šūnas ir ar daudzām (līdz 20) peritrich'ām skropstiņām. Cellulozes vidēs šūnas atkarība no rases ir no 1 līdz 3,5 μ gaŗas. Uz stērķeles agāra šūnas ir lielākās (2 līdz 5 μ) un resnākas (0,7 līdz 0,9 μ). Vecās kultūrās šūnas paliek īsākas un bieži sastopamas pat kokkveidīgās šūnas. Baktērijas krāsojas labi ar parastām baktēriju krāsvielām. Šūnu vidējā daļa mēdz krāsoties intensīvāki. Visas baktērijas ir Gram-negatīvas.

Organismi noārda cellulozi vienīgi aerobos apstākļos. Tikai *Bacillus latvianus* sadala mazliet cellulozi arī anaerobos apstākļos. Cellulozes noārdīšana sākas vispirms tai filtra papīra daļā, kuŗa atrodas tieši virs un nedaudz zem barības šķidruma virsmas. Lielākā daļa rašu sairdina filtra papīri minētā vietā divās līdz piecās dienās, pēc kam papīra apakšējā daļa atdalās no augšējās. Barības šķidrums pa lielākai daļai kļūst mazliet opalescējošs, bet pie dažām rasēm tas uzturas dzidrs visā darbības laikā. Atsevišķas rases ražo dzelteni brūnu vai melnu pigmentu, kas nokrāso nevien filtra papīri, bet arī barības šķidrumu. Viena suga (*V. stationis*) pat nokrāso filtra papīri zilganu. Uz cellulōzes agāra un cellulozes kramskābes platēm baktērijas rada ap kolonijām caurspīdīgas zonas. Dažām rasēm šādas zonas rodas vienīgi ap dziļām kolonijām. Zonu platums mainās no dažām desmitdaļām milimetra līdz 5—6 milimetri, atkarībā no rases. Šo zonu rašanās ir baktēriju eksoenzima izsaukta, kuŗš hidrolizē cellulozi.

Pētītie organismi gaļas buljonā, gaļas agārā un gaļas želatinā aug ļoti slikti. Turpretī viņi vairojas ļoti labi, ja šīm vidēm piedod klāt kādu ogļhidrātu. Visraksturīgākās augšanas pazīmes katrai rasei novērojamas uz dekstrōses želatina. Tādēļ kolonijas šinī vidē ir vairāk

noderīgas sugu identificēšanai, nekā kolonijas citās barības vidēs. Astoņas rases atšķidrina želatīnu stipri, 16 rases lēnām un 24 rases neatšķidrina nemaz.

Slāpekli šie organismi vislabāki var asimilēt no neorganiskiem slāpekļa savienojumiem: nitrātiem un amonija sāļiem. Lielai daļai rašu organiskās slāpekļa vielas, kā gaļas ekstrakts, peptons, aminoskābes, ir maz piemērota slāpekļa barība. Cellulozes noārdīšana ir stipri vājāka, ja baktērijām slāpeklis pieejams vienīgi organisku savienojumu veidā. No neorganiskiem slāpekļa savienojumiem viņas dod priekšroku amonija sāļiem. Ir zināma sakarība starp spējām reducēt nitrātus un spējām absorbēt amoniju no neorganiskiem sāļiem. Rases, kuŗas nereducē nitrātus, ir stipri aktīvākas amonija absorbētājas, nekā tās, kuŗas tos reducē. Šo pēdējo rašu ir 31, nereducējošo — 17. 17 rases ir spējīgas ražot amonjaku no peptona cellulozes barības vidēs.

Kā enerģijas avots gaļas ekstrakts ir ļoti mazvērtīgs, bet peptons, aminoskābes, glicerins, mannits un organisku skābju kalcija sāļi pavisam nederīgi. Vienīgi ogļhidrāti ir noderīgi enerģijas iegūšanai. Sekošie savienojumi tika pārbaudīti: cellulōze, dekstrōse, stērķele, laktōse, maltōse, sacharōse, arabinōse, ksilōse un inulīns. Lielākā daļa rašu spēj izmantot visus uzskaitītos ogļhidrātus, bet dažas rases neaug barības vidēs, kuŗas, kā vienīgo enerģijas avotu satura stērķeli, inulīnu, ksilōsi vai arabinōsi. Vislabāki organismi aug cellulozes barības vidēs, vissliktāki inulīna vidē. Gandrīz visas sugas ir ļoti spēcīgas diastases ražotājas. Stērķeles agāra platēs baktēriju kolonijas noārda visu stērķeli nepilnas nedēļas laikā.

Aprakstītās rases ražo skābi barības vidēs, kuŗas satur cukurus vai stērķeli. Šādās barības vidēs reakcijas maiņas ir lielākas, ja slāpeklis tiek dots nitrātu veidā. Turpretī, peptona vidēs, kuŗām ir lielākas buferspējas, pH maiņas ir mazākas. Viszemākais pH (ap 4.5) rodas dekstrōses vidēs, viņai seko laktōse, maltōse, stērķele un dekstrīns, kā skābes izejvielas. Maz skābes tiek ražots no sacharōses. Tikai nedaudz sugas skābina inulīna barības vides. Kellerman'a baktērijas, kuŗas tika lietotas salīdzināšanai, izrādījās kā ļoti spēcīgas skābes ražotājas. Šinī ziņā viņas ir vienlīdzīgas ar *Bac. latvianus* un *Bact. protozoides*. No agāra šķidrinošiem organismiem Kluyver'a vibrions arī ir ļoti darbīgs, kamēr *Microspira agarliquefaciens* ražo ļoti maz skābes. Cellulōzes barības vides reakcija var mainīties uz skābo vai uz sārmaino pusi, atkarībā no tam, kāds slāpekļa savienojums baktērijām ir pieejams kā slāpekļa avots. Ja slāpeklis dots nitrātu veidā,

tad reakcija mainās uz skābo pusi. Šīs reakcijas maiņas, kā redzams, izskaidrojamas ar to, ka organismi absorbē NO_3' vai NH_4' no dotām slāpekļa uzturvielām. Ja slāpeklis pieejams baktērijām reizē nitrātu un amonija sāļu veidā, tad barības vides reakcija var kļūt skāba vai sārmaina, vai arī palikt neutrāla atkarībā no šo sāļu koncentrācijas un šo koncentrāciju attiecības. Lai pārliecinātos, ka skābai reakcijai cellulozes amonija sāļu vidēs par iemeslu ir NH_4' absorbēšana, bet ne organiskas skābes rašanās cellulozei sadaloties, šādi skābi kultūru šķidrumi tika titreti elektrometriski. Titrāciju līkņu rakstūrs liecināja, ka skābā reakcija ir neorganiskas skābes izsaukta.

Cellulozes peptona un cellulozes asparagīna vidēs reakcijas maiņas ir ļoti mazas, parasti uz skābo pusi. Vienīgi *Bac. latvianus* ir izrādījies kā spēcīgāks skābes ražotājs šinīs vidēs (pH = 5.37). Kellerman'a baktērijas ražo skābi cellulozes peptona un cellulozes asparagīna vidēs. Turpretim cellulozes barības vidēs, kuŗas satura neorganiskus slāpekļa savienojumus, viņas izsauc ļoti niecīgas reakcijas maiņas, jo šādās vidēs tās noārda cellulozi vāji. Šie organismi, kā rādās, ir spējīgi ražot skābes no cellulozes.

Baktēriju spējas noārdīt cellulozi tika noteiktas gravimetriskā ceļā. No apstākļiem, kas iespaido cellulozes noārdīšanu, aerācija izrādījās par vienu no svarīgākiem. Jau nedaudz milimetrus zem šķidruma virsmas filtra papīra sairšana ir ļoti gausa. Liels iespaids ir arī barības vides reakcijai. Baktērijas noārda cellulozi visspēcīgāki vāji sārmainā barības šķidrumā (ap pH = 7.5). Visas rases ir darbīgas barības vidēs ar pH = 8.0, bet tikai 15 rases pie pH = 9.2. Zemākais cellulozes vides pH, pie kuŗa pētītas baktērijas var sākt vairoties un sadalīt cellulozi, svārstās ap 6.0. Absorbējot amoniju no dotiem neorganiskiem amonija sāļiem, baktērijas spēj pazemināt cellulozes barības šķidruma pH līdz 4.0 un vēl zemāk. Šādos apstākļos cellulozes noārdīšana ir maza un viņa drīz apstājas. Lai veicinātu baktēriju darbību barības vidēs, kuŗas satura amonija sāļus, ir nepieciešama kalcija karbonāta piedeva pietiekošos daudzumos. Ja slāpekli dod nitrātu veidā, tad šāda piedeva ir lieka.

Visi organismi noārda cellulozi pie 18° C. Optimālā temperātūra lielākai daļai rašu ir 25 līdz 27° C. Dažas sugas tomēr ir aktīvākas pie augstākas temperātūras, 29—31° C. Maksimālā temperātūra svārstās no 27 līdz 37,5° C., atkarībā no rases.

Baktēriju spējas sadalīt cellulōzi ir dažādas, atkarībā no rases. Lielākā daļa organismu noārda 20 dienās no 25 līdz 35% no dotās

cellulōzes (nitrāta barības šķidrumā). Dažas sugas, kā *Bact. elaphorum*, sadala pat pusi no lietotā daudzuma cellulozes minētā laikā. Kellerman'a organismi izrādījās maz darbīgi cellulozes noārdīšanā, īpaši ja slāpekli deva vienīgi neorganisku savienojumu veidā.

Hutchinson's un Clayton's konstatējuši, ka *Spirochaeta cytophaga* ražo gaistošās skābes no cellulozes. No visiem šinī darbā aprakstītiem organismiem vienīgi *Bac. latvianus* ir spējīgs ražot nelielu daudzumu gaistošo skābju. Kā parastie starpprodukti cellulozes noārdīšanas procesā tika konstatētas oksicellulōze un dekstrōse. Oksicellulōze rodas aizvien un viņu ir viegli konstatēt ar vāja metilenziluma šķīduma palīdzību. Dekstrōses identificēšanai no kultūru šķidrumiem tika izolēts ozasons un tam noteikta kušanas temperatūra, kuŗa svārstījās ap 204 līdz 206° C. Varētu sagaidīt, ka cellobiōse arī rodas kā cellulōzes hidrolizes produkts, bet mēģinājumi izolēt to cellobiōsozasona veidā bija bezsekmīgi.

Pretēji oksicellulōzei, dekstrōse uzkrājas manamos daudzumos tikai noteiktos apstākļos. Parastos apstākļos, dekstrōsi, kas rodas kā cellulozes hidrolizes produkts, baktērijas tūliņ oksidē tāļāk. Kavējot, jeb izslēdzot pēdējo procesu, ir iespējams uzkrāt dekstrōsi. Cellulōzes hidrolizes process, kā enzimatiskas dabas, var norisināties arī augstākā temperatūrā, piem. pie 38°—40° C., pie kuŗas cellulōzes organismi vairs nespēj darboties. Tāpat tas var norisināties bez gaisa klātbūtnes. Abi šie paņēmieni tika lietoti. Vīsvieglāk cellulozes hidrolizes produktus var uzkrāt, ja desmit dienas vecas kultūras noslēdz no gaisa ar parafīnu un novieto pie 25° C. Pēc 20 dienām kultūru šķidrums reducē Fēlinga šķīdumu un dod ar fenilhidrazinu dzeltenus adatveidīgus kristalus.

Dekstrōses rašanās cellulōzes noārdīšanas procesā pamudināja uz domām, ka *Azotobacter chroococcum* un cellulozes baktērijas varētu strādāt simbiotiski, pirmais apgādājot cellulozes baktērijas ar slāpekli un pēdējās azotobakteru ar enerģiju. Izrādījās tomēr, ka domātā sadarbība nav iespējama. Azotobakters gan varēja izlietot cellulozes noārdīšanas starpproduktus kā enerģijas avotu, bet cellulozes baktērijas nespēja asimilēt azotobaktera saistīto slāpekli. Šī organiskā slāpekļa viela, kā pārāk komplicētā sastāva, cellulozes baktērijām laikam nav pieejama.

Lai gan baktērijas vairojas ļoti labi stērķeles un dekstrōses barības vidēs un pat ražo dekstrōsi kā cellulōzes noārdīšanas starpproduktu, tomēr šie savienojumi augstākās koncentrācijās (piem. 1%)

traucē cellulozes sadalīšanu. Ja barības vides satura reizē cellulozi un dekstrōsi vai cellulōzi un stērķeli, tad baktērijas skābes neražo.

Organismi tika kultivēti labōrātōrijas apstākļos ilgāk kā trīs gadus. Šinī laikā neviena no izolētām rasēm nav zaudējusi savas spējas sadalīt cellulozi, kā tas gravimetriski tika noskaidrots. Kultūras tika uzglabātas stobriņos ar sterilizētu zemi un filtra papīru, vai stobriņos ar stērķeles agāru. Pēdējā gadījumā tie tika noslēgti ar parafinu, lai pasargātu viņus no izžūšanas. Šādās vidēs visas rases bija dzīvas pēc viena gada. Pēc diviem gadiem dažas rases bija nobeigušās. Ilgstoša kultivēšana barības vidēs ar cukuru vai stērķeli tomēr mazina baktēriju spējas sadalīt cellulozi.

Slēdzieni.

1. No cellulozes kramskābes un cellulozes agāra platēm ir iespējams izolēt cellulozes baktērijas tīrkultūru veidā.

2. Daudzas cellulōzes baktēriju rases ir izolētas no Anglijas zemēm. Viņu īpašības ir pētītas, un ir aprakstītas 17 jaunas cellulozes baktēriju sugas.

3. Auglīgās zemēs visbiežāk sastopamas ļoti kustīgas cellulozes baktērijas bez sporām. Šādās zemēs *Spirochaeta cytophaga* ir mazāk izplatītas.

4. Šīs kustīgās baktērijas noārda cellulozi vienīgi aerobos apstākļos. Vislabāki celluloze tiek sadalīta barības vidēs ar pH = 7.5. Skābās vidēs (pH = 5.0) celluloze netiek aizskārta. Optimālā temperātūra cellulozes noārdīšanai ir ap 25 līdz 27° C.

5. Vislabāki piemērota slāpekļa barība šīm baktērijām ir nitrāti un amonija sāļi. Slāpeklis organisku savienojumu veidā ir viņām mazāk noderīgs.

6. Enerģijas iegūšanai šīs baktērijas var izlietot vienīgi ogļhidrātus. Augstākās koncentrācijās (1.0%) dekstrōse un stērķele kavē cellulozes noārdīšanu.

7. Šīs baktērijas ražo skābes no cukuriem un stērķeles. No cellulozes skābes netiek ražotas.

8. Oksicellulōze un dekstrōse ir konstatētas kā cellulōzes noārdīšanas starpprodukti.

9. *Azotobacter chroococcum* spēj izlietot kā enerģijas avotu vielas, kas radušās cellulōzes noārdīšanas gaitā.

10. Aprakstītie organismi nav zaudējuši spējas noārdīt cellulozi pēc 3—4 gadu kultivēšanas labōrātōrijas apstākļos. Kellerman'a baktērijas nav zaudējušas šīs spējas pat pēc 18 gadu kultivēšanas labōrātōrijā.

„Latvju Kultūras" spiestuve, Rīgā, Tērbatas ielā 15/17.