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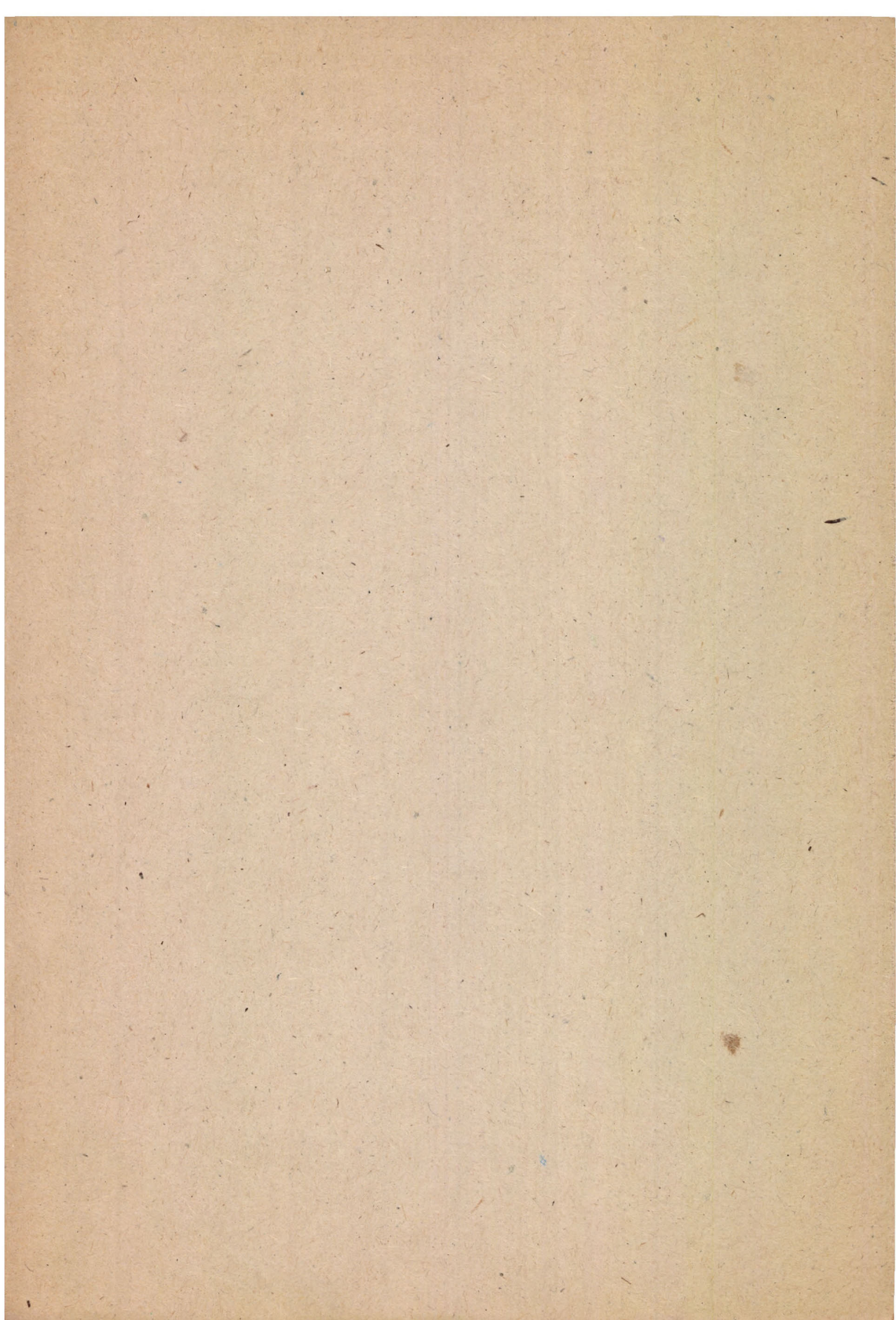
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REDIGIT:
J. HORVÁTH

ADIUUVANTIBUS:
A. BÁLINT, B. ENTZ, GY. FÁBIÁN, L. FELFÖLDY, O. SEBESTYÉN,
G. STOHL

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Tihanyi Biológiai Kutatóintézet, Tihany. F.: Horváth János

MNOSz. 5601—5602 Délmagyarország Nyomda, Szeged 51 527

Felelős vezető : Priskin Sándor

GASTROTRICHEN AUS DEM BALATON-SEE

VON

LAJOS VARGA (Sopron)

Aus dem Ung. Biol. Forschungsinstitut, Tihany, am Balaton-See

(Eingegangen am 11. Mai 1949.)

Die Süßwasser-Gastrotrichen Ungarns sind bisher fast unbekannt. Diese kleinen, verborgen lebenden Organismen fanden hier keinen Bearbeiter. Obwohl DADAY, der bekannte Forscher der ungarischen Süßwasser-Mikrofauna schon im Jahre 1881, als unsere allgemeinen Kenntnisse über die Gastrotrichen noch sehr mangelhaft waren, eine neue Art: *Ichthydium Entzii* aus einem Tümpel von der Umgebung von Kolozsvár beschrieb, wurde dieser Anfang systematisch und taxonomisch nicht weiter fortgeführt. Bei seinen sehr ausgedehnten Untersuchungen der Süßwasser-Mikrofauna Ungarns erwähnt er wohl die von ihm gelegentlich beobachteten Gastrotrichen-Arten, aber der systematischen Bearbeitung dieser Tierchen schenkte er keine Aufmerksamkeit. Bei der von ihm erwähnten einigen Arten gibt er nur den Lebensort an, z. B. „Uferbewohner“, „lebt im Schlamm“, aber von den weiteren ökologischen oder morphologischen Verhältnissen dieser Tierchen sagt er nichts.

So kam es, dass als DADAY selbst im Jahre 1918 die Liste der in den ungarischen Süßgewässern lebenden Gastrotrichen in der „Fauna Regni Hungariae“ zusammenstellte, insgesamt nur in zwei Genus gehörende vier Arten aufzählen konnte. Die Gastrotricha wurden hier noch als Subclassis der Classis Rotatoria behandelt.

Im Jahre 1935. erwähnt P. TÖRÖK 3 *Chaetonotus*-Arten aus dem Leitungswasser von Budapest.

Bei meinen langjährigen Untersuchungen über die Rotatorien der ungarischen Süßgewässer versäumte ich nicht auch die gefundenen Gastrotrichen zu bestimmen, beobachten und zu beschreiben. Dies war mein Zweck hauptsächlich bei den Untersuchungen, die ich seit langen Jahren in dem Biologischen Forschungsinstitut zu Tihany über die Mikrofauna des Balatonsees durchführte. Die folgende Aufzählung der gefundenen Gastrotrichen des Balatonsees ist das Ergebnis dieser Beobachtungen.

Bei der Aufzählung folge ich dem System von REMANE (1928--33). In seinem bekannten System bilden die Gastrotrichen eine eigene Klasse, abgetrennt von den Rotatorien. Sämtliche, im Balatonsee gefundenen Arten gehören in die Ordnung *Chaetonotoidea*.

Ordo: *CHAETONOTOIDEA*.

Fam.: *CHAETONOTIDAE*.

1. Genus: *Ichthydium* EHRBG.

1. *Ichthydium podura* O. F. MÜLLER.
(GRÜNSPAN, p. 245. COLLIN, p. 242).

Diese Art wurde schon von MARGÓ (1879) aus der Umgebung von Budapest erwähnt.

In dem Balatonsee beobachtete ich sie in den folgenden Zeiten:

11. VI. 1929. im Plankton bei Tihany. Wohl passiv durch den starken Wellengang hineingetrieben.

16. VII. 1935. 17. VII. 1936. 19. VII. 1939. in der Bucht von Aszófő im Detritus, zwischen *Hydrocharis* und Fadenalgen, sowie im Periphyton.

22. VII. 1936. im Psammon bei Balatonboglár, 8. VIII. 1936. im Psammon bei Siófok und Szárszó.

18. II. 1939. im Hygropsammon bei Zamárdi, wo das Wasser des Sees $+2.8^{\circ}\text{C}$, die Temperatur des Sandes $+1.5^{\circ}\text{C}$, aber die obere Schicht des Sandes gefroren war. Hier fanden sich gut entwickelte Exemplare.

29. VII. 1939. im Psammon bei Zamárdi. Sommer 1939, zwischen *Cladophora*.

Ichthyidium podura ist eine sehr kleine Art, deren Körper nackt, unbestachelt und mit weicher Haut ist. In den ungarischen Süßgewässern ist sie sehr häufig und verbreitet aufzufinden. Im Balatonsee kommt sie durch das ganze Jahr vor, lebt in allen möglichen Biotopen, hauptsächlich zwischen Wasserpflanzen, im Detritus und in dem Psammon. Sie kommt aber nie in grösseren Mengen vor. Die Hauptverbreitungszeit fällt auf Sommer und Herbst. In dem Hygropsammon beobachtete ich sie auch im Februar (1939), als die obere Schicht des Sandes gefroren war.

Die weiche Haut bildet bei den Bewegungen breite Falten, die meist an dem Rumpfgebiet auftreten.

Die Körperlänge ist stark variabel, je nach dem Lebensort des Tierchens. In dem Detritus und zwischen Wasserpflanzen lebende Exemplare sind immer kleiner und breiter als die in dem Psammon lebenden, die länger und schmaler sind. Gesamtlänge 65–96 μ , Breite des Kopfes 14–17 μ , Breite des Rumpfes 18–26 μ , die Länge der Schwanzgabel 7–9.5 μ .

Ichthyidium podura besitzt eine ziemlich hohe ökologische Valenz; sie ist eine eurytope und eurytherme Art.

2. *Ichthyidium balatonicum* n. sp.

(1. u. 2. Abbildung)

In dem Detritus von der Aszófőer Bucht fand ich am 16. VII. 1935. einige Exemplare einer *Ichthyidium*-Art, die von *I. podura* stark unterschied. Ich muss sie als eine neue Art betrachten und beschreiben.

Sie ist viel schlanker und etwas grösser als *Ichthyidium podura* O. F. MÜLLER. Der Kopf ist fünfklappig und etwas weniger breit als der Rumpf. Der vordere frontale Lappen springt etwas vor, eine kleine, bewegliche Stirnkappe bildend. Darunter findet sich ventral die etwas ovale und kleine Mundöffnung. Am Munde sitzen 2–2 seitlich gerichteten Tasthaare, die sehr beweglich sind; daneben mehrere, viel kleinere Haare, die die Nahrung in die Mundöffnung strudeln. Etwas weiter hinten am Kopfe befinden sich zwei seitlichen Tastbüschel, die aus langen Haaren zusammengesetzt und sehr empfindlich sind und stän-

dige Bewegungen ausüben. An der Ventralseite unter diesen Tastbüscheln beginnen die zwei Wimperstreifen oder Flimmerbänder, die bis zum Hinterende des Körpers reichen. Sie bestehen aus feinen, kurzen Zilien. Diese ventralen Wimperstreifen sind mit keinem queren Wimperband verbunden. Es ist nämlich bekannt, dass bei *Ichthydium podura* die ventralen Flimmerbänder am Kopf ganz vorne durch ein queres Wimperband verbunden sind.

Der Kopf geht ziemlich plötzlich in den kurzen, breiten Hals über. Fast am Beginn des Halses sitzen zwei lange Tasthaare, die etwas seitlich stehen. Der Hals ist kürzer als bei *Ichthydium podura*. Er geht allmählich in den Rumpf über, der etwa in der Mitte am breitesten ist.

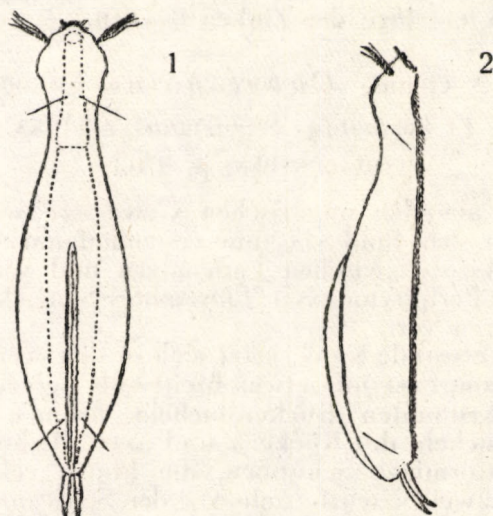


Abb. 1.—2.: *Ichthydium balatonicum* n. sp. Dorsalansicht (1.); Seitenansicht (2.).

Von hier ab verschmälert sich der Rumpf allmählich nach rückwärts bis zur Schwanzgabel, wo er in einer schmalen Abrundung endet. An der kaudalen Dorsalseite des Rumpfes sitzen wieder zwei Tasthaare, die etwas länger sind als die des Halses.

Das auffallendste und charakteristischste Merkmal des Tierchens ist der schmale, kammartige Rückenkiel des Rumpfes, der etwa in der Mitte des Gesamtkörpers beginnt, in der Mitte des Rumpfes am höchsten ist und sich ganz langsam verschmälernd vor der Schwanzgabel in den hintersten Teil des Rumpfes übergeht. Dieser Rückenkiel ist eine ziemlich starre Ausstülpung der Haut; bei der Dehnung des Rumpfes wird er etwas kleiner, beim Zusammenziehen des Rumpfes dagegen wölbt er sich stärker hervor, bleibt aber immer sehr auffallend. Die Haut des Rumpfes scheint etwas dicker zu sein als die des Halses und des Kopfes. Biegt der Körper seitlich, so erscheinen an der inneren Seite des Rumpfes und Halses einige breiten und sehr seichten Falten, die aber nie so scharf heraustreten als es bei *Ichthydium podura* der Fall ist. An dem Rückenkiel habe ich niemals Faltungen gesehen.

Die Schwanzgabel ist sehr kurz; die Zinken der Schwanzgabel stehen eng beisammen; die innere Seite der Zinken ist gerade, die

äussere Seite dagegen etwas ausgeschnitten. Sie krümmen ventralwärts sichelartig und sind stark zugespitzt. Das Aussehen der Schwanzgabel mit den Zinken erinnert an die Zehen einiger *Lecane*-Arten der Rotatorien.

An der inneren Organisation des Tierchens konnte ich nichts auffallendes beobachten. Die Haut ist sehr wenig durchsichtig. Der Ösophagus reicht fast bis zum Beginn des Rumpfes, wo er geradelinig dem Darmanfang anliegt. Der Darm ist ziemlich breit und mit dunkler Nahrung angefüllt, die hauptsächlich aus kleinsten Partikeln des organischen Detritus besteht.

Totallänge 110—120 μ , Breite des Kopfes 13—14 μ , Breite des Halses 9—10 μ , grösste Breite des Rumpfes 26—27 μ , grösste Höhe des Rückenkieles $\pm 5 \mu$, Länge der Zinken 9—10 μ .

2. Genus: *Chaetonotus* EHRBG.

1. *Chaetonotus brevispinus* ZELINKA.

(GRÜNSPAN, p. 276.)

Diese Art aus den ungarischen Gewässern wurde bisher noch nicht beschrieben. Ich fand sie zum erstenmal am 17. VIII. 1936. in der Bucht von Aszófő zwischen Fadenalgen und später am 26. VIII. 1936. ebenda im Periphyton von *Phragmites*-Stengel. Sie kam nur in einigen Exemplaren vor.

Der fast kreisrunde Kopf setzt sich in den wenig eingeschnürten Hals fort; der Rumpf ist nur etwas breiter als der Kopf. Die schwach nach hinten gekrümmten Rückenstacheln nehmen kaudalwärts an Länge zu. Die Stacheln des Rückens sind in elf Reihen angeordnet und entspringen kreisförmigen Schuppen, die hinten eckig ausgeschnitten sind. Die letzten zwei Seitenstacheln vor der Schwanzgabel sind dicker, länger und mehr gekrümmt als die benachbarten Stacheln. Der Zwischenraum der ventralen Wimperstreifen ist mit sehr dünnen, runden Schuppen bedeckt. Die vor der Schwanzgabel sitzenden Ventralschuppen sind 3—4-mal länger und tragen je einen langen Stachel.

GRÜNSPAN (1910) schreibt (p. 275.) über diese Art: „Am Kopfe fallen vier Körper auf, welche paarweise liegen. Sie erscheinen mit schwarzen Punkten erfüllt, die besonders dicht gegen den Rand zu stehen; sie können als Augen (Flecke) angesehen werden.“ Bei manchen Exemplaren konnte ich diese Beschreibung bestätigen; bei einigen Exemplaren fehlten die „schwarzen Punkte“, aber die vier Körperchen waren stärker lichtbrechend — vorhanden.

Gesamtlänge 132—140 μ , Breite des Kopfes 18 μ , grösste Breite des Rumpfes 20—22 μ , Länge der Gabelzinken 13—14 μ .

2. *Chaetonotus chuni* VOIGT.

(GRÜNSPAN, p. 294. COLLIN p. 249.)

Beobachtet: 16. VII. 1935 in der Bucht von Aszófő, im Detritus; 17. VIII. 1936. ebenda, an der unteren Seite von *Hydrocharis*-Blätter; 19. VII. 1939. ebenda, im Periphyton.

Der breite und ziemlich flache Körper ist sehr reich bestachelt. Die Stacheln sind an der Dorsalseite in neun Reihen geordnet; sie sind

kräftig, gross, gekrümmt und bei der Endkrümmung besitzen sie einen Nebenzahn. Sie entspringen länglichrunden Schuppen und nehmen nach den Seiten hin an Länge ab, während sie von dem Kopfe kaudalwärts an Länge zunehmen, so dass sie am Ende des Rumpfes dreimal so gross sind als am Kopfe. Sehr charakteristisch sind die zwei dorsalen, langen und dünnen, mit Nebenzahn versehenen Stacheln zwischen der Schwanzgabel, die manchmal die Gabelzinken an Länge übertreffen. Zwischen den Gabelzinken sieht man oft vier kurze, einfache und dünne Stacheln, die von der Ventralseite des Körpers entspringen. Die Gabelzinken sind gerade, ziemlich starr und ihre Enden sind verbreitert, bei meinen Exemplaren gerade abgeschnitten.

Der Kopf ist dreilappig, der Rumpf etwas breiter als der Kopf. Die Tasthaarbüschel bestehen aus einigen ziemlich kurzen Haaren. Der Hals ist undeutlich.

Fast bei jedem Exemplar sah ich im Körper 2—3 Eier. Die Nahrung besteht aus dem feinsten organischen Detritus.

Gesamtlänge 180—210 μ , Kopfbreite 40 μ , grösste Breite des Rumpfes 48—50 μ , längste Stacheln am Hinterende 70—76 μ , Länge der Gabelzinken 30—31 μ .

Chaetonotus chuni wurde bisher bei uns noch nicht beobachtet.

3. *Chaetonotus hystrix* METSCHNIKOFF.

(GRÜNSPAN, p. 270, COLLIN, p. 249.)

Gesammelt: 16. VII. 1935 in der Bucht von Aszófő im Detritus und Periphyton und am 19. 1939 an der Unterseite von *Hydrocharis*-Blätter, jedesmal vereinzelt.

Eine sehr kleine Art. Ihr Kopf ist länglich oval, der Hals ist etwas schmaler, der Rumpf bedeutend breiter. Der Rücken ist mit kräftigen Stacheln bewaffnet, die einen Nebenstachel besitzen; sie sind in 19 Längsreihen angeordnet. Die Kopf- und Halsstacheln sind sehr kurz, die Rückenstacheln länger; diese nehmen kaudalwärts an Länge zu und in der Nähe der Schwanzgabel sind sie etwa fünfmal länger als die des Kopfes. Jederseits vor der Schwanzgabel findet man je einen auffallend langen und kräftigen Seitenstachel. Charakteristisch ist es, dass auch an der Bauchseite ausserhalb der Zilienbänder kurze, zweispitzige Stacheln vorhanden sind, die in drei Längsreihen angeordnet erscheinen. Auch zwischen den Zilienbändern finden sich sehr kleine Schuppen mit feinen Borsten versehen. Die Zilienbänder sind vorne am Kopfe mit etwas längeren Zilien verbunden. Die Rücken-schuppen, die die Stacheln tragen, sind spießförmig und liegen nicht aneinander an.

Die Zinken der Schwanzgabel sind geteilt, sie tragen ein Endglied. Der Ösophagus ist kurz und erweitert sich in der Nähe des Darmes etwa zwiebelartig.

Gesamtlänge 80—88 μ , Breite des Kopfes ± 11 μ , Breite des Halses 9—10 μ , grösste Breite des Rumpfes 16—18 μ , Länge der Gabelzinken 12.5 μ .

Chaetonotus hystrix wurde aus Ungarn bisher noch nicht nachgewiesen.

4. *Chaetonotus larus* O. F. MÜLLER.

(GRÜNSPAN, p. 283. COLLIN, p. 257.)

Diese Art ist aus Ungarn schon lange bekannt. DADAY (1897) hat sie schon im Jahre 1892 beschrieben. Er hat sie in den Seen von Katona, Czege, Mezótóhát und Méhes (alle in Siebenbürgen), sowie im Tatra-Gebirge in dem 4. See von Tarpatak gefunden. Sie scheint sehr verbreitet zu sein. TÖRÖK P. (1935) fand sie im Leitungswasser von Budapest. Ich selbst beobachtete sie auch im Fertő (Neusiedlersee), und in fast allen Teichen, wo ich die Rotatorien untersuchte.

Fundorte im Balaton: 16. VII. 1935 in der Aszófőer Bucht, zwischen Fadenalgen; 17. VIII. 1936 ebenda auf der Unterseite der Blätter von *Hydrocharis*; 19. VII. 1939 ebenda zwischen Wasserpflanzen und im Detritus. 16. X. 1938 im Psammon von Zamárdi, 18. II. 1939 ebenda in Hydropsammon, als die obere Schicht des Sandes gefroren war, darunter aber die Sandschicht eine Temperatur von $\pm 1.5^\circ \text{C}$ hatte. Sie kommt regelmässig auch zwischen Ufer-*Cladophora* vor (VARGA, 1941). Im Balaton lebt sie also das ganze Jahr hindurch, scheint eine eurytope und eurytherme Art zu sein. Ihre Nahrung besteht aus den feinsten Detritusteilchen und kleinen Algen.

Chaetonotus larus besitzt einen ziemlich schlanken Körper. Der Kopf ist schwach dreilappig, eher rundlich. Der Hals setzt sich von Kopf und Rumpf wenig ab; der Rumpf ist nur etwas breiter als der Kopf. Die Schwanzgabel ist tief eingeschnitten. Der Rücken und die Seiten sind mit dreikantigen Stacheln bewaffnet, die am vorderen Körperdrittel sehr kurz sind und an dem mittleren und hinteren Drittel des Körpers ziemlich ohne Übergang an Länge stark zunehmen, so dass sie hier 4—5-mal länger werden. Die Stacheln entspringen dem Hinterrand der tief parabolisch eingeschnittenen Körperschuppen. An dem Kopf und Hals stehen die Stacheln in neun, an dem Rumpf in sieben Längsreihen. In jeder Längsreihe kann man etwa 15—18 Stacheln zählen, davon sind 6—8 lang. Auf der Ventralseite kann man in der Umgebung des Afters und auf dem Basalstück der Gabelzinken einige kleine Borsten finden, die aber bei den älteren, eiertragenden Tierchen oft fehlen können. Das Bauchfeld zwischen den Zilienbändern ist sonst ohne Borsten.

Die Körperlänge ist ziemlich variabel: 85—130 μ , die Breite des Kopfes 30—36 μ , die des Halses 25—30 μ , die des Rumpfes 32—40 μ . Länge der Gabelzinken 10—12 μ , Länge der grössten Stacheln 18—20 μ .

5. *Chaetonotus macrochaetus* ZELINKA.

(GRÜNSPAN, p. 279. COLLIN, p. 257.)

Gefunden: 16. VII. 1935 in der Bucht von Aszófő, zwischen Wasserpflanzen; 9. IV. 1936 ebenda im Detritus, 17. VIII. 1936 im Aufwuchs von *Phragmites*-Stengeln und im Detritus, 19. VII. 1939 auf der Unterseite der *Hydrocharis*-Blätter.

Die Form ist ähnlich *Chaetonotus larus*. Die Rücken- und Seitenstacheln sind in 9 Längsreihen angeordnet. Die Kopf- und Halsstacheln sind lang, stark, sehr gekrümmt, mit Nebenspitze. Die Stacheln sitzen auf pflugscharförmigen, ziemlich grossen Schuppen, die sich nur

mit ihren Seitenspitzen berühren. Das Zwischenfeld der Zilienbänder der Ventralseite ist mit rundlichen, zarten, in alternierenden Reihen geordneten Schuppen bekleidet.

Die Gesamtlänge ist ziemlich variabel: 65–105 μ . Breite des Kopfes 26–30 μ , die des Halses 23–26 μ , die des Rumpfes 29–32 μ . Länge der Gabelzinken 9–10 μ , Länge der grössten Stacheln 19–22 μ .

Diese Art wurde in Ungarn zum erstenmal von P. TÖRÖK (1935) aus dem Leitungswasser von Budapest beschrieben.

6. *Chaetonotus maximus* EHRBG.
(GRÜNSPAN, p. 263, COLLIN, p. 254.)

Diese Art ist in den ungarischen Gewässern sehr verbreitet. DADAY (1897) erwähnt sie schon im Jahre 1883 aus dem Zenoga-See des Retyezát-Gebirges (Süd-Siebenbürgen). Er beschrieb sie später aus den Seen von Katona, Czege und Mezôtóhát (Siebenbürgen), aus dem Salzsee von Halas, aus den Seen von Környe, Kecskéd und Velence. Sie lebt auch im Leitungswasser von Budapest (TÖRÖK, 1935).

Ich traf sie in fast allen Teichen und Seen, die ich für Rotatorien untersuchte und beschrieb sie sogar aus den *Sphagnum*-Polstern von Kőszeg (VARGA, 1936). Funde im Balaton: 15. VII. 1935 in der Bucht von Aszófő im Detritus und zwischen Wasserpflanzen; am 3. I. 1936 ebenda unter Eisdecke zwischen Fadenalgen; 9. IV. 1936 ebenda im Detritus, 19. VII. 1939 ebenda im Detritus und auf der Unterseite der Blätter von *Hydrocharis*; 22. VIII. 1936 im Psammon des Sees, verbreitet; 18. II. 1939 bei Zamárdi im Psammon, als die obere Schicht des Sandes gefroren war, 29. VII. 1939 ebenda im Psammon; sie lebt auch zwischen *Cladophora*.

Der Körper ist schlank, langgestreckt. Der fünflappige Kopf ist von dem Hals scharf abgesetzt, der Hals ist ziemlich stark eingeschnürt. Der Rumpf ist etwas breiter als der Kopf. Die einfachen, gebogenen Rückenstacheln nehmen kaudalwärts an Länge zu und am Ende des Körpers sind sie etwa 2–3-mal länger als am Kopfe. Die Seitenstacheln sind etwas kürzer als die des Rückens. Die Schuppen der Stacheln sind wappenschildförmig. Der Raum zwischen den Wimperbändern der Bauchseite ist mit kurzen, dünnen Schuppen bedeckt, die je einen kleinen Stachel tragen. Die Gabelzinken stehen stark auseinander. Auffallend lang ist der Ösophagus, der in allgemeinen eine Länge von über ein Drittel des Körpers erreicht.

Die Gesamtlänge ist sehr variabel: 120–175 μ ; Breite des Kopfes 27–32 μ , Breite des Halses 22–20 μ , die des Rumpfes 33–37 μ , Länge der Gabelzinken 20–23 μ , die des Ösophagus 50–60 μ .

7. *Chaetonotus multispinosus* GRÜNSPAN.
(GRÜNSPAN, p. 303, COLLIN, p. 253.)

Gefunden in der Aszófőer-Bucht am 3. I. 1936 zwischen Fadenalgen unter einer dünner Eisdecke; 3 Exemplare.

Eine sehr kleine Art, die eine gewisse Ähnlichkeit mit *Chaetonotus brevispinosus* ZEL. besitzt. GRÜNSPAN (1910, p. 304) schreibt über diese Art: „Körper dick, plump Rückenfläche mit kurzen, einfachen

Stachen bewehrt, die in $17+2$ Längsreihen stehen und runden Schuppen entspringen. Kopf deutlich fünflappig, dick..., Hals dick, etwas weniger breit... Ventraler Raum zwischen den Flimmerbändern mit zarten Schuppen, denen kurze Stacheln aufsitzen, bedeckt. An den Rumpfflächen seitlich von den Flimmerbändern kurze Stacheln in alternierenden Reihen. Fünf Stacheln an der Breitesten Stelle.“ Meine Exemplare zeigten mit dieser Beschreibung eine vollkommene Übereinstimmung, nur waren sie viel kleiner. Gesamtlänge des Körpers $85-112\ \mu$, Breite des Kopfes $30\ \mu$, Breite des Halses $27\ \mu$, die des Rumpfes $36\ \mu$, Länge der Schwanzgabel $14\ \mu$.

8. *Chaetonotus octonarius* STOKES (3. Abb.).

(GRÜNSPAN, p. 299.)

Fundorte: 17. VIII. 1936 in der Bucht von Aszófő, zwischen Wasserpflanzen; 19. VIII. 1939 ebenda, an der Unterseite der Blätter von *Hydrocharis*; 19. VII. 1938 Ufer von Siófok, zwischen Fadenalgen.

Das sehr kleine, interessante Tierchen ist leicht zu erkennen durch seine acht Stacheln, die seinen Rumpf an der Rückenseite bewaffnen. Diese gleich langen, derben Stacheln besitzen vor ihrem Endteil einen ziemlich langen Nebenstachel, so dass sie deutlich gega-

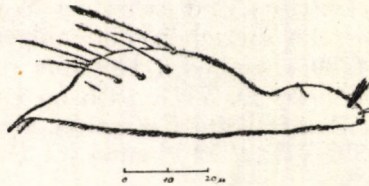


Abb. 3.: *Chaetonotus octonarius* Stokes, Seitenansicht.

belt erscheinen. Sie sind in drei Reihen angeordnet und zwar so, dass zwei Stacheln in der Mittellinie des Rumpfes, je drei an der rechten und linken Seite des Rumpfes stehen. Die Schuppen, von denen sie entspringen, sind fast kreisrund. Ausser diesen acht Stacheln fehlt an den anderen Körperteilen eine Bestachelung.

Der Körper ist schlank und zart. Der Kopf ist fünflappig, allmählich in den schmälere Hals übergehend. Der Rumpf ist etwas breiter als der Kopf. Die Schwanzgabel ist tief eingeschnitten, sonst zeigt sie nichts charakteristisches.

Gesamtlänge der gemessenen Exemplare: $72-85\ \mu$, Breite des Kopfes $24\ \mu$, Breite des Halses $21-22\ \mu$, Breite des Rumpfes $25-26\ \mu$, Länge der Schwanzgabel $18\ \mu$, Länge der Stacheln $27-28\ \mu$.

Die Art ist aus Ungarn noch nicht bekannt gewesen. Der nächste Lebensort ist in Bukowina (Czernowitz).

9. *Chaetonotus schultzei* METSchnikoff.

(GRÜNSPAN, p. 268, COLLIN, p. 248.)

Gefunden: 16. VII. 1935 und 3. I. 1936 in der Bucht von Aszófő im Detritus und zwischen Fadenalgen; im Jahre 1939 öfters an der Ufer vor Tihany zwischen *Cladophora*.

Diese Art ist die grösste unter den bisher besprochenen *Chaetonotus*-Arten. Ihr Körper ist flaschenförmig. Der Kopf ist dreilappig, mit dem Halse fast gleich breit, mit vier Tasthaarbüscheln und zwei hellen, lichtbrechenden Augenflecken. Der Rumpf ist dick, am Rücken stark aufgewölbt. Die Schwanzgabel ist mässig eingetieft, mit starken Gabelzinken. Der Rücken ist mit ziemlich kurzen, starken Stacheln bewaffnet, die kaudalwärts an Länge zunehmen und nahe dem Körperende die doppelte Länge der Kopfstacheln erreichen. Sie entspringen vorne abgerundeten, hinten tief parabolisch ausgeschnittenen Schuppen, die am Kopfe und am Halse sehr weich und zart sind. Die Stacheln besitzen bei etwa $\frac{1}{3}$ ihrer Länge zwei starke Nebenspitzen. Der Raum zwischen den zwei Flimmerbändern der Ventralseite ist mit sehr kleinen Stacheln bedeckt, die nach hinten an Länge zunehmen.

Gesamtlänge: 345—346 μ , die Breite des Kopfes 42—44 μ , Breite des Halses 40—42 μ , grösste Breite des Rumpfes 70—74 μ , Länge der Gabelzinken 34—35 μ .

Chaetonotus schultzei war aus Ungarn noch nicht bekannt. Er scheint ein eurythermes Tierchen zu sein.

10. *Chaetonotus serraticaudus* VOIGT.

(GRÜNSPAN, p. 288, COLLIN, p. 252.)

Gefunden: 17. VIII. 1956 in der Bucht von Aszófő, zwischen submersen Wasserpflanzen und an der Unterseite von *Hydrocharis*-Blättern.

Diese Art ist neben anderen schon an der Grösse erkennbar: sie ist unsere grösste Gastrotrichenart. Ihr fast gleichbreiter Körper ist auffallend schlank, planarienartig, langgestreckt. Der Kopf besitzt einen dreiteiligen Schild. Der Rücken und die Seiten sind haarkleidartig mit einfachen, kurzen Stacheln bekleidet, die ventralwärts bis zu den Flimmerbändern reichen und kaudalwärts an Länge zunehmen. Die letzten Seitenstacheln überragen etwas die Zinken der Schwanzgabel. Auch der Raum zwischen den Zilienbändern ist mit sehr kurzen Stacheln bekleidet. Charakteristisch sind am Ende des Körpers die 6—8 langen Stacheln, die von der Ventralseite zwischen den Zinken der Schwanzgabel hervortreten. Die Dorsalseite ist vor der Schwanzgabel ohne Stacheln, dafür aber mit Schuppen bedeckt. Eigenartig ist auch die Schwanzgabel gebaut: sie besteht aus zwei gekrümmten Röhren, mit kurzer, nach innen biegender Spitze. Die knotenartige Anschwellung der Röhren vor der Endspitze konnte ich bei meinem Tierchen nicht beobachten.

Das Tierchen bewegt sich ziemlich schnell, biegt seinen Körper rasch hin und her, bleibt plötzlich stehen, um dann zwischen dem dichten Gewirr des Detritus leicht durchzuschlüpfen. Die Röhren der Schwanzgabel öffnen und schliessen sich dabei wie die Teile einer Zange. Die Nahrung besteht aus sehr kleinen Grünalgen.

Gesamtlänge: 460—500 μ , Breite des Kopfes 58 μ , Breite des Körpers etwa in der Mitte 64 μ , Länge der Schwanzgabel 52 μ , Länge der Seitenstacheln bei der Schwanzgabel 35 μ .

Diese Art ist für die Fauna Ungarns neu.

11. *Chaetonotus similis* ZELINKA.

(GRÜNSPAN, p. 266.)

Gesammelt am 17. VIII. 1936 in der Bucht von Aszófő, im Detritus und Periphyton.

Diese Art ist an Gestalt, Kopfform und Grösse *Chaetonotus maximus* ziemlich ähnlich. Die Rückenstacheln sind aber breiter und dicker und tragen einen sehr kurzen Nebenstachel. Merkwürdig ist aber — wie ich bei meinen sechs beobachteten Exemplaren gesehen habe — dass der Kopf und der Hals bis etwa in die Gegend der beiden Tasthaare stachelfrei und nur mit kleinen Schuppen besetzt waren. Es ist bekannt, dass diese Erscheinung bei dieser Art vorkommt, aber meist ausnahmsweise. Bei den Balaton-Exemplaren fand ich aber keinen, dessen Kopf und Hals bestachelt gewesen wäre. Der Raum zwischen den Flimmerbändern der Ventralseite ist mit zilienähnlichen, kurzen Stacheln bedeckt.

Gesamtlänge 172—180 μ , Breite des Kopfes 38 μ , Breite des Halses 30 μ , grösste Breite des Rumpfes 41 μ , Länge der Gabelzinken 25 μ .

Chaetonotus similis ist für die Fauna Ungarns neu.

12. *Chaetonotus simrothi* VOIGT.

(GRÜNSPAN, p. 308, COLLIN, p. 255.)

Gesammelt: 16. VII. 1935 in der Bucht von Aszófő, zwischen *Hydrocharis*, im Detritus; 19. VII. 1939 ebenda, an der Unterseite der Blätter von *Hydrocharis*.

Das ziemlich grosse Tierchen besitzt einen schlanken, langgestreckten Körper. Der Kopf ist fünfklappig, die hinteren Lappen biegen seitlich etwas heraus. Der Hals ist wenig ausgebildet, geht allmählich in den etwas breiteren Rumpf über. Die Schwanzgabel ist aus zwei dünnen, leicht nach innen gekrümmten Röhren gebildet. Die ganze Rückenseite ist mit scharf gebogenen, einfachen Stacheln bewaffnet, die kaudalwärts an Länge zunehmen. Die hintersten Stacheln sind doppelt so lang als die Kopfstacheln. Die Stacheln entspringen sehr dünnen, schwer wahrnehmbaren Schuppen. Auch die Ventralseite des Tierchens ist mit kurzen Stacheln bedeckt.

Die Ernährung besteht hauptsächlich aus kleinsten Grünalgen, die den Magen grünlich färben.

Gesamtlänge 370—380 μ ; Breite des Kopfes 55—58 μ , Breite des Halses 48—50 μ , grösste Breite des Rumpfes etwa 70 μ , Länge der Gabelzinken 52 μ .

Chaetonotus simrothi wurde in Ungarn bisher noch nicht beobachtet.

13. *Chaetonotus spinulosus* STOKES.

(GRÜNSPAN, p. 277, COLLIN, p. 258.)

Gesammelt: 16. VII. 1935 in der Bucht von Aszófő, zwischen *Hydrocharis*; 9. IV. 1936 ebenda im Detritus; 17. VIII. 1936 ebenda im Detritus, 21. VIII. 1938 in der Bucht unter den Csúcshegy von Tihany, im Detritus auf Steinen.

Das merkwürdig gestachelte Tierchen ist ein Zwerglein der Gastrotrichen. Der gedrungene Körper besitzt einen fünflappigen Kopf, der von Hals abgesetzt ist. Der Hals geht allmählich in den dorsal stark aufgewölbten Rumpf über. Auf dem Rücken sitzen zwei Querreihen von sehr langen kräftigen Stacheln. In der vorderen Querreihe waren bei meinen Exemplaren 4, in der hinteren Querreihe 3 gegabelte Stacheln. Die hinteren Stacheln waren kürzer als die vorderen und trugen an ihrer Spitze nur schwer wahrnehmbare Nebestachel oder Nebenzahn, die aber an den vorderen grossen Stacheln gut ausgebildet waren. Die Seiten des Tierchens sind mit kurzen, kleinen Stacheln besetzt. Die Oberfläche des Rückens ist mit kleinen, lichtbrechenden Körperchen granuliert, die wahrscheinlich Reste von ehemaligen Schuppen sind, die ihre Stacheln verloren haben.

Gesamtlänge 62—65 μ ; Breite des Kopfes 12—13 μ , die des Halses 10 μ , grösste Breite des Rumpfes 21 μ . Länge der vorderen Stacheln 20 μ .

Chaetonotus spinulosus beschrieb ich zum erstenmal aus einem Altwasser von dem Tisza-Fluss (VARGA 1931).

14. *Chaetonotus zelinkai* GRÜNSPAN.

(GRÜNSPAN, p. 305, COLLIN, p. 256.)

Gefunden: 16. VII. 1925 in der Bucht von Aszófő im Detritus; 17. VIII. 1936 ebenda im Detritus und an der Unterseite der Blätter von *Hydrocharis*.

Das ziemlich grosse, sehr schlanke Tierchen besitzt einen gut abgesetzten Kopf, der nach GRÜNSPAN „hammerförmig“ ist, mit fünf Lappen und gut entwickeltem Stirnkappe. Die hinteren Kopflappen sind eckig. Der Hals ist schmal, lang und geht allmählich in den Rumpf über. Die Schwanzgabel ist ziemlich tief eingeschnitten, ihre Zinken biegen an ihrem Ende seitlich. Der Rücken ist mit einfachen, langen Stacheln bedeckt, die in 11 Längsreihen stehen und nach hinten bedeutend länger werden. Auffallend und charakteristisch sind die je drei, beiderseits stehenden sehr langen und kräftigen Endstacheln, die vor ihrem Ende einen gut entwickelten Nebestachel besitzen und die Gabelzinken weit überragen. Bei den Exemplaren von Balaton waren sie fast doppelt so lang wie die Gabelzinken.

Das Tierchen schwimmt träge, manchmal rückweise, lebhaft nach Nahrung suchend, die aus kleinsten Grünalgen und Diatomeen besteht.

Gesamtlänge: 235—250 μ ; Breite des Kopfes 36 μ , die des Halses 28 μ , grösste Breite des Rumpfes 44 μ , Länge der Gabelzinken 33 μ , Länge der hintersten grossen Seitenstacheln 62 μ .

Chaetonotus zelinkai beschrieb ich aus den *Sphagnum*-Polstern von Kőszeg (VARGA, 1936).

3. Genus: *Heterolepidoderma* REMANE.*Heterolepidoderma ocellatum* METSCHNIKOFF.(= *Lepidoderma ocellatum* METSCHN.)

(GRÜNSPAN, p. 251, COLLIN, p. 245)

Gefunden: 19. VII. 1939 in der Bucht von Aszófő, auf der Unterseite der Blätter von *Hydrocharis*; 16. VIII. 1939 im Detritus auf Steinen in der Bucht unter dem Csúcshegy von Tihany.

Diese Art besitzt auf den ersten Blick eine gewisse Ähnlichkeit mit den *Ichthydium*-Arten. Ihr Körper ist gedrunken. Der Kopf ist meist fast kreisrund, nur selten sieht man fünf unbedeutende Lappen. Seitlich im Kopf sind zwei stark lichtbrechende, ovale Körperchen, die als Augenflecke betrachtet werden können. Sie fehlten bei den Exemplaren von Balaton niemals. Der Körper ist fein gestrichelt; die Strichelung besteht aus vielen Schuppenreihen. Die sehr kleinen, breiten Schuppen sind langgestreckt, mit Längskiel, ohne Stachel. Die Schwanzgabel ist tief eingeschnitten, die Gabelzinken sind verhältnismässig kurz, mit einem dünnen Endglied.

Das Tierchen bewegt sich ziemlich schnell, ernährt sich von den feinsten organischen Detritusteilchen, es schluckt aber kleine Grünalgen auch.

Gesamtlänge ziemlich variabel: 75—120 μ ; Breite des Kopfes 22—24 μ , Breite des Halses 19—20 μ , grösste Breite des Rumpfes 28—30 μ , Länge der Schwanzgabel 20 μ .

Diese Art ist in Ungarn bisher noch nicht beobachtet worden.

4. Genus: *Lepidoderma* ZELINKA.*Lepidoderma squamatum* DUJARDIN.

(GRÜNSPAN, p. 248; COLLIN, p. 244)

Fundorte: 22. VIII. 1936 im Hydropsammon bei Balatonszárszó und Szántód; 19. VII. 1939 in der Bucht von Aszófő auf der Unterseite der *Hydrocharis*-Blätter; im Sommer von 1939 zwischen *Cladophora* an den Ufern von Tihany oft beobachtet. Bei den Untersuchungen, die ich über anderen Gewässern nach Rotatorien durchführte, fand ich sie fast immer. Sie scheint also bei uns sehr verbreitet zu sein.

Der Körper ist schlank, der Kopf schwach fünfflappig, allmählich in den wenig eingeschnürten Hals übergehend. Der Rumpf ist schlank, so breit wie der Kopf. Die Schwanzgabel ist in den Körper tief eingeschnitten. Der ganze Körper ist, die ventralen Flimmerbänder ausgenommen, mit flachen Schuppen bedeckt, die in Längsreihen angeordnet sind, so dass man auf den ersten Blick den Eindruck hat, dass die Haut des Tierchens mit winzigen Blasen bedeckt ist. Die Form der Schuppen ist an den einzelnen Körperteilen verschieden, meist rundlich und kiellos. Auch die Basalteile des Fusses sind beschuppt. Die Schwanzgabel endet mit einem spitzen Glied.

Die Gesamtlänge ist ziemlich variabel: 120—160 μ ; Breite des Kopfes 26—30 μ , Breite des Halses 21—24 μ , grösste Breite des Rumpfes 28—33 μ , Länge der Schwanzgabel 18—23 μ .

Lepidoderma squamatum ist für die Fauna Ungarns neu.

ÖKOLOGISCHES

Es fanden sich also 18 Gastrotreichen-Arten im Balatonsee. Die meisten Arten konnten in der Bucht von Aszófő gesammelt werden. Diese Bucht liegt an der Strasse zwischen Balatonfüred und Tihany und ist seit etwa 22 Jahre durch den Damm dieser Strasse von dem Balaton so abgetrennt, dass das Wasser der Bucht nur unter einer Brücke mit dem offenen See in Verbindung steht. Ein kleiner Bach von Westen kommend, mündet in die Bucht ein. Sie ist etwa 200 m lang, 100 m breit und sehr seicht: 30—60 cm tief. Überall wächst üppiges Röhricht (*Phragmites*), das im Winter geschnitten wird. Im Wasser sind *Myriophyllum*, *Utricularia* und im Sommer *Hydrocharis morsus ranae* in grosser Menge vorhanden; die schwimmenden Blätter der letztgenannten Pflanze decken die Oberfläche des Wassers fast vollkommen zu.

Das Wasser der Bucht ist ziemlich klar und ruhig, da die Winde keinen Wellengang verursachen können. Der Grund ist mit dicken Schlamm bedeckt, der vielerorts schon Faulschlamm ist, an seiner Oberfläche aber liegt eine dicke Detritus-Schicht, in der die meisten Gastrotreichen lebten. Der Wasserstand hängt mit dem des Balatons zusammen. Die üppige Pflanzenwelt des Wassers verursacht, dass das Wasser nicht beleuchtet werden kann und sich im Sommer und Herbst sozusagen in halber Dunkelheit befindet: auch eine günstige Lebensbedingung für die Gastrotreichen. Die Wassertemperatur weicht von der des Balatons um $\pm 1-2$ Grad ab.

Die genaue chemische Analyse des Wassers zeigt, dass Ca- und CO_3 -Gehalt hier höher ist als im Wasser des offenen Balatons, Mg-Gehalt dagegen kleiner. Die Wasserstoffionenkonzentration (pH) beträgt 8.1 (im Balaton 8.6—8.8). Die Faktoren der Biozönose verursachen, dass die Bucht vielfach ein selbstständiger Biotop geworden ist.

Diese ökologischen Verhältnisse verursachten es, dass in dieser Bucht, in der ich (VARGA, 1939) insgesamt 166 Arten und 3 Varietäten der Rotatorien nachweisen konnte, die Lebensverhältnisse auch für die Gastrotreichen sehr günstig waren.

Ich bin aber überzeugt, dass mit gründlicher Untersuchung im Balatonsee noch mehrere Gastrotreichen-Arten gefunden werden können. Die allgemeinen ökologischen Verhältnisse des Balatonsees und die einzelnen Faktoren für seine Biocönose sind so günstig, dass in seinem Wasser noch viele mikroskopischen Tiere und Pflanzen entdeckt werden können. Der See ist ja gar nicht gesättigt, verschiedene Tiere wandern hinein oder werden eingeschleppt. Die Erforschung der Lebewelt des Sees muss deshalb ständig und gründlich sein, muss sich auf das ganze Jahr und möglichst auf die verschiedensten Biotopen erstrecken. Für die weitere Erforschung der Gastrotreichen-Fauna müssen hauptsächlich die beschatteten Biotope berücksichtigt werden: Litoral- und Profundalregion der ruhigen Stellen, Detritus, Aufwuchs (Periphyton) des Röhrichtes und von anderen höheren submersen Wasserpflanzen, Unterseite der grösseren Pflanzenblätter, Psammon, das Wasser und der Schlamm in den Röhricht-Inseln, ruhige Buchten. usw.

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ГАСТРОТРИХЫ ИЗ ОЗЕРА БАЛАТОН

Автор: ЛАЙОШ ВАРГА

РЕЗЮМЕ

Я описал 18 видов гастротрихов из разных биотопов озера Балатона, которых я наблюдал во время исследований фауны коловраток этого озера. Описанные гастротрихы принадлежат к отряду Chaetonotoidea а именно ко второй семье этого отряда, к Chaetonotidae. Для фауны Венгрии 10, для фауны Балатона 13 из этих видов являются новыми. Среди описанных видов имеется один новый вид неизвестный до сих пор в науке (*chthyidium balaticum* n. sp.). Этот вид отличается от *chthyidium podian* O. P. Müll., кроме других признаков, более длинным и более тонким телом. Самый характерный и бросающийся в глаза признак однако, узкий спинной киль туловища, который начинается приблизительно в середине всего тела, достигает максимальную высоту в середине туловища, и постепенно утончаясь — переходит перед вилообразным хвостом в самую заднюю часть туловища.

Место и время находки я описал вместе с отдельными видами. Я отметил, кроме того и главные морфологические и экологические данные, а также размеры тела и главных частей тела. Можно сказать, что описанные гастротрихы озера Балатона меньше по размеру, чем виды наблюдаемые в других озерах. Этот факт между прочим, доказан и относительно многих других членов микро-фауны Балатона.

EPIZOISCHE PERITRICHEN AUS DEM BALATON II

VON

JOLAN STILLER (Budapest)

Aus dem Ung. Biol. Forschungsinstitut, Tihany, am Balaton-See.

(Eingegangen am 29. April, 1949)

Durch die Kriegereignisse gehindert, gelang es mir erst im Juli 1948, nach 8-jähriger Pause meine Untersuchungen über die epizoische Peritrichenfauna des Balaton-Sees bei Tihany fortzusetzen (STILLER, 1941).

Die Witterungsverhältnisse waren zu jener Zeit sehr ungünstig. Heftige Stürme und andauernder Regen erschwerten das Einsammeln der Wirtstiere. Die Steine der Brandungszone waren, bis auf wenige Kieselalgen, sowie einzelne Fäden von *Bangia atropurpurea* und Büscheln von *Cladophora glomerata*, welche in kleinen Vertiefungen fest verankert waren und ebenfalls keine Epizoen trugen, reingefegt. Unter den Steinen befanden sich ebenfalls keine Tiere, da sie zum Teil durch den heftigen Wellenschlag weggeschwemmt wurden, zum Teil aber in geschütztere, noch etwas feuchtliegende, tiefere Schichten der Driften sich zurückzogen. Nur unter jenen Steinen, welche im Schutze eines neuangepflanzten kleinen Röhrchens vor dem Biologischen Institut liegen, war noch etwas Leben vorhanden.

Wenn sich der Wind vorübergehend legte und das Wasser mehrere Stunden hindurch unbewegt oder einem nur schwachen Wellenschlag ausgesetzt war, dann erschienen an geschützten Stellen der Kleinen Bucht die bevorzugtesten Wirtstiere der Peritrichen: *Asellus aquaticus*, *Carinogammarus Roeselii*, sowie *Canthocamptus minutus* wieder in grossen Mengen. *Dendrocoelum lacteum* spielte in dieser Bioceenose eine nur untergeordnete Rolle und hatte nie Epizoen, trotzdem die zu jener Zeit viel häufigere *Polycelis nigra* von zahlreichen *Trichodina steini* und der selteneren *Urceolaria mitra* befallen war. Versuchsweise hatte ich einigemal die Symphorionten von *Polycelis nigra* losgelöst, indem ich die befallenen Körperteile des Wirtstieres mit Hilfe des Deckglases zerdrückte und die auf dem Objektträger nun frei umherkriechenden und nach einem neuen Substrat suchenden Tiere in ein Uhrglas hineinwusch, welches sowohl *Polycelis nigra* als auch *Dendrocoelum lacteum* enthielt. In keinem der Fälle liess sich *Urceolaria mitra* oder *Trichodina steini*, wenn auch nur vorübergehend, auf *Dendrocoelum lacteum* nieder. Diese beiden Peritrichen-Arten scheinen also streng artspezifisch zu sein, oder sich in der Auswahl des Wirtstieres zu mindest an die Gattung *Polycelis* zu halten.

Carinogammarus und *Asellus* wiesen den reichsten Bewuchs auf. Selbst ganz junge, kleine Exemplare waren bereits von Peritrichen befallen. Jene Exemplare von *Asellus* und *Carinogammarus*, welche sich

vor dem starken Wellenschlag an geschützte Orte zurückzogen, fielen nach ihrem Wiedererscheinen durch ihren besonders reichen Peritrichenbewuchs auf, welcher mitunter schimmelartig, auch mit freiem Auge sichtbar war. Die sonst meist individuenarmen Kolonien ihrer Epizoen erreichten bei solcher Gelegenheit die Höchstzahl der Zooïden. Im Schutze ihres Schlupfwinkels entziehen sich die Peritrichen der hydrodynamischen Wirkung, welche nicht nur die einzelnen Zooïde, sondern oft ganze Kolonien von ihrem Wirtstiere abreisst. Nachdem solche Zooïden immer wieder einen neuen Stiel bilden müssen, unterbleibt ihre Teilung oder erfolgt nur in sehr beschränkter Masse und die Kolonien bleiben bei stärkerer Wasserbewegung meist individuenarm. Sehr häufig sind zu jener Zeit solitäre Formen kolonienbildender Arten.

Canthocamptus minutus war mit einer nicht näher bestimmten *Nais*-Art die peritrichenführende Leitform der cladophorabewachsenen *Phragmites*-Stiele. Weniger an der Zahl war *Canthocamptus* zwischen den *Cladophora*-Büscheln der Ufersteine oder in der Tierassoziation der Laichkrautbestände vertreten. An sämtlichen Standorten war fast jedes Exemplar von *Canthocamptus* mit *Cothurnia affinis* besetzt.

Als neues Wirtstier hatte ich auch den erst unlängst eingewanderten, heute aber bereits sehr gemeinen interessanten Amphipoden pontischer Herkunft: *Corophium curvispinum* (ENTZ-SEBESTYÉN, 1946, p. 201—302) auf seine Epizoen untersucht. *Corophium* findet man immer in grossen Mengen, wenn man Laichkraut in einen mit Wasser gefüllten Behälter auswäscht und den Inhalt frisch untersucht. Besonders die älteren Exemplare gehen nämlich in diesem, an Zersetzungstoffen reichen und nicht durchlüfteten Wasser sehr bald ein und die wenigen jungen Exemplare, welche man noch nach 1—2, höchstens 3 Tagen in den abgesetzten schleimigen, selbstgebauten Röhrchen findet, besitzen meist keine Epizoen. An *Corophium*-Röhrchen sassen wiederholt vereinzelte Exemplare der in der Auswahl des Substrats nicht spezialisierten *Vorticella convallaria*. Am Körper vom *Corophium* sassen zur Zeit dieser Untersuchungen insgesamt drei Peritrichen-Arten: *Zoothamnium longifilum*, *Z. minimum* und *Cothurnia anomala*. O. SEBESTYÉN fand nach einer mündlichen Mitteilung ein Exemplar von *Vaginicola crystallina*, welches nach stürmischem Wetter höchstwahrscheinlich sekundär auf diesem sonst ungewöhnlichen Substrat sich angesiedelt hatte.

Die schleimigen *Corophium*-Röhrchen bieten den Epizoen auch bei stürmischem Wetter guten Schutz, da sich die Wirtstiere tief in die Röhrchen zurückziehen und ihre Epizoen durch den Wellenschlag nicht abgestreift werden. Nur die Zahl der Wirtstiere selbst wird vermindert, denn ein grosser Teil der Röhrchen wird durch die Wasserbewegung vom Laichkraut losgelöst.

Das Wasser des Brandungsufers war bei stürmischem Wetter sehr reich an Tripton, welches oft einen breiten, dunkelbraunen Spülsaum bildet. Dieser Spülsaum enthielt nur wenige Lebewesen, welche durch den Wellenschlag von ihrem ursprünglichen Standort weggerissen, dorthin gerieten. Einige Tardigraden, Rotatorien und Kieselalgen waren regelmässig vorhanden. Von Ciliaten fanden sich vereinzelt: *Stentor coeruleus*, *Urocentrum turbo* und ganz ausnahmsweise *Paramecium caudatum* in Gesellschaft der *Achromatofla-*

gellate *Rhynchomonas nasuta*, welche sonst nur zwischen dem Detritus der Laichkrautbestände oder der beiden neuangepflanzten Röhrichte der Kleinen Bucht zu finden waren.

Von Peritrichen fanden sich nur wenige Arten an diesen gegen das Ufer getriebenen Partikelchen. Vereinzelte Kolonien von *Epistylis plicatilis*, manchmal nur deren von den Zooïden verlassenen Stiele, sassen an Detrituspartikelchen pflanzlichen Ursprunges. An Arthropodenresten sass oft in grossen Mengen eine bisher nicht bekannte Art: *Cothurnia clausiens*, welche scheinbar ein coenobiontes Mitglied der Detritus-Assoziation ist. Ich hatte sämtliche, zu jener Zeit erreichbare Pflanzen und Tiere, sowie leblose Substrate nach diesen Epizoen untersucht, doch konnte ich diese *Cothurnia*-Art nirgends als an den erwähnten Arthropodenresten im Detritus der Brandungszone finden.

Bis zum Jahre 1940 konnte ich im Balaton insgesamt 31 epizoische Peritrichen-Arten feststellen. Trotz der ungünstigen Witterung stieg diese Zahl im Laufe meiner im Juli 1948 vorgenommenen Untersuchungen auf 45. Hiervon waren eine Gattung, 9 Arten und eine Varietät für die Wissenschaft neu.

Auch bei diesen Untersuchungen hielt ich die Frage der Spezialisierung in der Auswahl des Wirtstieres vor Augen und es zeigte sich wieder, in welcher hohen Masse der obligatorische Symphorismus bei den epizoischen Peritrichen vorherrscht. Von den im Jahre 1948 gefundenen 25 Arten bzw. Varietäten kam nur *Zoothamnium varians* auf zwei Wirtstieren, namentlich *Asellus aquaticus* und *Carinogammarus Roeselii* vor.

Im Juni 1948 kamen folgende Arten zum Vorschein:

Urceolaria mitra CLAP. u. L. auf *Polycelis nigra*, selten.

Trichodina steini CLAP. u. L. auf *Polycelis nigra*, häufig.

Rhabdostyla inclinans d'UDEK. auf *Nais* sp., sehr häufig.

Epistylis carinogammari sp. n., Gelenke von *Carinogammarus Roeselii*, sehr selten.

Epistylis corollata sp. n., Fühlerbasis von *Asellus aquaticus*, sehr selten.

Opercularia asellicola KAHL, Fussgelenke von *Asellus aquaticus*, sehr selten.

Intranstylum asellicola, Fussgelenke und Kopf von *Asellus aquaticus*, massenhaft.

Intranstylum steini WRZ.-KAHL, Kiemenblätter von *Carinogammarus Roeselii*, selten.

Vorticella campanula EHRBG., Gehäuse von *Dreissena polymorpha*, selten.

Vorticella convallaria L., Schleimhülle von *Corophium curvispinum*, selten.

Vorticella abbreviata KEISER, Fussgelenke von *Carinogammarus Roeselii*, selten.

Vorticella kahlui STILLER, Thorax und Beine von *Leptodora Kindtii* FOCKE, sehr selten.

Zoothamnium varians STILLER, *Carinogammarus Roeselii* und *Asellus aquaticus*, massenhaft.

Zoothamnium varians var *major* var. n., Abdominalsegmente von *Asellus aquaticus*, selten.

Zoothamnium longifilum sp. n., Abdomen von *Corophium curvispinum*, selten.

Zoothamnium carinogammari sp. n., Abdominalsegmente von *Carinogammarus Roeselii*, massenhaft.

Zoothamnium robustum sp. n. Beine von *Carinogammarus Roeselii*, sehr selten.

Zoothamnium minimum sp. n. Abdomen und Fussgelenke von *Corophium curvispinum*, sehr selten.

Entziella asellicola gen. n. sp. n. Beine von *Asellus aquaticus*, sehr selten.

Vorticelline. Gattung unbekannt, auf einem *Asellus*-Ei.

Vaginicola crystallina EHRBG. auf *Corophium curvispinum*, einmal.

Cothurnia affinis KAHL. Abdominalsegmente von *Canthocamptus minutus*, häufig.

Cothurina clausiens sp. n. Arthropodenreste im Spülsaum, häufig.

Cothurina anomala sp. n., Beine von *Corophium curvispinum*, sehr häufig.

Lagenophrys aselli PLATE, Kiemenblätter von *Asellus aquaticus*, selten.

BESPRECHUNG DER ARTEN

Rhabdostyla inclinans ROUX.

Seit ihrem ersten Entdecker: O. F. MÜLLER (1786) wurde diese Art von zahlreichen Forschern wiedergefunden. D'UDEKEM beschrieb sie im Jahre 1864 als *Gerda inclinans*, KENT (1882) als *Scyphidia inclinans*, STOKES als *Rhabdostyla chaeticola*, SVEC (1897) als *Rhabdostyla discostyla* und ROUX (1901) als *Rhabdostyla inclinans*. Unter diesem Namen fasste PENARD (1922) die beiden Abarten: die ungestielte *Scyphidia (Rhabdostyla) discostyla* SVEC und die auf den Borsten von *Naïs* sitzende, kurzgestielte *Rhabdostyla inclinans* gesondert an, vermutet aber ebenfalls eine Identität dieser beiden Arten.

Diese Art wurde bisher nur auf Wasseroligochaeten gefunden. Ihre bevorzugtesten Wirtstiere sind verschiedene *Naïs*-Arten. SVEC fand sie ausserdem auf *Tubifex*-Arten. KAHL erwähnt und beschreibt eine bedeutend schlankere und etwas kleinere ($40\ \mu$) Form, welche auf *Pristina longiseta sassi* (KAHL, 1935, S. 676, 728:Fig. 6). Ich fand diese Art überall, wo ich ihr Wirtstier, *Naïs* fand. Sie war sowohl im Balaton-See, als im Flusse Tisza bei Szeged, sowie im Grossen Plöner See in Holstein sehr gemein. Es fanden sich zwei von PENARD (1922, S. 265—266, Fig. 250) prächtig dargestellten Abarten: die auf den Borsten sitzende, dünngestielte *Rh. inclinans* und die der *Gerda inclinans* und *Scyphidia inclinans* entsprechende, ungestielte Abart mit stielartig ausgezogenem Hinterende, welche unmittelbar auf der Haut des Wirtstieres zu sitzen pflegt.

Im Juli 1948 fand ich in den aus *Cladophora glomerata* und verschiedenen Bacillariophyten gebildetem Aufwuchs des kleinen Röhrchens vor dem Biologischen Forschungsinstitut überaus viele Exemplare einer nicht näher bestimmten *Naïs*-Art, welche reich mit der ungestielten, spärlicher mit der gestielten Form von *Rhabdostyla inclinans* besiedelt waren. Die gestielte Form sass aber nicht auf dem

auch von PENARD (1922) dargestellten dünnen kurzen Stiel. Derselbe war kurz, sockelartig, oft unregelmässig geformt und die Tiere bildeten im Schutze einer Borste selten auch kleine Kolonien von 2—4 Individuen.

Die Kolonienbildung wurde bereits bei mehreren *Rhabdostyla*-Arten beobachtet. Die Kolonienbildung von *Rh. brevipes* erwähnt ENZSEN. (1902). STILLER (1931) fand, dass auch *Rh. ovum* nur die meist solitär bleibende Form einer bis dahin unbekannten *Epistylis*-Art ist und führt dieselbe seither als *Epistylis ovum* an. Der Umstand, dass es sich nunmehr bei der dritten *Rhabdostyla*-Art: *Rh. inclinans* herausstellte, dass sie — zwar äusserst selten — zur Bildung von Kolonien befähigt ist, also eigentlich eine meist solitär bleibende *Epistylis*-Art darstellt, bringt den Gedanken nahe, dass die Gattung *Rhabdostyla*, wie die ebenfalls zuweilen kolonienbildende Gattung *Pyxidium* möglicherweise überhaupt keine systematische, sondern nur eine ökologische Gruppe der Peritrichen darstellt, da es nicht ausgeschlossen ist, dass auch die übrigen Arten unter bestimmten ökologischen Verhältnissen Kolonien bilden können.

Die Kolonienbildung der in Tihany gefundenen *Rhabdostyla inclinans* erinnert sehr an diejenige von *Epistylis (Opercularia) humilis* (KELLCOTT) KAHL. Auch die Körperform ist sehr ähnlich, sodass die Möglichkeit einer Identität der beiden Arten sehr nahe steht, trotzdem *Epistylis humilis* nach den literarischen Daten nur auf *Gammarus* und Entomostraken gefunden wurde, *Rh. inclinans* hingegen als spezifischer Symphoriont von Wasseroligochäten bekannt ist. Ich selbst habe *Epistylis humilis* bisher noch nie gefunden und kann daher diese beiden Arten nicht miteinander vergleichen, da mir auch KELLCOTTs im Jahre 1887 erschienene Arbeit, in welcher er *E. humilis* als *Opercularia humilis* beschreibt, bisher nicht zugänglich war und ich bei dem Vergleich nur auf die sehr kurze Beschreibung und die etwas schematische Reproduktion der Originalzeichnung von KELLCOTT in KAHL (1935, S. 683 und Fig. 2 auf S. 681) angewiesen bin, auf welcher mehrere wesentliche Unterschiede zwischen dieser Art und *Rh. inclinans* zu verzeichnen sind.

Der Peristomsaum der in Tihany gefundenen Tiere ist zwar verdickt, aber nicht so scharf wurstförmig abgesetzt wie bei *Epistylis humilis* an der Abbildung von KELLCOTT, welche tatsächlich keine Ähnlichkeit mit der Gattung *Opercularia* aufweist, in welche KELLCOTT seine neue Art ursprünglich einreichte. Nun hege ich aber doch Bedenken, ob ein so guter Beobachter wie KELLCOTT diese Art so ganz ohne Begründung in die Gattung *Opercularia* eingereiht hätte. Wenn man *Rh. inclinans* unter dem Deckglas beobachtet, dann bleibt das Peristom dieser Tiere nur ganz kurze Zeit ausgestreckt. Infolge ihrer hohen Deckglasempfindlichkeit ziehen die Tiere ihren gewölbten Diskus bald ein und der Peristomsaum zieht sich schnauzenförmig hervorspringend, zierlich gefaltet zusammen, ähnlich wie man es bei den Arten der Gattung *Opercularia* sieht. Es scheint also sehr wahrscheinlich, dass sich die sehr ähnlich gestalteten Zooïden von *E. humilis* ähnlich verhalten und dieser Umstand mag KELLCOTT dazu veranlasst haben, seine Tiere in die Gattung *Opercularia* einzureihen. Auf KELLCOTTs Abbildung ist der Schlund nur undeutlich und nur in seinem oberen Abschnitt eingezeichnet. Die Zooïden von *Rhabdostyla inclinans* haben einen sehr langen Schlund, welcher bis zum Ende des zweiten Körper-

drittels reicht, also bis zu jener Zone, in welcher sich beim Übergang zum Schwärmerzustand der aborale Cilienkranz ausbildet. Derselbe entsteht in einer oft ziemlich scharfen, rinnenartigen Vertiefung. Das stielartig verjüngte Körperende wird dabei immer etwas eingestülpt. Der sich darüber befindliche Körperteil ist im Verhältnis zum eingestülpten Teil stark verbreitert und bis zur zierlich gefalteten Schnauze tonnenförmig ausgebildet. Auch die im Übergang zum Schwärmerzustand befindlichen Tiere sind meist übergeneigt, ähnlich, wie dies PENARD treffend darstellt (1922, S. 265, Abb. 250/2), doch findet man häufig auch aufgerichtete Exemplare.

Mit Sublimat fixiert waren die Tiere noch mehr übergeneigt und bildeten noch dichtere und feinere Quersalten als im Leben.

Der Schlund wurde von den meisten Forschern bedeutend kürzer dargestellt. Dies mag mit dem Umstand zusammenhängen, dass der letzte Abschnitt des Schlundes kanalartig verengt ist und keine deutlich sichtbare Wandung besitzt. Dieser Abschnitt wird daher nur gelegentlich der Nahrungsaufnahme sichtbar. Auch die Umgrenzung der Nahrungsvakuolen ist nur undeutlich. Der obere Teil des Schlundes ist meist so geräumig, wie bei jenen Vertretern der Gattung *Opercularia*, welche einen verhältnismässig engeren Schlund besitzen. Jedenfalls gehört *Rhabdostyla inclinans* und möglicherweise auch die mit ihr eventuell identische *Epistylis humilis* zu den Mitgliedern jener kleinen Gruppe, welche als Übergangsformen zwischen den Gattungen *Epistylis* und *Opercularia* aufgefasst werden können, welche aber auf Grund ihrer kennzeichnendsten Merkmale auch von KAHL mit Recht in die Gattung *Epistylis* eingereiht wurden.

Der Kern von *Rhabdostyla inclinans* ist bedeutend länger als bei *Epistylis humilis*. Wir wissen jedoch, dass die Grösse, oft aber auch die Lage der Peritrichenkerne mitunter ziemlich grosser Variabilität unterworfen ist, welche oft vom physiologischen Zustand des betreffenden Tieres abhängig ist. Vorläufig bleibt also die Frage offen, ob der Unterschied der Kerne dieser beiden Arten als systematischer, oder bloss als physiologischer Unterschied aufgefasst werden soll.

Die Länge der in Tihany gefundenen Tiere betrug 48–50 μ . Nach KAHL beträgt die Länge von *Epistylis humilis* 40–50 μ . Der Unterschied bewegt sich also innerhalb der Grenzen der normalerweise auftretenden Variabilität.

EPISTYLIS CARINOGAMMARI sp. n. (Abb. 1)

Diese Art bildet meist niedrige bäumchenförmige Kolonien an den Fussgelenken von *Carinogammarus Roeselii*. Die Kolonien sind oft derart ausgebreitet, dass die Zooiden den Stiel vollkommen verdecken und derselbe erst dann zum Vorschein kommt, wenn sich die unter dem Drucke des Deckglases rasch ablösenden Tiere entfernt haben. Dieselben irren dann mit Hilfe ihres adoralen Cilienkranzes unruhig hin und her, ohne richtige Schwärmer zu bilden. Mitunter findet man aber kleine Kolonien mit zwei Zooiden, welche dicht nebeneinander, unmittelbar auf dem stark sich verbreiternden, unregelmässig gerunzeltem Hauptstiel sitzen. Die Quersalten sind kaum vertieft und bilden keine so scharfen Querabsätze wie bei den älteren,

individuenreicheren und bereits verzweigten Kolonien (Abb. 1). Die Abzweigung erfolgt seitlich, am oberen Ende des Hauptstieles. Die Seitenzweige sind ungleich lang und sind ebenfalls durch Querabsätze gegliedert. Sämtliche Stiele nehmen nach oben an Breite zu, doch bleiben sie immerhin noch schmaler als die Basis des daraufsitzen- den Tieres. Der Basalabschnitt des Hauptstieles ist haftplattenartig verbreitert. Die Ansatzfläche ist also immer gerade, da die Kolonie nicht in die unregelmässig geformte Vertiefung des Fussgelenkes eingepflanzt ist, sondern meist dicht daneben, aber bereits an das Bein selbst angeheftet ist.

Die Kolonien erreichen eine Höchstzahl von 8 Individuen. Die Stiele sind immer farblos und wasserhell, ohne merkbare Längsstreifung.

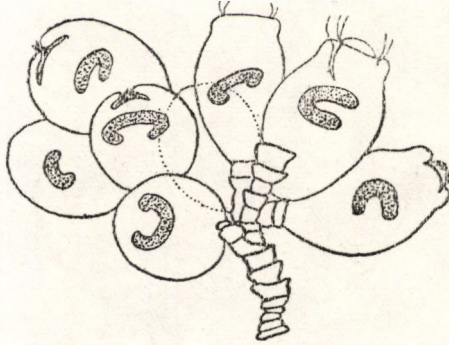


Abb. 1. *Epistylis carinogammari* sp. n. 400fach.

Die Körperform ist bilateral symmetrisch, eiförmig, etwa zweimal so lang wie breit. Der Peristomsaum ist verdickt, aber weder umgeschlagen, noch scharf abgesetzt. Der Diskus ist gewölbt und legt sich im Ruhezustand deckelartig über den engen und kurzen Schlund. Die Pulsationsblase liegt unter dem Peristomsaum. Der Kern ist hufeisenförmig gebogen und meist, quer gelagert. Das Protoplasma ist farblos und durchscheinend, die Pellicula scheinbar ungestreift.

Die Grösse variiert innerhalb einer Kolonie zwischen verhältnismässig weiten Grenzen. Der Längen-Breitenindex des grössten Individuums der auf Abb. 1 dargestellten Kolonie beträgt $50\ \mu$, der des kleinsten Zooiden $40\ \mu$.

EPISTYLIS COROLLATA sp. n. (Abb. 2)

Diese seltene Art bildet kleine rosettenartige Kolonien an der Fühlerbasis von *Asellus aquaticus*. Der niedrige Stiel der festsitzenden Kolonien wird von den $50\text{--}60\ \mu$ langen Zooiden vollkommen verdeckt. Derselbe kann nur dann beobachtet werden, wenn man den betreffenden Körperteil des Wirtstieres derart glücklich zerlegt, dass der Stiel vollkommen frei wird. Gewöhnlich lösen sich die Tiere vom Stiel, dieser bleibt jedoch im Gelenk des nur schwer loslösaren Fühlers sitzen und kann dann nicht gut beobachtet werden.

Diese Art erinnert gewissermassen an *Epistylis stammeri* NENNINGER und besitzt den Habitus von *Intranstylum macrostylum*.

Die Kolonie besitzt einen sehr kurzen, knorrigen Hauptstiel, dessen Form sich der Vertiefung an der Basis des Fühlers anpasst. Ungefähr in gleicher Höhe gehen die kurzen, dicken, unregelmässig geformten Stiele hervor, an welchen die Zooiden sitzen. Diese Stiele sind gewöhnlich nicht mehr verzweigt, nur selten wächst seitwärts ein etwas dünnerer Stielansatz hervor, welcher aber an den beobachteten Kolonien kein Zooid trug.

Die Seitenwände der Stiele sind unregelmässig gewellt. In der Mitte verläuft ein sehr dickes Bündel feiner Fibrillen, welches gegen den Hauptstiel etwas konisch verschmälert ist. Diese Fibrillen scheinen auch in den Körper des Zooiden einzudringen und im Kortikalplasma zu enden. Auffallend ist die dichte Granulation der kortikalen Plasmanschicht im unteren Körperende, welche an der Ansatzstelle besonders

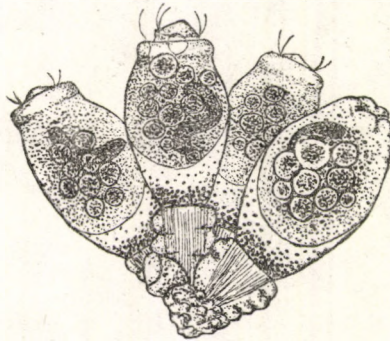


Abb. 2. *Epistylis corollata* sp. n. 400fach.

dicht ist. Da das Kortikalplasma regelmässig frei von Einschlüssen ist, so ist die Möglichkeit nicht ausgeschlossen, dass diese Granulation mit der dichten Fibrillenbildung des Stieles zusammenhängen mag. Die kurze Zeit meines Tihanyer Aufenthaltes und die kleine Zahl der gefundenen Kolonien liessen eine genauere cytologische Untersuchung nicht zu. Das zwischen den Granula sichtbare Ektoplasma ist farblos und hyalin. Das ebenfalls granulierte Entoplasma ist infolge der zahlreichen, sehr grossen Nahrungsvakuolen nicht durchscheinend. Es ist gegen das Ektoplasma mit einer sog. Tunica propria scharf abgegrenzt.

Der Körper ist bilateral symmetrisch, oval, unten, dem dicken Stiel entsprechend, breit abgestutzt. Der Peristomsaum ist schwach verdickt aber nicht scharf abgesetzt. Gelegentlich der Kontraktion bildet das Peristom keine Schnauze. Der zusammengezogene Peristomsaum ist mit welliger Kontur etwas gefaltet und lässt in der Mitte eine Öffnung frei. Der Diskus ist etwas konisch, zeigt aber keinen nabelartigen Vorsprung und bildet am Rande eine Ringfurche, in welche der Cilienkranz eingepflanzt ist. Die Pulsationsblase liegt im Diskus, zur Hälfte über dem Peristomsaum. Das Vestibulum ist ziemlich geräumig und geht in einen kurzen, fast rohrartig verengten Pharynx über, welcher aber scheinbar nur das Ende des ersten Körperdrittels erreicht. Der Kern ist wurstförmig, seine Lage veränderlich.

INTRANSTYLUM ASELLICOLA KAHL.

Diese Art hatte ich zum ersten Mal im Jahre 1940 an den Beinen von *Asellus aquaticus* gefunden (STILLER, 1941, S. 218, Abb. 5). Die Tiere waren zu jener Zeit sehr selten und spärlich. Im Jahre 1948 fand sich jedoch sozusagen kein *Asellus* ohne diese Art, welche auch bezüglich ihrer Individuenzahl eine der Leitformen der Symphorionten-Assoziation des *Asellus aquaticus* darstellte.

Bei windstillem Wetter sind langgestielte Kontraktilien vorherrschend. Zur Zeit der Stürme, bei heftigem Wellenschlag aber, ist *I. asellicola*, wohl infolge der Festigkeit seines verhältnismässig kurzen längs- und quergestreiften Stieles die Leitform der Assoziation. Es könnte nun angenommen werden, dass der erhöhte Sauerstoffgehalt des besser durchlüfteten, stark wellenbewegten Wassers des Brandungsufers die Vermehrung dieser Art bevorzugt, doch ist ihre Vorherrschaft eher ihrer Widerstandsfähigkeit den hydrodynamischen Einflüssen gegenüber zuzuschreiben. Während nämlich die übrigen Epizoen des im Sammelglas gehaltenen *Asellus aquaticus* in mehr oder minder kurzer Zeit verschwinden, nimmt die Zahl von *I. asellicola* stark zu.

Das Wasser dieser Kulturen ist unbewegt und verhältnismässig reicher an Nährstoffen. Auch die Temperatur ist geringeren Schwankungen unterworfen als das an Nährstoffen ärmere, ständig erneute Wasser der untersuchten Brandungszone. Sobald sich die Peritrichen diesen geänderten Verhältnissen anpassen können, finden sie hier günstigere Lebensbedingungen als an den frei lebenden Wirtstieren. *I. asellicola* scheint von allen asellicolen Peritrichen die grösste Anpassungsfähigkeit zu besitzen und erreicht hier ihre höchste Entfaltung.

Die Variationsformen sind hier ebenso mannigfaltig wie z. B. bei der unter saproben Verhältnissen gezüchteten *Vorticella microstoma*, welche eine Fülle der extremsten Formen aufweist (STILLER, 1946), während die auf freilebenden Wasserasseln sitzenden Tiere, innerhalb der Population keine nennenswerte Variabilität zeigen.

Seit diesen Beobachtungen erhielt ich die grosse Peritrichenarbeit von NENNINGER, in welcher die Verfasserin über die Variationsbreite des Körpers von *Intranstylum asellicola* berichtet, welche in verschiedenen eingestellten Kulturen gut zum Ausdruck kam (NENNINGER, 1948).

Die Tihanyer Kultur war nicht künstlich eingestellt. Sie unterschied sich vom Lebensraum der freilebenden Tiere nur durch Ausschaltung der Wasserbewegung und grösserer Temperaturschwankung, der damit verbundenen Änderung der Durchlüftungsverhältnisse, der Erhöhung der Konzentration im Wege der langsamen Verdampfung des Kulturmediums und Anreicherung der Nahrungsstoffe infolge des allmählichen Absterbens der *Cladophora*-Büschel und Exkremente der Wirtstiere, welche Umstände schliesslich zur Veränderung der physikochemischen Verhältnisse dieses Lebensraumes führten. Die schlechtere Durchlüftung wurde hier zum Teil durch die Assimilationstätigkeit der *Cladophora*-Büschel rekompensiert.

Eine auffallende Eigentümlichkeit der im Jahre 1948 gefundenen, freilebenden Rasse ist die abweichende Ausbildung des Stieles. Der Stielfaden ist immer etwas exzentrisch gelagert und auch die einzelnen Zooiden sitzen gleichsam verschoben am Stiele, wodurch die eine

Seite, etwa $\frac{1}{3}$ der Breite des oberen Stielendes, frei hervorragt (Abb. 3 a). An den Verzweigungen war der Stiel gegliedert. Diese Gliederung trägt ebenfalls zur Festigung des Stieles bei stürmischem Wetter, oder rascher Bewegung des Wirtstieres bei. Die Seitenzweige sind nicht immer so regelmässig quergestreift und eingekerbt wie der nach oben sich verbreitende Hauptstiel und ihre Seitenwände haben mitunter einen mehr oder minder unregelmässigen welligen Verlauf. Ausserdem ist der Stiel nicht so drehrund, wie ihn KAHL bei *Intranstylum asellicola* zeichnete (1935, S. 728, Fig. 23), sondern mehr abgeflacht, während die querfaltigen Zweige an der von KAHL dargestellten

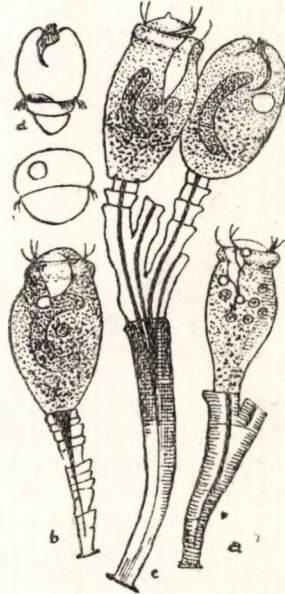


Abb. 3 a, b, c. *Intranstylum asellicola* Kahl, a freilebende Kolonie mit exzentrisch ausgebildetem Stiefaden, b solitäre Form mit abweichend ausgebildetem Stiel aus der Kultur, c abweichend gestaltete Kolonie vom Kopfe des Wirtstieres aus der Kultur. 400fach

Stammform aus dem ebenfalls querfaltigen Hauptstiel baumartig abzweigen.

Bei den meisten Kolonien endigen die voneinander abgesonderten Stiefäden ungefähr in der Höhe der Abzweigung. Es finden sich aber nicht selten Kolonien, bei welchen der eine Stielmuskel tief in den Hauptstiel hineinreicht und weiter unten schliesslich in einen feinen, immer noch kontraktilen Faden ausläuft, während der Stielmuskel des Seitenzweiges nur bis zur Abzweigung reicht. Die Kolonie weist also in extremsten Fällen das typische Bild einer *Carchesium*-Art auf. Hieraus folgt, dass *Intranstylum asellicola* eigentlich eine *Carchesium*-Art mit oft nur mangelhaft ausgebildetem Myonem ist.

Das untere Stielende ist immer etwas haftplattenartig verbreitert. Die meist nur aus 2, höchstens aus 3 Individuen bestehenden kleinen Kolonien sitzen bei starkem Wellenschlag mit Vorliebe in den Biegungen der Fussgelenke oder im Schutze einer Borste. Bei windstillem

Wetter hingegen, wenn die Gefahr einer Abstreifung durch die Wasserbewegung geringer ist, sitzen sie am häufigsten auf den Borsten selbst. Nicht selten findet man sogar solitäre Exemplare an der äussersten Spitze einer Borste.

Wenn man *Asellus aquaticus* längere Zeit in Gefangenschaft hält, dann bleibt — wie oben bereits erwähnt — *Intranstylum asellicola* als Leitform der Epizoen-Assoziation am längsten am Leben. Sowohl die Ausbildung des Stieles als auch die Körpergrösse und Form des Diskus variieren innerhalb ziemlich weiter Grenzen. Der Längen-Breitenindex der freilebenden Tiere betrug $40 \times 20 \mu$ und die Tiere erreichten nur selten eine Länge von 45μ . Der Längen-Breitenindex der im Sammelglas gehaltenen Exemplare variierte zwischen 35×20 und $50 \times 30 \mu$.

Abb. 3 b veranschaulicht ein solitäres Exemplar mit treppenartig gegliedertem Stiel, ähnlich wie ihn PRECHT bei seinem *Haplocaulus nicolae* darstellt. Diese Form führt zu jenen ganz abweichend ausgebildeten Kolonien über, welche mitunter massenhaft am Kopfe ihres Wirtstieres sitzen (Abb. 3 c). Diese Kolonien haben einen bedeutend längeren, längs- und quergestreiften Hauptstiel als die an den Füssen sitzenden Kolonien der in Gefangenschaft lebenden Wirtstiere oder der freilebenden Formen und die Seitenzweige sind noch abweichender gestaltet. An Stelle der regelmässigen, feinen Querstreifen ist die Stielwand unregelmässig gewellt, stellenweise treppenartig abgesetzt, am häufigsten aber mit flügelartigen Verbreitungen. Diese Formen erwecken bei flüchtiger Beobachtung den Eindruck eines *Zoothamnium*, doch sieht man bei stärkerer Vergrösserung, dass die so ziemlich in gleicher Höhe zusammentreffenden Stielfäden dicht nebeneinander, aber voneinander abgesondert verlaufend, ein spitz endendes Bündel bilden, welches schliesslich noch in einen feinen Faden ausläuft. Der Diskus dieser Formen war, im Gegensatz zum etwas gewölbten Diskus der Normalindividuen, immer genabelt.

Die Körperform der frei lebenden und der im Sammelglas gehaltenen Tiere entspricht in ihren übrigen Merkmalen, den im Jahre 1940 gefundenen Exemplaren (STILLER, 1941), nur ist das untere Ende oft etwas mehr verjüngt und die Pellicula bedeutend schwächer quergestreift. In extremsten Fällen erscheint sie sogar vollkommen glatt.

Mit konzentriertem Sublimat fixiert zeigen die Tiere enge Längsfalten, wodurch sie bei schwächerer Vergrösserung scharf längsgestreift erscheinen. Der Rand des Peristoms ist dann tief eingekerbt. Die Schnauze ragt hierbei nur etwas hervor.

Das Peristom ist sehr selten etwas schräg abgestutzt.

Nicht selten findet man Exemplare, bei welchen statt der üblichen einen Pulsationsblase, ungefähr in der Mitte der basalen Pharynxwand, 2—3 Pulsationsblasen ausgebildet sind, ohne dass sich am Körper irgendwelche pathologische Veränderungen bemerkbar machen würden.

Intranstylum asellicola ist nicht sehr deckglasempfindlich und bleibt, ohne merkliche Erhöhung des Zellurgors oft längere Zeit ausgestreckt. Durch den Sauerstoffmangel schliesslich zur Schwärmbildung veranlasst, erhalten sie nur ausnahmsweise die auf Abb. 3 a dargestellte Form mit nur wenig eingezogenem Peristom und tiefer Einschnürung unter dem ebenfalls in einer Rinne eingepflanzten

aboralen Cilienkranz, wodurch ein dicker Ringwulst entsteht. Gewöhnlich ziehen die Schwärmer das Peristom derart ein, dass sie eine äquatorial eingeschnürte Kugelform annehmen. In dieser Einschnürung wird der aborale Cilienkranz ausgebildet.

ZOOTHAMNIUM VARIANS STILLER. var. MAJOR var. n.

Zoothamnium varians war in diesem Jahre häufiger als im Jahre 1931, als diese Art zum erstenmal zum Vorschein kam. Sie lebte auf *Carinogammarus*, war aber noch häufiger an *Asellus* zu finden.

Ausser der Stammform trat auch eine derber gebaute Variation dieser Art an den Fussgelenken von *Asellus aquaticus* auf. Die kugelförmige Form war 50 μ lang und ebenso breit, die grösste, zweimal so lange als breite Form erreichte eine Länge von 90 μ .

Die Pellicula ist auch bei dieser Varietät fein, aber deutlicher quergestreift, als bei der Stammform und an den Seiten fein eingekerbt. Ein weiterer Unterschied war der sehr dicke Muskelfaden, welcher mitunter einen Durchmesser von 5 μ erreichte. Derselbe durchzog auch den ganzen Hauptstiel bis zur flachen, breiten Haftplatte. Er ist weniger kontraktile als der dünne Muskelfaden der Stammform und man findet mitunter Kolonien, deren Muskelfaden in Stücke zerfällt. Die Pulsationsblase liegt im Diskus in der Höhe des Peristomsaumes, oder aber etwas höher.

Kontrahiert bilden die Tiere keine Schnauze. Sie lösen sich, ohne einen aboralen Cilienkranz auszubilden, leicht vom Stiele.

ZOOTHAMNIUM LONGIFILUM sp. n. (Abb. 4. a, b, c)

Diese Art, welche mitunter in grossen Mengen am Abdomen von *Corophium curvispinum* sitzt, fällt in erster Linie durch den auffallend

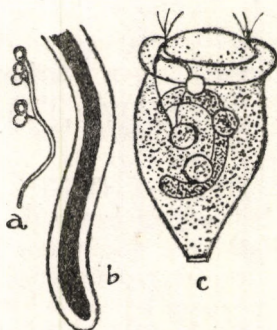


Abb. 4 a, b, c. *Zoothamnium longifilum* sp. n. a Diagramm, b Endteil des Hauptstieles, c das Zooid. 400fach.

langen Hauptstiel auf, welcher bis an das rundliche Stielende von einem sehr dicken Muskelfaden durchzogen ist. Die Seitenzweige sind kurz und die Endzweige oft kaum angedeutet. Die Stielwand ist oft uneben, bildet aber keine Querfalten. Ausnahmsweise finden sich aus 8–12 Individuen bestehende Kolonien, aber am häufigsten sind die auf Abb. 4 a dargestellten individuenarmen Kolonien.

Die Körperform ist bilateral symmetrisch, gegen unten verjüngt, unter dem wulstartig verdicktem Peristomsaum eingeschnürt. Der Durchmesser des Peristomsaumes ist etwa so lang, wie die bauchige Körpermitte, oder etwas länger.

Der Körper ist farblos und durchscheinend. Der Pharynx reicht ungefähr bis zur Körpermitte. Der Kern ist lang, wurstförmig, an beiden Enden gebogen und so ziemlich konstant in einer vertikalen Ebene gelegen. Er zerfällt oft in mehrere Teile. Die Pellicula erscheint ungestreift.

Die Länge der Tiere beträgt 50 μ , die grösste Breite 30—35 μ .

ZOOTHAMNIUM CARINO GAMMARI sp. n. (Abb. 5)

Morphologisch steht *Z. carinogammari* der Meeresform *Z. duplicatum* KAHL und dem von NENNINGER als Epizoon von *Carinogammarus Roeselii* und *Asellus aquaticus* beschriebenen *Z. procerius* var. *ovatum* am nächsten.

Im Juli 1948 war diese Art das häufigste Epizoon des unter den Ufersteinen lebenden *Carinogammarus Roeselii* und bildete von allen epizoischen Peritrichen des Balatons mit 25—30 Zooiden die individuenreichsten Kolonien. Dieselben sitzen mitunter so dicht nebeneinander, dass ihre Stiele von den zahlreichen Zooiden ganz verdeckt sind und die einzelnen Kolonien nur schwer voneinander zu trennen sind. Sie bilden dann einen, oft auch mit freiem Auge sichtbaren schimmelartigen Aufwuchs an den Füßen, besonders aber in den Fussgelenken ihres Wirtstieres.

Die Kolonien erreichen eine Höhe von 300—350 μ und ihre dichtotom verzweigten Nebensteriele gehen in gleicher Höhe aus dem meist durch eine Gliederung abgetrennten Hauptstiel hervor. Der Endstiel ist meist kürzer als die halbe Körperlänge des darauf sitzenden Tieres. Oft unterbleibt die Teilung eines der Zooiden und der Seitenzweig bildet gleichzeitig den vom normalen bedeutend längeren Endstiel. Diese Tiere wachsen auf das doppelte des normalen Individuums an, ohne den für die typischen Makronten charakteristischen Dimorphismus aufzuweisen. Eine Konjugation konnte nie beobachtet werden. Sämtliche Stiele sind farblos und wasserhell. Die Stielwand ist derart dünn, dass sie mitunter zerknittert ist und der Stiel an einzelnen Stellen dünner erscheint. Infolge seiner Durchsichtigkeit ist eine äusserst feine Längsstreifung entlang des ganzen Stieles gut sichtbar. Am Hauptstiel nimmt diese Längsstreifung an Stärke zu.

Das Myonem ist sehr dick, erscheint aber stellenweise gleichsam unterbrochen und die oft zugespitzt endenden Abschnitte sind nur durch einen dünnen Stielfaden miteinander verbunden (Abb. 5). Der Stielfaden durchzieht die ganze Kolonie bis zum Ende des Hauptstieles, welcher ebenfalls kontraktile ist.

Das obere Stielende ist immer breiter, als das verjüngte Körperende des darauf sitzenden Tieres. Die Ecken des Stielendes sind gegen die Ansatzstelle sanft abgerundet. Das untere Stielende bildet keine Haftscheibe, wie wir es bei den epiphytisch lebenden Peritrichen finden, oder an jenen epizoischen Formen, welche an einer geraden, glatten Oberfläche sitzen, sondern es ist unregelmässig abgerundet, stellenweise eckig, wie es eben die Form des besetzten Körperteiles,

bzw. die Vertiefung, in welcher die Kolonie verankert ist, bestimmt. Diese grossen, langgestielten Kolonien sind einer Abstreifung weit eher ausgesetzt, als die kurzgestielten Formen. Aus diesem Grunde heften sie sich immer in den Fussgelenken oder an die Basis einer schiefgestellten Borste an und entziehen sich durch rasches Zusammenballen der Kolonie den hydrodynamischen Wirkungen. Da sich *Carinogammarus* gelegentlich starker Stürme in den Schutz der Uferdriften zurückzieht, wo das Wasser verhältnissmässig unbewegt ist kann sich diese Art ungehindert vermehren, umsomehr als sie im feinzerriebenen Detritus reichliche Nahrung findet. Dies erklärt die verhältnissmässig hohe Individuenzahl, welche bei den übrigen Epizoen dieser lebhaft beweglichen Wirtstiere sonst kaum zu finden ist.

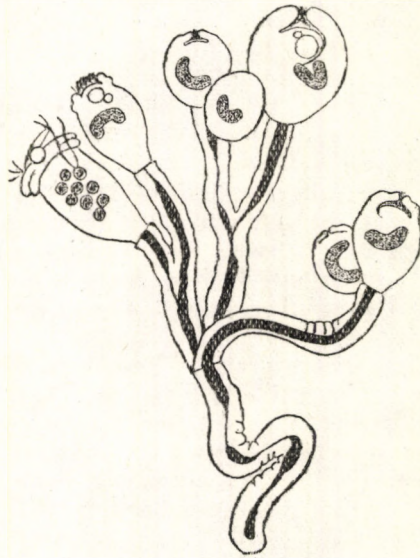


Abb. 5. *Zoothamnium carinogammari* sp. n. 300fach.

Die Tiere haben einen schlank urnenförmigen Körper von 40–50 μ Länge. Die makrontenhaft angewachsenen Individuen sind immer etwas aufgetriebener.

Der Peristomsaum ist zweiteilig, sein Durchmesser länger als die grösste Breite des Körpers. Der Diskus ist sehr schwach gewölbt, fast flach und gelegentlich der Nahrungsaufnahme schräg aufgerichtet. Am Rande befindet sich eine tiefe Ringfurche für den Cilienkranz. Dem mehr aufgetriebenen Körper der makrontenhaften Individuen entsprechend, ist auch deren Diskus mehr gewölbt. Der weitgeöffnete Schlund ist geräumig und reicht bis etwas unter die Körpermitte. Die Pulsationsblase liegt im Diskus und entleert sich durch die obere Wölbung des Pharynx.

Das Protoplasma ist licht und durchscheinend. Nur die das Entoplasma oft dicht anfüllenden Nahrungsvakuolen erschweren die Lebendbeobachtung des Kernes. Das Kortikalplasma füllt fast das ganze verjüngte Körperende aus. Es ist farblos und wasserhell, aber

die Grenze des Ento- und Ektoplasmas ist nicht sehr deutlich. Die Pellicula erscheint auch bei grösserer Vergrößerung ungestreift.

Die Form, Länge und Lage des Kernes ist verschieden. Am häufigsten sieht man dickere und mehr kurze, wurstartige, mitunter hufeisenförmig gebogene Kerne in verschiedener Lage. Selten ist der Kern sehr lang und S-förmig gewunden. Auf ein und derselben Kolonie ist die Länge und Form des Kernes so ziemlich dieselbe. Der Unterschied könnte also eher auf physiologische Ursachen, bzw. auf den physiologischen Zustand der Zooiden zurückgeführt werden.

Diese Art ist decklasempfindlich und geht auch im Sammelglas ziemlich schnell ein. Die Kolonien werden immer individuenärmer und verschwinden meist schon am 2.—3. Tag.

ZOOTHAMNIUM ROBUSTUM sp. n. (Abb. 6)

Diese Art sass äusserst selten an den Beinen von *Carinogrammarus Roeselii*. Der breite, dicke Stiel ist höchstens 1 1/2-mal so lang wie



Abb. 6. *Zoothamnium robustum* sp. n. 400fach.

der Körper. Der Hauptstiel ist gegen oben etwas verbreitert, die Abzweigung unregelmässig. Der Stiel ist ebenfalls unregelmässig, stellenweise mit etwas wulstartigen Verdickungen, stellenweise aber treppenartig abgesetzt und ebenfalls unregelmässig längsgestreift. Die Seitenzweige und ihr Myonem sind etwas dünner, als das auffallend dicke (etwa 5 μ), fast bis zum unteren Stielende reichende, zugespitzt endende, kaum kontraktile Myonem des Hauptstieles.

Der Körper ist untersetzt, unten breit abgestutzt, unter dem Peristomsaum nur schwach eingeschnürt. Der Peristomsaum bildet die grösste Breite des Körpers. Es ist ebenfalls unregelmässig, an einzelnen Stellen durch eine Furche zweiteilig eingeschnürt. Der Diskus ist gelegentlich der Nahrungsaufnahme sehr schief gestellt, konisch, mit kleinem nabelartigen Vorsprung. Am Rande verläuft eine Ringfurche für den aus kräftigen Cilien gebildeten adoralen Cilienkranz. Die Pulsationsblase liegt im Diskus.

Der Pharynx reicht ungefähr bis zur Körpermitte. Die sich abschnürenden Nahrungsvakuolen sind rund und nicht sehr gross. Das Entoplasma ist granuliert, das Kortikalplasma farblos und hyalin. Der Kern ist dick, hufeisenförmig und quer gerichtet.

Die Grösse beträgt 55 μ .

ZOOTHAMNIUM MINIMUM sp. n. (Abb. 7)

Diese Art bildet mit *Z. plectostylum* und *Z. nanum* eine engverwandte Gruppe. Sie war zur Zeit dieser Untersuchungen sehr selten und wurde im Balaton nur auf *Corophium curvispinum* gefunden. Meist sassen zwei Individuen auf kurzen, dichotom verzweigten Stielen, doch finden sich mitunter auch Kolonien mit 6—8 Zooöiden. Dieselben sitzen immer tief im Gelenk oder an der Basis einer Borste an derart kurzen Stielen, dass die Stielbildung nur selten sichtbar wird. Die Kolonienbildung erinnert an die marine Art *Z. nanum*, welche KAHL als Epizoon nicht näher bestimmter Amphipoden der Kieler Bucht beschrieben hat, doch war der Hauptstiel nie so lang und die ganze Kolonie der-



Abb. 7. *Zoothamnium minimum* sp. n. 400fach.

art niedrig, dass der Stiel ganz verdeckt ist. Bei *Z. plectostylum* ist der Hauptstiel bedeutend länger, deutlich längsgestreift, gegen oben verdickt, ohne Einschnürungen, mit unregelmässig wellig verlaufenden Seitenwänden.

Der Stiel ist farblos und dünnwandig, in fast regelmässigen Abschnitten tief eingeschnürt. Der Hauptstiel ist immer nur ganz kurz, fast sockelartig ausgebildet und zeigt eine deutliche Längsstreifung. Die Haftplatte ist in engen Vertiefungen nicht ausgebildet. Wenn aber die Kolonie mehr auf der Körperoberfläche sitzt, findet man eine etwas breitere, flache, farblose Haftplatte. Das Myonem ist nicht sehr dick und nur schwach kontraktile.

Der Körper ist nicht so schlank wie bei *Z. plectostylum*, sondern bauchig aufgetrieben, nach unten nur selten schwach verjüngt, meist nahezu kugelig, doch findet sich ausnahmsweise ein bedeutend schlankeres, etwas füllhornartig gebogenes Individuum auf derselben Kolonie. Der bei der Gattung *Zoothamnium* auf derselben Kolonie so häufig beobachtete Grössenunterschied der Individuen ist auch hier sehr häufig, ohne dass eine ausgesprochene Makrontenbildung zu beobachten wäre.

Der Peristomsaum ist wulstartig verdickt, aber weder umgeschlagen, noch deutlich vom Körper abgesetzt. Der Diskus ist etwas gewölbt und bei manchen Exemplaren schwach konisch ausgebildet. Gelegentlich der Nahrungsaufnahme ist er auffallend schief gestellt. Die Cilien sind, wohl infolge der verborgenen Lebensweise des in der Schleimröhre sitzenden Wirtstieres lang und kräftig ausgebildet. Die Pulsa-

tionsblase liegt unmittelbar unter dem Peristomsaum. Die Pellicula ist scheinbar glatt.

Der Schlund reicht ungefähr bis zur Mitte des Körpers. Das farblose, durchscheinende Entoplasma enthält zahlreiche kleine, runde Nahrungsvakuolen. Gegen das wasserhelle Ektoplasma des unteren Körperendes ist das Entoplasma stark granuliert. Der Kern befindet sich ungefähr in der Körpermitte. Er ist kurz, dick und etwas hufeisenförmig gebogen.

Unter dem Drucke des Deckglases tritt bald eine lebhaft Schwärmerbildung ein. Der aborale Cilienkranz entsteht in einer Einschnürung etwas unter der Körpermitte. Der Körper wird nicht stark deformiert. Gelegentlich der Kontraktion nimmt der Körper eine regelmässige Kugelform an, ohne eine Schnauze zu bilden.

Diese Art ist die kleinste der mir bekannten *Zoothamnium*-Arten. Ihre Grösse beträgt normalerweise 22–25 μ , seltener, wie bei *Z. nanum* 30–35 μ .

ENTZIELLA ASELLICOLA gen. n. sp. n. (Abb. 8)

Die Vertreter dieser Gattung vereinigen die morphologischen Merkmale der beiden, so grundverschiedenen Gattungen: *Opercularia* und *Zoothamnium* in sich. Sie besitzen den Körper einer *Opercularia* und die charakteristische Stielbildung der Gattung *Zoothamnium*. Diese beiden Gattungen sind durch keine Übergänge miteinander verbunden.

Ich führe diese neue Gattung in dankbarer Erinnerung an Prof. G. ENTZ jun., der mich gelegentlich meiner früheren, im Biologischen Forschungsinstitut zu Tihany vorgenommenen Untersuchungen so tatkräftig unterstützte, unter dem Namen *Entziella* in die Wissenschaft ein.

Diese immer sehr seltene Art sitzt mit besonderer Vorliebe an der Fühlerbasis von *Asellus aquaticus*. Sie bildet Kolonien von höchstens 4 Individuen, welche an unregelmässig ausgebildeten, nahezu in der gleichen Höhe abzweigenden Seitenzweigen sitzen.

Der Körper ist oft bilateral symmetrisch, oft jedoch schlanker und etwas füllhornartig gebogen. Der Peristomsaum ist nur äusserst selten sehr schwach verdickt, kaum angedeutet und zieht sich bei der Kontraktion, wie für die Gattung *Opercularia* kennzeichnend, zierlich gefaltet zusammen. Der Diskus ragt an einem langen halsartigen Fortsatz schräggerichtet über den Peristomsaum. Er besitzt meist einen spitzen Nabel, welcher aber mitunter fehlt. Der Diskus ist dann etwas gewölbt. Die Pulsationsblase befindet sich im halsartigen Fortsatz. Wenn sich der Diskus zurückzieht und der halsartige Teil derart kontrahiert, dass er sozusagen spurlos verschwindet, dann schmiegt sich die Pulsationsblase dicht an eine spitz auslaufende Ausbuchtung des für die Gattung *Opercularia* kennzeichnenden, sehr geräumigen Schlundes. Die sich vom Pharynx abschnürenden Nahrungsvakuolen sind auffallend gross und bläschenartig. Ihre Mitte ist mit kompakter Nahrung angefüllt, welche durch einen lichten Hof von der Vakuolenwand abgesondert ist. Oft findet man nur eine Nahrungsvakuole.

Der Kern ist im Leben trotz des nicht sehr getrübbten Entoplasmas unsichtbar. Er kommt auch mit Sublimat fixiert nur ziemlich un-

deutlich zum Vorschein. Seine Lage im Leben ist also unsicher. An fixierten Tieren ist er wurstförmig und höchstwahrscheinlich längsgerichtet.

Das untere Körperende ist stark verjüngt. Gelegentlich der Kontraktion bildet es eine wurstförmige Querfalte. Der Hauptstiel ist dick, glatt und meist schwach gebogen. Das Myonem ist sehr dick und scheinbar nicht sehr kontraktile. Wie an Abb. 8 ersichtlich, fallen die Abzweigungen so ziemlich in die gleiche Höhe. Der Stiefaden ist hier immer noch dick und nicht sehr kontraktile. Die Seitenzweige sind kurz; die längsten erreichen weniger als die halbe Körperlänge. Sie sind sehr unregelmässig ausgebildet und haben seitlich oft mehrere flügelartige Fortsätze. Die Stiele sind farblos, hyalin mit sehr feinen, kaum sichtba-

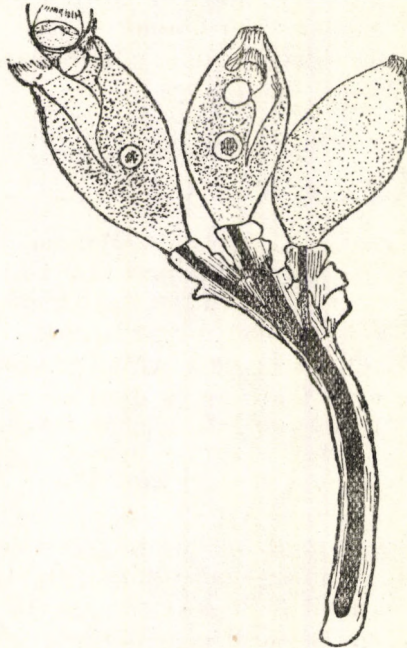


Abb. 8. *Entziella asellicola* gen. n. sp. n. 400fach.

ren Längsstreifen. Das untere Stielende ist unregelmässig abgerundet. Es besitzt nie eine Haftplatte, sondern schmiegt sich in seiner Form der Vertiefung an der Basis der Fühlers an.

Die Länge des Körpers beträgt 65–75 μ . Der Hauptstiel ist 1 $\frac{1}{2}$ bis 2mal körperläng.

Diese Art war immer nur an ganz frisch heimgebrachten *Asellus* zu finden. Im Sammelglas gehen die Tiere sehr bald ein. Sie lösen sich auch sehr leicht vom Stiele los. Dies mag zum Teil auch ihre Seltenheit erklären. Die Tiere kamen nur an windstillen Tagen zum Vorschein und waren auch dann nur vereinzelt zu finden.

Eine Vorticelline unbekannter systematischer Zugehörigkeit veranschaulicht Abb. 9. Das Tier kam nur in einem Exemplar als Epizoon eines *Asellus*-Eies zum Vorschein.

Es sass auf einem ziemlich steifen Stiel von $32\ \mu$ Länge, welcher bis an das nur schwach haftplattenartig verbreiterte Stielende von einem nicht sehr kontraktile Myonem durchzogen war. Da es sich um ein solitäres Exemplar handelt, welches aber ganz sicher keine *Vorticella* ist, konnte die Gattung nicht bestimmt werden.

Sehr eigenartig ist die Ausbildung des Körpers, doch konnte bei diesem einzigen Exemplar nicht entschieden werden, ob es sich um beständige systematische Merkmale oder nur um eine zufällige Missbildung handelt. Möglicherweise ist dieses Exemplar nur die Entwicklungsform einer bisher unbekannten Gattung ähnlich wie *Opercularia scyphostyla* NENNINGER (NENNINGER 1948, S. 200, Abb. 48 b), welche möglicherweise ebenfalls eine neue Gattung ist.

Der Körper war $48\ \mu$ lang, bilateral symmetrisch, bis zum Anfang des unteren Körperdrittels urnenförmig. Am Anfang des letzten Drittels übergeht der stark eingeschnürte Körper in einen flach tellerartig vorspringenden Teil, welcher sich gegen den Stiel kegelförmig



Abb. 9. *Vorticelline*, unbekannte Gattung, 400fach.

verjüngt. Gelegentlich der Kontraktion legte sich dieser Teil kappenförmig über den kugelig zusammengezogenen urnenförmigen Körperteil und der vorspringende Rand bildete einen wellenförmig gefalteten Saum. Das eingezogene Peristom bildete eine kleine Schnauze.

Der Peristomsaum ist wurstförmig abgesetzt. Der gewölbte Diskus legt sich in Ruhestellung über den Schlund. Derselbe reicht bis zum Anfang des unteren Drittels, also bis zur tiefen Einschnürung oberhalb des plattenförmigen Vorsprunges. Die sich abschnürenden Nahrungsvakuolen waren im Moment der Abschnürung fast spindelförmig, rundeten sich aber sofort ab. Sie waren bläschenartig, enthielten wenig geformte Nahrungspartikelchen und liessen dadurch den lichtgrauen Körper ziemlich durchscheinend. Nur das untere, verkehrt kegelförmige Körperdrittel enthielt zahlreiche, lichtbrechende Granula. Das Kortikalplasma war sehr dünn und nicht scharf abgegrenzt.

Die Pulsationsblase lag tief im Körper, ungefähr am Ende des ersten Körperdrittels, an die innere Pharynxwand angeschmiegt.

Der Kern ist länglich bohnenförmig. Nach Fixierung mit konzentriertem Sublimat kam ein, an den Makronukleus dicht angeschmiegt Mikronukleus zum Vorschein.

COTHURNIA CLAUSIENS sp. n. (Abb. 10. a, b, c)

Nach starken Stürmen war am Ufer den Kleinen Bucht immer ein dunkelbrauner Spülsaum ausgebildet, welcher unter anderem viele feinzerriebene Arthropodenreste unbestimmter Herkunft enthielt. An diesen Bruchstücken sass oft dicht nebeneinander eine *Cothurnia*, welche auf den ersten Blick durch die eigentümliche Ausbildung der Hülse auffiel.

Systematisch steht diese Art den von PENARD beschriebenen Moosformen *Cothurnia elastica* und *C. richtersi* am nächsten.

Die Hülse ist glashell, farblos und sehr dünnwandig. Gegen oben zu wird die Hülsenwand immer dünner, so dass der häutchenartige Rand in der Seitenansicht unsichtbar bleibt. In ausgestrecktem Zustand ragt das meist paarweise sitzende Infusor etwas über den Hülsenrand. Die Hülse besitzt dann eine meist bilateral symmetrische, unten breit abgerundete Form; selten ist die zartgebaute Hülse an der Basis flachgedrückt, doch ist es wahrscheinlich, dass dies erst unter dem Drucke

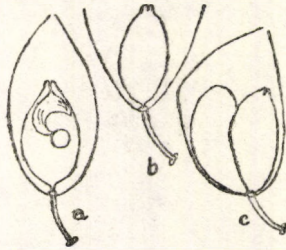


Abb. 10 a, b, c. *Cothurnia clausiens* sp. n. a geschlossene Schmalseite, b kelchartig erweiterte Breitseite, c geschlossene asymmetrische Form, 400fach.

des Deckglases geschieht. Der obere Rand der Hülse ist gerade abgestutzt und weithalsig, der Querschnitt ist aber nicht ganz kreisförmig, sondern etwas oval. Wenn sich das Infusor in die Hülse zurückzieht, wird dieselbe entlang der beiden nebeneinander sitzenden Infusorien stark abgeflacht und der Rand schliesst sich im optischen Längsschnitt der Schmalseite giebelartig zusammen (Abb. 10 a), während der optische Längsschnitt der Breitseite einem nach oben stark verbreitetem Kelch gleicht (Abb. 10. b). Doch nicht jede Hülse wird so ganz fest verschlossen. Oft bildet der obere Rand eine spaltförmige Öffnung, welche, wenn sich nur ein Tier in der Hülse befindet, in der Mitte etwas erweitert ist.

Infolge der grossen Zartheit der Hülsenwand wird die Form der Hülse oft etwas deformiert, oder ist bereits ursprünglich etwas asymmetrisch ausgebildet. In solchen Fällen nimmt die Hülse in 3/4-Ansicht d. h. zwischen der Schmal- und Breitseite die auf Abb. 10. c, dargestellte Form an, wobei die kürzere Seite der Hülse gerade bleibt, die längere hingegen stark gebogen wird. Hierdurch wird der giebelartige Verschluss seitwärts verschoben.

Die Tiere sitzen an einem sehr kleinen, knotenförmigen Zwischenstiel, welcher leicht übersehen werden kann. Der Aussenstiel ist dünn und biegsam und erreicht mitunter die halbe Hülsenlänge. Er ist

farblos und sitzt an einer ebenfalls farblosen, oft sehr dünnen Haftplatte.

Der Körper der Tiere ist gedrunken, bilateral symmetrisch, etwas bauchig ausgebuchtet, meist auch am unteren Ende ziemlich dick. Gegen das Peristom ist der Körper trichterförmig verbreitert.

Der Peristomsaum ist zweiteilig, meist, stark eingeschnürt, eine bei der Gattung *Cothurnia* meines Wissens noch nicht beobachtete Erscheinung. Am Rande des flachen Diskus ist ebenfalls eine Ringfurche ausgebildet, in welcher der obere Umlauf des adoralen Cilienkranzes eingepflanzt ist. Die Cilien sind lang und kräftig.

Das Protoplasma ist farblos, aber nicht durchscheinend, so dass selbst die Konturen der mandelkörnig sich abschnürenden Nahrungsvakuolen nur ganz undeutlich sichtbar sind. Dieselben stachen eher durch ihren, lichten, nur wenige kleingekörnelte Nahrungspartikelchen enthaltenden Inhalt ab. Der Kern ist ebenfalls sehr schwer sichtbar. Er ist lang, wurstförmig längsgerichtet, im oberen Körperteil hirtensstabförmig gekrümmt. Das Kortikalplasma ist sehr dünn. Die Pellicula sehr fein quergestreift.

Der Pharynx ist weitgeöffnet, aber nicht sehr lang. Er reicht ungefähr bis zum Ende des ersten Körperdrittels. Die Pulsationsblase liegt unmittelbar unter dem Peristomsaum. Neben der Hauptblase war oben und unten, je eine kleine Nebenblase ausgebildet, welche alternativ pulsierten: die Systole der einen Nebenblase fiel mit der Diastole der anderen Nebenblase zusammen.

Gelegentlich der Kontraktion zieht sich der Körper eiförmig zusammen und bildet eine Schnauze. Mit heissem konz. Sublimat fixiert entstehen am Körper in regelmässigen Querabschnitten, zwischen tiefen Querfalten dicke Ringwülste. Die Schnauzenbildung wird noch ausgeprägter.

Die Länge der Hülse beträgt 35—50 μ .

COTHURNIA ANOMALA sp. n. (Abb. 11. a, b, c)

Diese Art scheint ein spezifischer Symphoriont von *Corophium curvispinum* zu sein. Sie kam vor dem Auftreten ihres Wirtstieres nie zum Vorschein und wurde auch seither auf keinem anderen Substrat gefunden.

Die Hülse ist, wie bei *Cothurnia clausiens* farblos und durchsichtig, sehr dünnwandig, am oberen Ende fast bis zur Unsichtbarkeit verdünnt. Ihre Form ist abgeflacht. Die Breitseite ist unregelmässig, auf der einen Seite oft fast geradwandig, auf der anderen stark ausgebuchtet, meist schief abgestutzt. Die Schnalseite ist fast bilateral symmetrisch. Der Breitenindex der Schmal- und Breitseite verhält sich wie 1:2. Infolge der Zartheit der Hülsenwand kommt es ziemlich häufig zu Deformationen, welche in extremsten Fällen zu der auf Abb. 11. c. dargestellten Missbildung führt. Diese Hülse ist derart zerknittert, dass sie die darinnen sitzenden zwei Infusorien zusammenpresst, so dass der untere Teil des Körpers vom hinausragenden, etwas bauchig aufgetriebenen Teil stielartig abgesetzt wird. Diese beiden Infusorien erwecken den Eindruck von Hungerformen, welcher Umstand auf die gestörte Lebenstätigkeit zurückzuführen ist.

Die Hülse besitzt einen verhältnismässig dicken, deutlich längsgestreiften kurzen Stiel, welcher durch Vermittlung einer breiten, aber sehr dünnen, Haftplatte an den Extremitäten des Abdomens des Wirtstieres angeheftet ist. Die Haftplatte löst sich sehr leicht vom Substrat los, doch findet man häufig auch solche Exemplare, deren Hülse samt dem fibrillären Stiel losgerissen wird, während die Haftplatte selbst am Wirtstier bleibt. Die Tiere sitzen an einem breiten, flachen, seitlich abgerundeten, sockelartigen Innenstiel.

Die Körperform ist gedrunken. Die eine Seite ist meist stärker ausgebaucht und etwas gebogen. Das Peristom bildet die grösste Breite des Körpers. Der Peristomsaum ist wurstartig verdickt, abstehend, aber nie umgeschlagen. Der Diskus ist flach und breit, nur sehr selten schwach gewölbt. Im Ruhezustand legt er sich über den $\frac{1}{4}$ körperlange Schlund. Das farblose Protoplasma schliesst nur wenige kleine

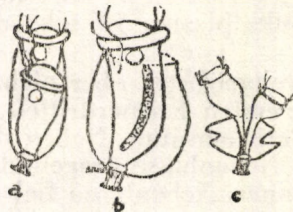


Abb. 11 a, b, c. *Cothurnia anomala* sp. n., a Schmalseite, b Breitseite, c zerknitterte Hülse, Missbildung der Infusorien

Nahrungsvakuolen ein. Der längsliegende Kern ist bandartig, meist nicht umgebogen. Die Pellicula zeigt keine Querstreifung.

Die Körperlänge beträgt regelmässig 35–40 μ , doch finden sich Hungerformen, welche nur 30 μ lang und 15 μ breit sind.

Unmittelbar nach starken Stürmen kommt *Cothurnia anomala* nur vereinzelt vor, da sie von allen Epizoen am leichtesten abgestreift wird. Bei windstillem Wetter war diese Art nicht nur sehr häufig, sondern meist auch mit hoher Individuenzahl vertreten. Auf jedem *Corophium* fanden sich durchschnittlich 10–15 Exemplare.

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ЭПИЗОИЧЕСКИЕ ПЕРИТРИХИ ОЗЕРА БАЛАТОН

Автор: Лр. ИОЛАН СТИЛЛЕР

РЕЗЮМЕ

На основе наших исследований, количество известных нам эпизоических перитрихов озера „Балатон“а увеличивалось с 31 до 45. Один род, 9 видов и одна разновидность являются неизвестными до сих пор в науке. Специализация в выборе хозяина достигла у этих эпизоа такую высокую степень, что среди 25 видов только *Zoothamnium varians* встречался на двух хозяевах, хотя мы держали *Carinogammarus* и *Assellus* и разные другие перитрихоносы долго в одной и той-же стеклянной посуде. *Rhabdostyla inclinans* редко образует мелкие низкие колонии, таким образом она является, собственно говоря, видом *Epistylis*, оставшимся чаще всего солитерным. Может быть, она тождественна с *Epistylis humilis*.

Intranstylum Asellicola — являлся самым выносливым эпизоическим перитрихом, изменчивость которого в условиях свободы на *Asellus aquaticus* незначительная, в плену однако, особенно в культурах, богатых продуктами разложения, встречается множество разнообразных разновидностей. Иногда встречаются колонии, стебель которых похож на *Carchesium* этот вид похож на *Carchesium* со слабо развитой мионемой.

Движение волн влияет на количество индивидов и на образование стеблей перитрихов, образующих колонии. На огражденных местах, и на хозяевах, образующих трубы, колонии состоят из большого количества индивидов чем на местах, подверженных сильному движению волн. На этих местах стебель более короткий, коренастый, поперечная и продольная полосатость его более густая, кроме того стебель часто является членистым. Общий вид колонии напоминает эпизоа быстро-подвижных хозяев. Кажется что на местах с сильным движением воды, и мионема является более крупной.

COLLOTHECA VOLUTATA N. SP. A NEW BENTHIC ROTIFER FROM LAKE BALATON

BY

O. SEBESTYÉN (Tihany) and L. VARGA (Sopron)

From the Hungarian Biological Research Institute, Tihany, Lake Balaton.

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On the bottom of the Kis-öböl, a bay on the E shore of the Tihany peninsula, on top of the inorganic sediment, a layer of organic detritus accumulates, made of fragments of littoral macrovegetation (*Potamogeton*, *Myriophyllum*, *Phragmites*) and those of animal origin. This substance has a loose structure and is inhabited by organisms such as algae (mostly Diatoms) and various members of the microfauna. The whole mass, including detritus and living organisms, is subjected to wave action which disturbs the sediment layer, disperses its constituents into the water medium and occasionally throws part of it out of the water, thus forming detritus drifts on the shore (see SEBESTYÉN, 1949, in this volume).

On December 19th 1945, a tube-living rotifer which was not fixed to any substratum was found in the bottom of the shallow shore water of the bay mentioned. When, in the late autumn of 1948, regular studies were begun concerning the conditions of life in the detritus sediment and of the plant and animal associations inhabiting it (by SEBESTYÉN), this rotifer regularly appeared in the samples in considerable numbers. More collections were made, and having sufficient living material, a thorough investigation was carried out by both authors.*) During the course of these studies it was observed by L. VARGA that this *Collotheca* species differs markedly as to organization and mode of life from all other members of the genus known hitherto. We wish now to introduce it into the system by the name of *Collotheca volutata* n. sp. (volutare from the Latin, meaning to roll, to turn, etc.) (Fig. 1—2).

Ten species of *Collotheca* have hitherto been found in lake Balaton:

a) pelagic forms from the free waters: *C. Balatonica* VARGA (VARGA 1933/36), *C. libera* ZACH., *C. mutabilis* HUDSON, *C. pelagica* ROUSS. (VARGA, 1932);

b) sedentary forms from the quiet littoral (a bay with dense reed growth) *C. ambigua* HUDSON, *C. cornuta* DOBIE, *C. coronetta* CUBITT, *C. ornata* EHRBG., *C. proboscidea* EHRBG. (VARGA, 1939);

c) a sedentary form from the psammon: *C. wiszniewskii* VARGA, (VARGA, 1938).

* Times of collections when *C. v.* was found: 1945: Dec. 19, under ice; winter of 1948/49: Nov. 10, Dec. 8, 13, Jan. 5 (temperature of water under ice 0° C, pH 7.73—7.85), 8, 10, Febr. 21, March. 23 (only resting eggs in the tubes; temperature of water 5° C, pH < 7.96, no ice).

It seems that the detritus sediment layer exposed to wave action in the shallow shore water is — at least during the cold season — the true habitat of this rotifer. It was rather unexpected to find a representative of the genus in such a locality, as was the case with *C. wiszniewskii* found in the psammon. The adaptability of the members of this genus to the conditions of the milieu seems to have a wider range than

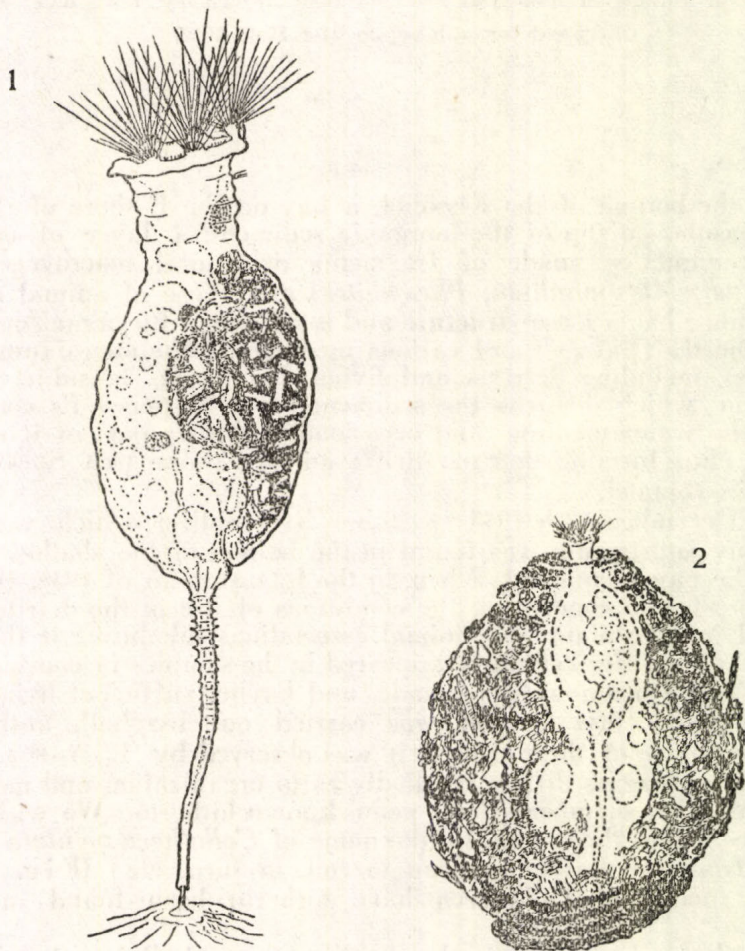


Fig. 1. *Collotheca volutata* n. sp. ♀ extended. The tube is not shown.

Fig. 2. Tube of *Collotheca volutata* n. sp. The front of the tube left without detail, in order the inhabitant to be seen. About the foot three parthenogenetic eggs in different stages of development.

was previously suspected. Both species show an intimate relation to the characteristics of their peculiar habitats.

Description of the female.

The tube. The animal when withdrawn inside the tube has a cystlike appearance, with a rather transparent and colorless outer coat and a core of a pinkish shade. The shape and size of the tube vary: in

general it has the shape of a barrel or sack, with a darker base and a narrow opening. (Figs. 2, 5, 12—15). The axis running through the center of the base of the tube and its opening is curved somewhat. It is made of a gelatinous substance, secreted by the rotifer, and is more adhesive than the cases of other members of the genus.

The substance of the base (sole) of the tube seems to be more compact than that of the side walls, and has a rather indefinite spiral structure. It continues toward the inside of the tube in a small mound, to the upper surface of which the rotifer is attached. (Figs. 5, 12.) The more or less cylindrical wall is made up of a more delicate material in which empty valves of Diatoms are imbedded in abundance, they — very likely — originate from the excretum of the rotifer. Such elements are lacking both in the sole and the mound. Around the opening of the tube, which is usually an irregular circle, the wall seems to be more delicate. The diameter of the opening is much smaller, than that of the tube or the base, but large enough to allow the animal a comfortable passage through it. Minute particles both of organic and inorganic material adhere to the surface of the tube. When treated with hydrochloric acid, the inorganic particles disappear and the valves of Diatoms become visible, demonstrating their abundance and variety. Not infrequently a bunch of Diatoms may be found in the cavity of the tube, still exhibiting the characteristic brown color of the algae. The origin of such masses has not as yet been discovered. A few indefinite circular rings on the wall might be due to periodicity in manufacturing the case. (Fig. 5.)

As mentioned, the animal is attached by its foot to the upper surface of the mound, this being the only place of attachment. When drawn inside, the body is surrounded on all sides by the cavity of the tube, this being the case with members of the *Melicerta* and *Limnias* genera too. In this sense our animal differs definitely from all the other tube-living *Collotheca* species known, because, they being attached to the opening of the tube too, the proximal part of the tube turns inward on contraction and when extending, it turns inside out. The large size of the tube in proportion to that of the body is also characteristic, together with the presence of empty valves of Diatoms in the substance of the wall. These minute but rigid particles give firmness to the tube, while the elasticity of the wall is due to the gelatinous secretion of which the tube is made. Both properties of the tube, viz. firmness and elasticity, have some advantage since this rotifer, being unattached to any firm substratum, is exposed to various disturbances caused by frequent wave action. It might be rolled and tossed about among the detritus particles or dispersed in the water, to sink again without any damage being done either to the tube or to its inhabitant. The tube protects the resting egg too, after the mother's death and provides for the distribution of the species, through the above-mentioned properties, amidst the peculiar dynamic vicissitudes of the habitat. (Figs. 13—15.)

The body. (Fig. 1.) As to the main features, the female *C. volutata* resembles the other members of the genus in general, though it seems to be more delicate. The body is slightly bent ventrally, its main axis exhibiting a curve similar to the tube. The cuticle is delicate and transparent. Folds and creases appear in great numbers on the surface of the body, resulting in a warty outline. However, these wrin-

kles are apt to disappear soon. A few ringlike folds are frequently seen on the neck. The folds and creases on the foot are permanent. The division of the body into head, neck, trunk and foot is distinct. The proportion of the head + neck : trunk : foot is about 2.5 : 5 : 3.

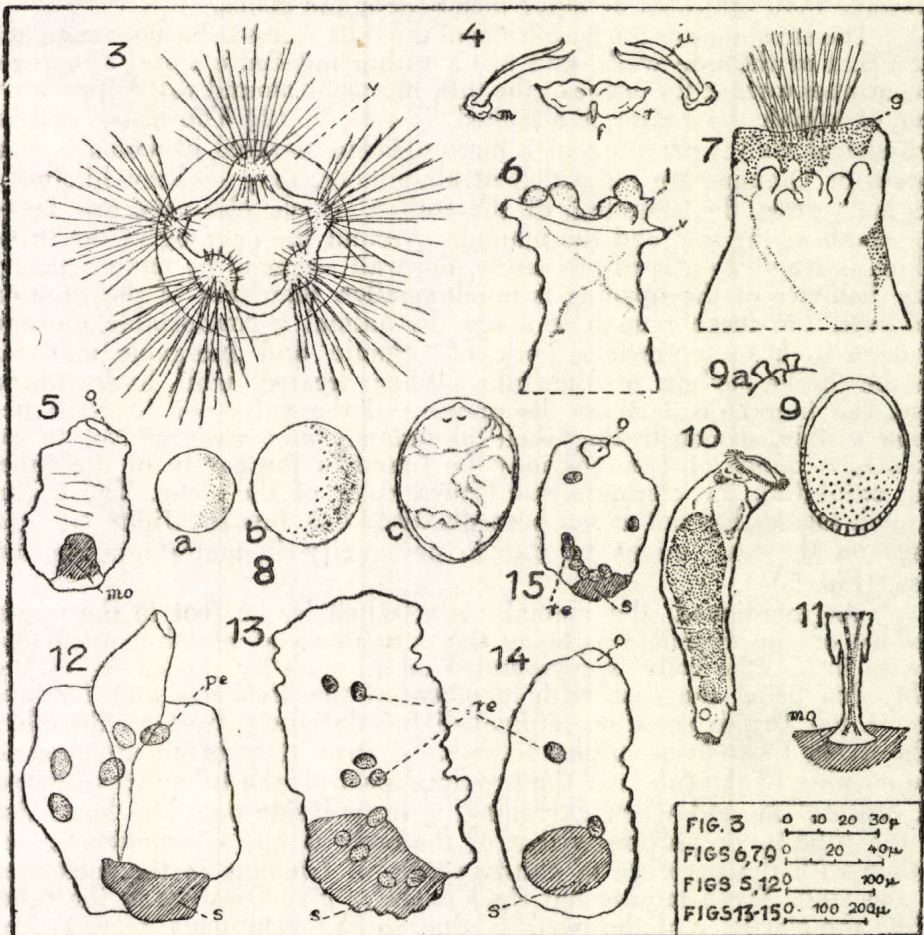


Fig. 3—15. *Collotheca volutata* n. sp. Fig. 3. The corona with the velum from above. Living individual. Fig. 4. Parts of the throphus. Fig. 5. Sketch of a tube, 8th. Dec. 1948. Fig. 6. Upper part of the body; lateral view, showing the membrane of the dorsal coronal lobe. Living individual. Fig. 7. The neck with the partly contracted corona. The bristles forming one unit; outline of the lobes showing through the cuticle. On the top of the neck and on the side are minute subcuticular granules. Fig. 8. Parthenogenetic eggs in different phases of development: a = within the body; b = attached to the tube; c = just before hatching. Fig. 9. Resting egg showing both membranes; the projections of the inner coat but partly drawn. Surface view. 8th January, 1949. Fig. 9a. Few projections with larger magnification. Fig. 10. Male specimen, alive. Fig. 11. Pedunculus attached to the surface of the mound by means of the disc. Fig. 12. Sketch of a female specimen within the tube in extended condition. In the tube there are parthenogenetic eggs. Detail of the corona is not depicted. Living individual. 8th Dec. 1948. Figs. 13—15. Sketches of uninhabited tubes with resting eggs, 25th March, 1949. Explanation of signs: d = dorsal lobe of the corona; e = eye spot; f = fulcrum; g = granules; l = lateral membrane of dorsal lobe; mo = mound; m = manubrium; o = opening of the tube; pe = parthenogenetic eggs; re = resting eggs; 3 = ramus; s = sole of the tube; u = unci; v = velum.

The head. (Figs. 3, 6.) At the base of the corona a delicate circular membrane, the velum, is present. (Figs. 3, 6; v) The disc forms five semiglobular lobes arranged regularly. The dorsal one, nearly a complete sphere, is drawn out a bit above the others, owing this position to the presence of a very short stalk, contrary to the other ones which sit immediately on the disc. The dorsal lobe is halfway enveloped by a delicate membrane reaching only halfway lengthwise and not extending above the lobes into the coronal net, as in the case of *C. cornuta*. This lobelike membrane lacks both cilia and „bristles“. (Figs. 6).

The coronal lobes carry the delicate long rod-like cilia („bristles“) which do not beat and are peculiar to the genus. The length of the longest bristles is about equal to the diameter of the disc. (Fig. 3).

The withdrawal of the corona happens quickly, and when but incompletely done, the bristles form one unit resembling a paint-brush. (Fig. 7). The upper part of the bunch remains outside and is visible, while the lower part, hidden in the infundibulum, could not be detected, though the outline of the coronal lobes shows through the cuticle. When in extension, which is a slow, a gradual — one might say a cautious — process, the situation just described recurs, very soon the disc bearing the lobes unfolds, the five bunches of delicate bristles spread out, and the appearance of the velum marks the end of the process. The velum, though but a very delicate membrane, seems to take part in the stiffening of the corona.

The edge of the disc between the lobes carry a row of minute cilia, the presence of which is characteristic of our species. On other members of the same genus they are missing, with the exception of *C. coronetta*. The surface of the infundibulum is also covered with cilia, especially the ventral part. By the beat of these cilia a current propels the food towards the mouth. The cilia covering the inner surface of the lobes take part in the same process.

Minute granules in the subcuticular plasma below the corona could distinctly be seen through the transparent and colorless cuticle of the neck (Fig. 7). These granules, uniform in size, have a high degree of refraction and are in constant motion. Inside the neck the cone-shaped infundibulum is situated, its narrow basal opening continues into the wide vestibulum, at the posterior end of which the mouth is located. The opening of the mouth falls below the neck, on the anterior part of the trunk.

Eyes are lacking on the adult female, though a pair of hemispherical purple-red eye-spots, without lenses, could be seen through the egg-shell of the embryo (Fig. 8 c). The dorsal antenna with a few short setae is situated on a minute mound on the neck, just above the brain, which in turn has an elongated pear-like shape.

When the body is extended usually only the corona and part of the neck can be seen outside the tube. (Fig. 12).

The trunk. The neck widens abruptly to the voluminous trunk, which is dorsally somewhat swollen. In its upper part — as has been mentioned — the mouth is located. This opens into the slender oesophagus. On the bottom of the mastax, the rather degenerated trophi are found: on the upper part of the fulcrum, which is minute and rod-shaped, there are the two leaf-like rami. To the manubrium, which has

the shape of a disc, the unci are attached. These being slightly bent, have the form of a dart and are joined at their base. (Fig. 4). The rigid valves of the Diatoms could not be ground by the delicate trophi, the rôle of the jaws being rather to push forward the food into the succeeding parts of the alimentary canal. Both the mastax and the stomach lie immediately under the subcuticular plasma layer, and are in most cases stuffed to their highest capacity with Diatoms of various sizes and shapes, so that they extend mostly to the base of the neck, right into the neighbourhood of the brain. The globular salivary glands are located on both sides of the upper edges of the stomach, as usual.

The short and wide intestine generally contains empty valves in abundance. The rectum, also a short and wide part, presses the bulk of the valves through the anus out of the body into the inside of the tube. The anus is located dorsally above the foot as usual. The great bulk of food enclosed by the stomach exhibits the characteristic brown color of Diatoms. Through the cuticle the outline of the valves could be distinctly seen.

The tubules of the excretory organ could be detected from the middle of the trunk on, on the ventral side. The contractile vesicle is rather voluminous. The excrement is expelled through the cloaca into the cavity of the case.

The globular ovaries with the yolk-gland lie ventral to the intestine. Sometimes 3—4 parthenogenetic eggs — in different phases of development — could be seen in the body. After being discharged they keep the globular shape for a while (Fig. 8a-c). Their content seems to be compact. Since the development of the embryo begins within the mother's body, no nuclei could be seen. The eggs are attached to the wall of the tube, in contrast to most of the other members of the genus, where they are attached to the foot of the female. (Figs. 2, 12). The eggs soon assume an oval shape and their contents are no more homogeneous. It has been mentioned that the developing embryo has a pair of eye-spots.

The oval-shaped resting eggs have a deep yellow color, are enveloped by a thick membrane, on the surface of which minute projections with blunt ends are scattered in regular distribution. On the outer surface of the resting eggs, freshly discharged, a second membrane could be seen laying close to the projection; however the ends of the latter are not fixed to the membrane. (Fig. 9). Later on this membrane disappears. Its rôle might be the protection of the oviduct, etc., during the passage of the egg, against the injuries which might be caused by the rough surface. No such outer membrane has been described of any other rotifers. The number of resting eggs — in contrast to all other members of the genus — is high. This fact perhaps has something to do with the structure of the egg, viz. the presence of the outer membrane. From the sample collected on March 25th, 1949, ten tubes including only resting eggs were separated, their numbers being the following: 2, 2, 3, 3, 5, 5, 7, 9, 10, 10, the mean value being 5.6! The resting eggs on most of the rotifers are not released by the female, but are set free after its death. It has been established of this species that the female produces several resting eggs which find protection in the tube after the mother's death. (Figs. 13—15).

The very slender and short foot is clearly marked off from the rest of the body. The upper portion has several deep folds and creases,

the lower portion has but a few shallow ones (Fig. 1). Two muscles appear distinctly through the cuticle. The contractibility of the foot seems not to be very great. Several bends of the foot are, however, possible. Between the foot and the pedunculus there is a joint. The toes could be observed only with difficulty and rarely. On the posterior end of the pedunculus there is a disc which assures firm attachment of the organism to the base of the tube (Fig. 11). It is almost impossible to sever the body from the mound. It seems that this firm attachment makes possible the frequent, energetic and quick contraction of the body.

The male (Fig. 10).

One male specimen was found by VARGA in a sample on Jan. 5th 1949 collected from under a 20 cm thick ice-layer. It is very active, small in size, and thoroughly transparent. The body is nearly cylindrical, widening somewhat about the middle. Toward the anterior and posterior ends it is slightly bent. The posterior part of the body has a few slight folds and creases but they disappear when the animal swims in an extended attitude. On the anterior end an uninterrupted wreath of cilia is present, the center of the wreath projecting forwards. Both velum and corona are missing. On the edge of the well-developed disc-shaped brain two sickle-shaped eye-spots could distinctly be seen. Slight traces of the infundibulum might be observed. No alimentary canal. The minute contractile vesicle located on the posterior end of the body represents vestiges of the excretory organ. The voluminous testis with its great mass of spermatozoa fills the whole body of the male. Penis is lacking. There is a bunch of hair at the end of the very short and cone-shaped foot. We could not observe the process of copulation, it very likely takes place within the tube.

*

Measurements: length of female, extended, 240—280 μ ; length of tubes 350—420 μ (November—January), 400—800 μ (March, containing only resting eggs); length of parth. eggs 40—45 μ ; length of resting eggs 50—70 μ ; length of male 100—105 μ .

Mode of life.

C. volutata is both a current - and filter-feeder, being monophagous too. It selects its food, which consists of various species of Diatoms (*Navicula*, *Pinnularia*, *Cymbella* etc.) some of them of considerable size. Such algae grow abundantly among the particles in the detritus layer. The food is consumed in great quantity, and the empty valves, to which but very slight damage has been done, when passing through the alimentary canal, are used to make the tube. The construction of the tube was not observed.

This rotifer, as far as it could be established, is a semi-sessile organism in the sense that the body of the animal is attached exceedingly firmly to its self-made case, which is a non-living matter, but animal and tube forming one unit, are unattached to any substratum. This unit — as any other constituent of the detritus layer: living organisms or lifeless matter — moves about passively or lies quietly at the bottom, according to the dynamic conditions of the milieu. In favourable circumstances, which means quiet water, the animal emerges partially from its case, and with its delicate corona spread out sets to feeding. On the slightest

mechanical disturbance the body contracts and, thus hidden in the tube, it finds protection against the various unfavourable conditions of its surroundings. It seems that both in organisation and mode of life *C. volutata* adapts itself in a high degree to the peculiar conditions of the habitat. *C. volutata* seems to favour cold water and is very likely a stenothermous form.

Life cycle.

The life cycle of *C. volutata* could be only established partly because the observations were limited to the cold season (November to end of March). Parthenogenetic eggs are produced constantly in the first part of the cold season (Nov.—Jan.). Following the appearance of the males fertilized eggs appear late in the cold season. This last phenomenon marks the turn of the kinetical phases of life to the akinetical one. In a March collection a few tubes were found including, beside the resting eggs, the extended body of a dead female, the stomach of which contained Diatoms, but the corona was missing.

Interrelationship with other members of the genus.

C. volutata are in the closest relation to *C. cornuta*. However, there are many differences between these two forms, especially as to the structure of the corona and the proportions of the various parts of the body. The dorsal lobe of the corona of *C. cornuta* is long and has a long, active, fingerlike lateral lobe. Rudiments of such lobe are present on *C. volutata*, but it envelops the dorsal lobe only halfway both length- and crosswise. The edge of the coronal disc between the lobes is free from cilia on *C. cornuta*. The extensive corona of this latter species is nearly as long as the trunk. Its foot is longer than any other parts of the body added together. Its whole length (580—635 μ . COLLIN, 1912, p. 39) is about twice that of *C. volutata*. Its two eyes are hardly detectable. The tube — which is attached to various littoral plants — is voluminous, hyaline, and the body is attached to its upper edge.

C. volutata might be brought in some sense into interrelationship with the psammobiont *C. miszniewskii* too. They are about of equal size, the structure of the corona is similar, however the lateral membrane on the dorsal lobe, the cilia between the lobes on the edge of the disc, and velum are missing on the latter species. Its neck exhibits no wrinkles, its foot is less delicate. The tube — being attached to grains of sand — is gelatinous, being free of any foreign substance, with the exception of a very few particles sticking to the surface.

If these three forms were arranged in order of succession, *C. miszniewskii* with its simple organisation might be at the end, followed by *C. volutata* and *C. cornuta* with the most differentiated organisation, would take the place at the top.

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COLLOTHECA VOLUTATA N. SP.

НОВАЯ КОЛОВРАТКА БЕНТОСА ОЗЕРА БАЛАТОНА

Автор: ОЛЬГА ШЕБЕШТЬЕН и ЛАЙОШ ВАРГА

РЕЗЮМЕ

В осадке детрита воды побережья озера Балатона обнаружен новый член рода *Collotheca* и мы называем его *C. volutata* n. sp.

Эта коловратка прикреплена ко дну своей трубы лишь посредством pedunculus, а край трубы является свободным. Труба состоит из студенистого секрета, в который вкладываются пустые скорлупы диатомей.

Труба не прикреплена ни к какому субстрату и может свободно перемещаться, соответственно динамическим условиям среды.

Самая характерная черта *C. v.* структура венца, который снизу охвачен нежной оболочкой (velum). Кутикула нежная, бесцветная и прозрачная. Иногда она образует повсюду складки и морщины. Складки, встречающиеся на ноге, постоянные.

Если что-нибудь беспокоит *C. v.* она внезапно сокращается и может совершенно скрыться в объемистой трубе. В вытянутом состоянии большая часть тела, за исключением головы и части шеи, остается скрытой. Животное вытягивается очень осторожно.

C. v. питается посредством фильтрования текущей воды. Кроме того она является монофагом. Она питается многочисленными диатомеями разной величины и формы, встречающимися в окружающей среде.

Пустые выделенные скорлупы включаются в состав трубы. Мы обнаружили присутствие как партеногенетических, так и постоянных яиц. Последних можно определить — по истечении короткого времени — по наличию внешнего слоя, окутывающего внутреннюю оболочку, на которой имеются мельчайшие выступы. Эта же самка может выбрасывать несколько постоянных яиц. Эти яйца после смерти матери все еще находят приют в трубе. Самца мы наблюдали только один раз. Нам не были обнаружены ни молодые формы, ни процессы образования труб.

Во время холодного периода года были найдены некоторые женские экземпляры *C. v.*, по всей вероятности вида *stenotermus*. Их организм, а также и их образ жизни хорошо приспособляются к динамическим условиям окружающей среды.

Систематически *C. v.* может быть помещен между *C. wizenwiskii* Varga и *C. cornuta* Dobie.

ТЕКСТ К РИСУНКАМ

1. рис. *Collotheca volutata* n. sp. ♂. В вытянутом состоянии, трубы не видно.
2. „ труба *Collotheca volutata* n. sp. Передняя поверхность трубы без деталей, чтобы показать ее жителя. Около ноги 3 партеногенетических яиц в разных стадиях развития.
- 3—15 рис: *Collotheca volutata* n. sp.
3. рис. венец с оболочкой сверху. живой индивидуум.
4. „ часть trophi.
5. „ набросок трубы (8. дек. 1948 г.)
6. „ верхняя часть тела, вид сбоку. Видна оболочка задней доли венца.
7. „ Стянутый венец. Реснички образуют единую форму. Через кутикулы видны очертания долей. На шее и на боку имеется мельчайшая подкутикулярная грануляция.
8. „ Партеногенетические яйца в разных стадиях развития. а = внутри тела, б = прикрепленные к трубе, в = непосредственно перед вылуплением.

9. „ постоянное яйцо с обоими оболочками. Выступы внутренней оболочки нарисованы только частично. Вид поверхности. 8. января 1949 г.
 9/a „ несколько выступов в большом увеличении.
 10. „ живой самец.
 11. „ *Redunculus* прикреплено к поверхности рта с помощью диска.
 12. „ набросок самки внутри трубы в вытянутом состоянии. В трубе видны 4 патеногенетических яйца. Подробности венца не нарисованы. Живой индивид. 8. дек. 1948 г.
 13—15 рис.: наброски необитаемых труб с постоянными яйцами .25. марта 1949 г
 Условные обозначения:

d = задняя доля венца
 e = глазное пятно
 f = fulcrum
 g = грануляция
 l = боковая оболочка задней доли
 mo = рот
 o = отверстие трубы
 p = партеногенетические яйца
 r = постоянные яйца
 z = ramus
 e = подошва трубы
 u = unci
 v = velum
 m = manubrium

STUDIES ON DETRITUS DRIFTS IN LAKE BALATON*

BY

OLGA SEBESTYÉN

From the Hungarian Biological Research Institute, Tihany, Lake Balaton

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Results of previous investigations of the drifts on the shore of Lake Balaton (ENTZ, SEBESTYÉN and SZABÓ, 1942) suggested that a thorough study of drifts built of detritus might help to elucidate the problem of organic detritus, including its rôle and significance in the cycle of organic substances within our lake.

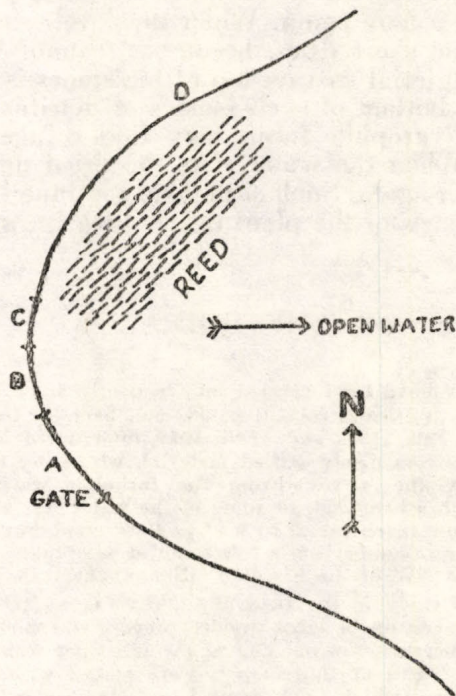


Figure 1. A sketch of Kis-öböl bay, Tihany, Lake Balaton showing localities of collections (section „A”—„D”).

* A report of this paper was read before the Xth International Congress of Limnology, Zürich, August, 1948. A brief summary will be published in the Proceedings of the I A L.

In the course of field observations covering several years it could be established that on certain sections of the shores of the Tihany peninsula, detritus was cast ashore frequently and in abundance. A section of the W shores is specially subjected to the accumulation of detritus (see ENTZ, SEBESTYÉN and SZABÓ, 1942, Plate I. Fig. 4). On the E shores of Kis-öböl, a bay located in the neighbourhood of the Biological Institute, is known for this. The shores of this bay were therefore chosen for the present studies (Fig. 1).

The main road running along the shores is protected from the waves in the bay by a stone wall and loose quarried stones (SEBESTYÉN, 1948 p. 104). A section of the SW part of the shores of the bay — about 15 m long (section „A“, Fig. 1.) — located between a small reed growth and the gate of the Institute altogether 36 m in length (sections „A“—„C“) is a typical place where detritus drifts are frequent. Along this 15 m stretch detritus accumulates in great masses and, depending on the water level and wave action, it forms either a dark sediment belt of 2—3 m in width resembling „főrna“ (SERANDER), the particles may be dispersed in the turbulent water, lending a dark brown color to it, or — at least part of it — is cast ashore. Sooner or later this material washes into the water again, floating for a while before sinking. When conditions allow, it is washed ashore again. When the level sinks gradually, the detritus mass left on shore dries, because it cannot be reached by the waves any more. Material cast on top of big stones is especially exposed to that fate. At the bottom of such masses of detritus in the favourable season, terrestrial hygrophile forms may find refuge (ENTZ, SEBESTYÉN and SZABÓ p. 35). When the water rises the dried detritus comes under the rule of the water again. Such situations continue for years. This may be the reason that parts of the plant debris turn brown and have a turf-like appearance.

METHOD

Field observations have been carried on frequently since 1930 on the shores of Kis-öböl (ENTZ, SEBESTYÉN and SZABÓ p. 53—60). Samples for quantitative analysis were collected between June, 1942 and April, 1944, interrupted by the winter. Most of the samples were taken from newly drifted material, which lay close to the water and was being sprinkled by the waves. From the turbulent water the floating detritus particles were taken with a hand-net, or some of the water was simply drawn up. From the bottom of the shallow reach the „főrna“ like sediment was brought up by means of a hand-net or a jar. For comparison a few samples were taken from the Aszófői-öböl, an extensive bay located NW of the Kis-öböl. (SEBESTYÉN 1948, p. 100).

Following a brief study in the field, the desired material, viz. 50—100 cm³ from the detritus drift, was taken up in large wooden pincers and carried in a porcelain cup to the laboratory. The measuring of one cm³ of the substance was done as follows: using small metal pincers, particles of the samples were placed with care in a measuring-cylinder of 10 cm³ volume, which held about 4 cm³ lake water, filtered twice, till the contents of the cylinder increased by one cm³. This was then poured out into a watch glass. For microscopic investigation a binocular preparatory microscope was used (Oc. V, Obj. 40). All the elements which could be recognised with the lens power mentioned, were noted, except those of plant debris. Qualitative studies were made in a similar way, without measuring the volume or enumerating the elements. The material was always studied in a wet condition, so as to find the animal constituents alive. It was no use measuring the weight considering that the amount of water adhering to minute objects such as an ephyppium or a lower crustacean, etc., would outweigh the object itself.

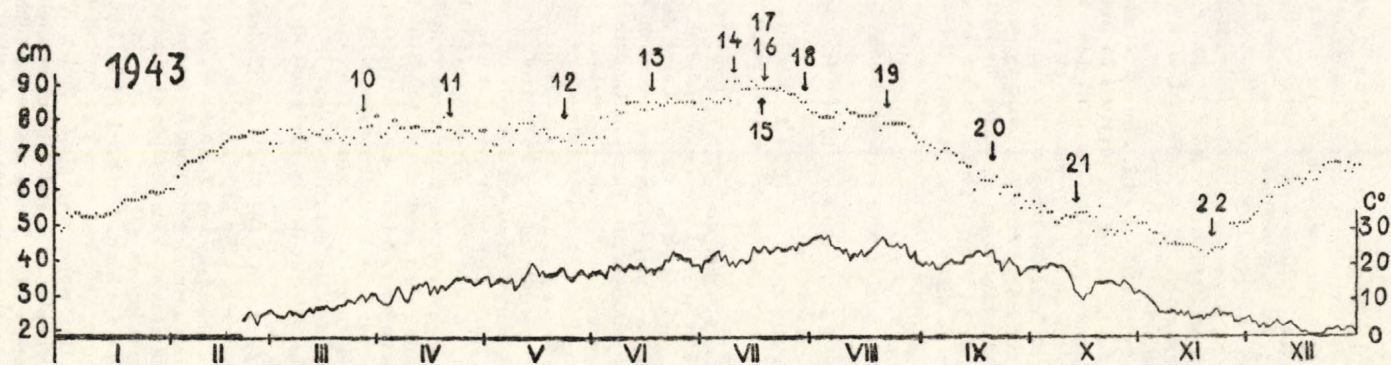
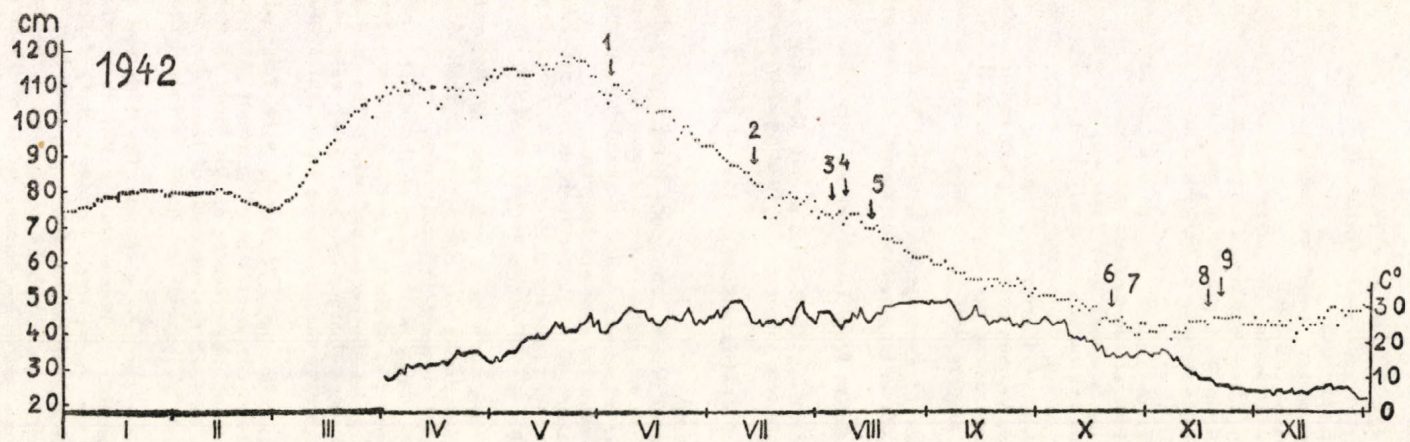


Figure 2—2. Level (.....) and temperature (——) of lake water, Tihany, 1942, and 1943.

THE SAMPLES.

All the samples except Nos 16ab and 17ab were collected in Kis-öböl bay. If not indicated otherwise the samples are from detritus drifts. (q = qualitative analysis; Q = quantitative analysis; F = floating detritus).

June 4th, 1942. Unusually high water for about two months. Level now descending. Stormy weather a few days previously. NE wind.

No. 1. (q). Few pelagic species present among the plant debris (*Ceratium hirundinella*, *Keratella cochlearis*, *Conochilus* sp., alive; *Melosira*, *Pediastrum*, *Keratella*, dead). A few *Bangia* filaments originate from the rich growth of algae attached to stones in the vicinity. A statoblast of *Lophopus*, a species not known hitherto in the lake, is found.

July 14th, 1942. Stormy weather for days strengthening to a gale at night and continuing during the previous 24 hours. Part of the detritus still afloat.

No. 2. (q + Q). The drift („A“ section) is about 2—3 days old, but washed constantly in and out. It consists of green and brown, that is newly broken and old particles of macrovegetation; *Cladophora glomerata* filaments, partly empty cells. *Epistylis* colonies, empty gemmules and shells of Ostracods frequent. Tardigarda (*Macrobiotus macronyx*) noted for the first time. Various animal and plant constituents.

August 6th, 1942. Drifts everywhere along the shores (Sects. A B C D). The previous night a heavy shower (16 mm). Raining. Off „A“ section there is much floating detritus in the water (see No 3a).

No. 3. („A“ section) (q + Q). Branches of *Potamogeton* beneath the detritus drift, which mingle with reed fragments 6—14 cm in length. Fewer animal constituents than in No. 2.

No 3a (F, q). Most of the fragments derive from insect larvae, very likely of *Cryptochironomus* sp.

August 10th, 1942. Medium water level. Drift formed on the day of collection, wave action had ceased when sample was taken. Much floating detritus in the water.

No. 4. (Section „B“) (q + Q). Habit of drift is similar to that of Nos 2 and 3, very likely it is of the same material.

August 17th, 1942. Level descending.

No. 5. (q + Q). Fragments of most varied origin, Arthropods being represented mostly by ephippia and shells of Cladocera. When collection was made from the bottom of the open water off shore, fragments of similar origin were noted in abundance. Among the live constituents wheel animacules and chironomid eggs are frequent.

October 23d, 1942. Water-level about 30 cm lower than during previous collection, portions of the bottom of the bay emerged above water. Drift scarcely developed, consisting of sand, shells of *Dreissena*, *Lithoglyphus*, as well as of the fallen leaves of trees. The plant debris is brown.

No. 6. (q + Q). Filaments of *Cladophora* — with a rich coat of *Diatoma vulgare* — partly dying, from some cells swimmers broke out. *Spirogyra* frequent. Most of the plant debris made up of the most resistant elements in plant tissue.

October 24th, 1942. (Section „D“). Close to the edge of the water powdery fine particles a continuation of the „föna“ like sediment in the shallow water. This latter forms a belt about 2 m wide along the shores, beyond which the muddy bottom appears in a lighter colour. Here and there floating detritus. Quiet water, no waves. The detritus is very likely left on the shore by the descending water (not a true drift in s. s.).

No. 7. (q + Q). Shells of Cladocera, mostly badly damaged, very frequent, unsuitable for specific identification. Other chitinous fragments listed in group „Arthropoda“ are abundant too, *Diatoma vulgare* frequent. The presence of this form, as well as the abundance of chitinous fragments seems to mark the approach of the end of the favourable season. This sample is distinguished by having the most various living animal constituents (21!).

November 19th, 1942. Low water for over a month. The 17th was a windy day, followed by a gale lasting for another 24 hours. On the 19th there was no wind, the water was almost quiet. Along the shores (incl. section A, B, C) fallen leaves of poplar trees and detritus accumulated in huge masses, forming a steep barrier at the water's edge. There are sections where only mollusc shells (*Dreissena*, *Lithoglyphus*) are cast out without any detritus. It is an instructive demonstration of the rôle of various factors in the formation of drifts. Here and there detritus dispersed in the water.

No. 8a (off section „C“; Bottom sediment; q). Structure of material shows its origin, which is the coating („Aufwuchs“, RUTTNER) from water plants and submerged stones, detached and tossed about by the waves. Inorganic particles and Diatoms still adhere to each other. Very few live constituents, mostly infusoria, a few *Alona affinis* with winter eggs.

No. 8b. (Section „B“; q). Drift material taken from near the previous sample. Fragments of reed and water plants measuring about 1 cm or less, also a few larger pieces of reed and some poplar leaves. Detritus partly old, partly newly broken. It differs from No. 8a, again showing the selective property of the waves. Filamentous algae and Diatoms — alive — more frequent than in No. 8a. Few forms with active motion. Fragments of Cladocera and other Arthropods frequent, but less than in previous month. Water mites and water bears move about slowly, temperature of water 4° C.

No. 8c. (q). Floating detritus (off shore section „A“). Shells of Ostracods and some flat green mineral substance (muscovite?) of similar size. Shells of glochidium and veliger larvae. Ehippial female of *Alona affinis*. As to living specimens Nematoda (frequent), *Canthocamptus*, a few Ostracods, free ehippia and the larva of *Driessena* (sphaerium phase) are to be mentioned.

No. 8d. Drift material from the same section (q + Q). Many groups are represented, live specimens and fragments. Nematods in abundance, some eggs (?) in decaying plant tissues. Among the fragments, shells of Ostracods, veliger larvae and empty cases of *Oligochaeta* cocoons noted. Many more animal constituents than in No. 8a. Filamentous algae.

November 21st, 1942. Previous collections only two days earlier. Three samples taken from the shore, about 1—1.5 m from the water's edge.

No. 9a. (q). Finely distributed organic particles, inorganic elements missing. No organism with active motion. A few ehippia (*Monospilus*) and some live gemmules. Dead specimen of *Corophium*. *Cladophora* and *Spirogya* alive.

No. 9b. (q). Sample taken at a greater distance (1.5 m) from the water's edge than the previous one. Material similar to No. 9a, with the difference that it contains plant debris of larger size too. No live constituents, a very monotonous sample.

No. 9c. (q). Consists only of Nematods and Infusoria in a live condition. The material very likely originating from the coating of various substrata, still bears a resemblance to its typical structure. The abundance of Nematods is evidently due to this. The effect of wave action is shown in the separation of the gemmules into single specimens.

March 29th, 1943. No collection during winter. Previous days with clear sky and warm weather. Drifts of pebbles and reed decorate the shores. Here and there small patches of detritus gently washed by the waves. In water floating detritus.

No. 10. (q + Q). The animal constituents are mostly fragments. With the exception of Nematods (25 live individuals per cm³) 12 groups are represented by a few living individuals.

No. 10a (q). From section „A“ some water with floating detritus was drawn up. When poured into a glass cylinder, sedimentation soon began. Volume of sediment about 6%. It consists of plant debris containing epidermis particles and the other parts of plant tissues having the highest resistance. The following forms were found alive: Nematods, a few; Flagellate Protozoa and Infusoria, scarce; Diatoms, abundant. Shells of Ostracoda and Cladocera (*Monospilus*), empty gemmules and byssus thread. Green mineral particles mentioned above present. After the sedimentation of formed elements, the water seemed rather opaque, in it a minute organism (a colourless *Mastigophora*?) was present in great numbers.

April 21st, 1943. Detritus drifts on the shore washed by the waves. (No. 11). In the water (section „A“) floating detritus (No. 11a).

No. 11. (q + Q). Empty ehippia of *Monospilus* in abundance. Unusually few shells of Ostracoda, which fact was related somewhat to the gentleness of wave action.

No. 11a (q). A net haul from the shore water. A few living specimens of *Micronecta* noted, fragments of animal origin being the same as in sample No. 11.

Comparing the spring material (Nos. 10, 11) with the ones collected during the previous autumn, not much difference could be established. Empty shells of *Alona* and *Euryceus* (?) are more corroded than in Nos 9 a b c, while the heavily built shell of *Monospilus* bears no signs of such process. It is known that in this species the resting egg is encased in the entire shell and that „hibernation“, takes place in this condition. The specific gravity of such an ehippium with a shell having several layers of chitinous substance, must be high enough, and may resist wave action better than an empty and thin shell of a species with a more advanced form of ehippium.

May 24th, 1943. No. 12. (q + Q). Plenty of *Epistylis* partly inside empty cases of *Oligochaeta* cocoons and in gemmules. Living animal constituents scarce. Fragment material is made of 21 groups, the highest number found during the course of this study. Chitinous particles and shells of Ostracoda are the most frequent. Specimens of *Macrobiotus* (in mould with eggs) are smaller than the autumn examples.

June 17th, 1943. No. 13 (q). The plant particles are rather coarse. *Epistylis* abundant, some Rotators and ephippia with eggs. Free branches of *Cladophora*. Among the fragments cast skins of Insecta larvae and shells of Ostracoda noted.

July 11th, 1943. No. 14. (q + Q). Water above medium level. The material cast out — only poorly developed drifts — is wet, though it is not freshly washed out by the waves. Mingled with plant debris only a very few animal constituents are present (Rotators, Protozoa, gemmules). Composition of fragment material is rather monotonous.

July 19th, 1943. Water is still above the medium level. Volume of material cast out during the last two weeks amounts to almost nothing. At the time of collection a gentle wave action. At section „A“ floating detritus in abundance. Part of the formed material collected from the neighbourhood of the reed growth in the bay (see No. 15 b) differs from this, both in structure and colour. The one originating from the reed is lighter in colour and has a fibrous structure.

No. 15 a (q). Newly fragmented green particles of plants mingled with the old, brown material. *Epistylis* and other Infusors found alive. Fragments of Arthropoda, empty gemmules, etc., present.

No. 15 b (q + Q). Its general aspect is similar to No. 15 a. More green elements than in No. 15 a. Among the plant debris of usual size very fine particles are also present, which sink very slowly. *Epistylis* colonies with no more than 32 individuals are attached, mostly to plant debris. Of animal constituents only very few individuals are present. Among the fragments, cast skins of chironomids (larvae and pupae) in abundance. Some fish scales and a dead young fish.

July 20th, 1943. The Aszófői-öböl bay, where these four samples (Nos. 16 a b, 17 a b) were taken, is much larger than Kis-öböl, from which most of the samples originate. Two samples were taken on the shore (Nos. 16 b and 17 b), one immediately at the water's edge (No. 16 a) and the other (17 b) somewhat further. Two hauls were brought up, one being sediment (No. 16 a), the other floating detritus (17 a).

No. 16 b. (q). Old plant debris with very finely distributed particles. Hypotricha Ciliata, Nematoda and *Spirogyra* — all alive — in abundance. Cast skins of chironomids (*Cryptochironomus*, and *Protenches*) dominating among the fragments, the very resistant prothoracic horns of the pupa found separately. Shells of Cladocera (*Acroperus*?) abundant.

No. 17 b. (q). The outwashed material is not reached by the waves. Many inorganic constituents, old plant debris, some filamentous algae, pollen of Coniferae were noted, Nematoda only representing the animal constituents.

No. 16 a (q). A net haul taken from the water in the close neighbourhood of No. 16 b. It consists of the most resistant parts of plant tissues, *Spirogyra*, Nematoda, Rotatoria, various forms of Infusoria (incl. *Epistylis*) and *Dreissena* were found alive. Fragments are the same as in No. 16 b, with the addition of some dead *Corophium* and fragments of cocoon shells.

No. 17 a. There is a wide, dark brown movable layer of detritus above the inorganic sediment of pale grey colour. It is made up of newly broken and old particles. Both animal and plant constituents — alive — are lacking. Fragments of Arthropoda in abundance.

July 31, 1943. Water level descending. Since the previous day, with a heavy storm, a great mass of detritus floats in the shore water, with some finely distributed particles. Material washed out on the shores, and a „föna“ like sediment on the bottom.

No. 18 (q + Q). Section „A“. The drift material, brown in colour, is made up of plant debris, including the tiny branches of moss, of a turfy appearance. Newly broken particles less frequent. With the exception of *Epistylis* and eggs of unknown origin the groups are represented by few individuals. Branches of *Cladophora* and other filamentous algae — not identified — are scarce. All the gemmules are those of *Spongilla fragilis*. Forming a pavement layer, the group is divided into halves along the equator of the gemmules.

August 23d, 1943. No. 19. Detritus drift (section „A“) made of the usual turfy material. (q + Q). Few living organisms present, among them *Spirogyra* (scarce) and *Epistylis* (in abundance). Shells of Ostracoda, of veliger larvae, and chitinous fragments are more varied than the living constituents, resembling No. 18.

September 23d, 1943. The water level is rising. During this month the shore was decorated with detritus drifts only at section „A“. Rainy weather. A neuston formation made up of chitinous fragments, mostly of Cladocera.

No. 20. (q + Q). Plant debris in a turfy condition. *Cladophora* and *Spirogyra* alive. Animals with active motion but few, (*Epistylis* and other Infusoria), shells of Ostracoda, Cladocera and skins of Arthropoda being the most frequent among the fragments.

October 16th, 1943. Water level low for three weeks. Temperature sinks. The weather is windy and rainy. Much detritus lies on the shore (Section „A“) and because of the descending level could not be washed into the lake again by waves of medium strength. The drift forms a band-like barrier on the shore, built up of horizontal sections. The material is arranged in such a manner that the parts furthest from the water's edge consist of the coarsest particles, while those immediately at the water's edge, are made up of finely distributed debris. From such an arrangement the gradually decreasing power of the wave action might be concluded. The shore water is full of floating detritus. An unusually large mass of detritus gathered in this section, in consequence of the stormy season.

No. 21 (q + Q). Among the living constituents the water flea *Ilicryptus* is to be noted especially, it is abundantly present (23 ind./cm³) alive and nearly as many dead or empty skins). A few living *Monospilus*, ehippia of the same in abundance, but empty shells prevail. Fragments of Arthropoda (incl. insect larvae) very numerous. A year ago *Macrobiotus* was a very frequent constituent of the drifts, while this year since May no specimens have been found till now. The sample is rich in both living and dead constituents.

November 24th, 1943. Having reached the minimum level about two weeks ago, the water is rising again but it has not yet attained medium level. Drifts on shore, the one (Section „A“) built of coarser material, while those near the reed-growth are of finer particles; this selection again is connected with the degree of wave action.

No. 22. (Section „A“, q - Q). Mostly plant debris, including very fine particles too. *Diatoma vulgare*, abundant, *Cladophora*, partly with epiphytes (*Diatoma vulgare*). With the exception of *Epistylis* there are very few animals present. One example of *Aelosoma*, badly damaged, but it moves about. Shell of Ostracoda relatively few. The groups represented by fragments outnumber those representing the living constituents.

No. 22a (q). Material from the close of the reed growth is made of finer particles with some fibrous structure (epidermis of reed stalk). Elements noted: Nematoda and Diatoms, in abundance, showing that it originated from the coating of various substrata (*Potamogeton pectinatus* in the neighbourhood, its coating consisting of the same constituents).

April 24th, 1943. No. 23. A high water level. The submerged stones at the water's edge have no coating. A few shells of Unionidae and of *Lithoglyphus* lay on shore. Detritus cast on shore scarce, this being only on top of large rocks (boulders) where it could not be reached by the waves. The surface of such layers is dry, they are wet underneath. The material has a felt-like structure, a brown colour, being built up of elements found regularly in the drifts. *Cladophora*, a few colonies of Cyanophyceae and Nematoda represent the living constituents. The dead material (fragments) much less monotonous.

RESULT OF THE ANALYSIS

Plant constituents

As to volume, most of the material is of plant origin: bits of reed and submerged aquatic plants (*Potamogeton perfoliatus*, *Myriophyllum spicatum*, etc.), all growing in the bay. In a systematical sense there is not much variety in the origin of the plant debris, but it differs decidedly according to age. Particles newly broken off could be recognised by the colour, etc., and in such cases even specific identification might be possible. Among the older fragments, however, no more could be established — with the lens power used — than perhaps a distinction of reed from other water plants (Hung. „hinár“). Fresh reed debris

could be recognised by its fibrous structure too. The old particles, fragments of higher vegetation, moss leaves, minute plants (*Lemna*) turn to a brown somewhat resembling turf in appearance.

Among the fragments of higher vegetation — in a low percentage — other plant organisms of lower systematical standing are mingled, such as moss, fungi and algae. Among the algae filamentous forms are frequent: Cyanophyceae, *Cladophora glomerata*, *Spirogyra* occasionally *Bangia*. *Cladophora* is present in almost every sample. It grows abundantly, attached to stones throughout the year, while the appearance of *Bangia* depends on high water level and protracted stormy weather. (ENTZ, SEBESTYÉN, 1946, p. 297). The cells of the *Cladophora* filaments were partly living, partly empty. Besides these species other forms of filamentous habit were found, but with the exception of *Spirogyra* a form of frequent occurrence, no identification could be made. *Pediastrum* is one of the few plankton constituents (see p. 52). Fragments of fungi (*Saprolegnia* and others) could be found quite frequently. Diatoms, usually alive, are the most common of the algae; there is hardly a sample without them. Among the forms recognised were *Melosira*, a plankton constituent, a few benthic species, *Diatoma vulgare* growing abundantly on *Cladophora glomerata*, appeared with the highest number of individuals among the algae. In some autumn and spring collections (Nos. 4, 6, and 10, 11.) swimmers were present, in one instance they were breaking out from *Cladophora* cells (No 6, Oct. 23).

Moss leaves and the tops of tiny branches are not infrequent. Identifications were not made. As to their origin, one is apt to think of the moss patches which decorate the stones lining the banks of the bay. These stones, brought here from the geyserite hills of the neighbourhood, are renewed each year.

Animals and their fragments

The Table includes the data from the analysis of the animal constituents. An effort was made to find a grouping suitable to the material, that is why, although the elements are arranged in a somewhat systematical order, the groups are not of equal systematic value.

The animal elements were in various conditions, as follows:

A. Living

a) Adults and those in various phases of development capable of active motion; the following classes are represented: Flagellata, Ciliata, Hydrozoa, Platyhelminthes, Aschelminthes, Chaetopoda, Tardigrada, Crustacea, Eutracheata, Arachnomorpha, Conchifera and Pisces.

b) Resting stages: eggs, cocoons, cysts, gemmules, ephippia and statoblasts.

B. Dead

Specifically the same as in A a—b. Forms where decomposition takes place immediately after death (Ciliata, Mastigophora, Turbellaria etc.) could not be found. Forms with high regenerative properties (hydra), remain alive long after they are injured (see p. 57).

Number and frequency of animal constituents (living, dead, fragments) of the samples (1 cm³). Explanation of signs: S = sediment; F = floating detritus; + = present (but no numerical data); f = frequency in %; m = highest number of live individuals or fragments present in the samples (1 cm³); a = average number of live individuals or fragments in the samples (1 cm³) (drift material from Kis-öböl only being considered); * = data of quantitative investigations only being considered; numbers in fat type = living specimens; numbers in brackets = dead specimens; numbers in ordinary type = fragments.

● = frequent, alive; ○ = frequent, fragments.

[illegible]

C. Resistant parts and fragments.

a). In connection with development: exuviae of larvae and pupae of Arthropoda, Cladocera, etc., empty cases (gelatinous, chitinous, etc.) of eggs, cocoons; gemmules, etc. already hatched.

b). Indicating death: Any fragments of forms mentioned in A. a—b. For instance, the calcareous shell of Mollusk larvae of young and adult Mollusks, of Ostracoda etc. Shell of veliger and glochidium larvae and Ostracoda are not so easily broken as those of adult mussels. This ought to be due to the small size as well as to the higher percentage of organic material in those shells. Chitinous material and byssus thread have especially high resistance.

Protozoa (F=84.6%). Of this group Infusoria occur the most frequently in the samples (F=84.6%). Flagellate Protozoa are rare, Rhizopoda being represented only by a few empty shells of *Centropyxis aculeata* and *Diffugia* sp.

Most of the Ciliata belong to the Order Peritricha, *Epistylis* being the most frequent and abundant. Colonies with zooids up to 50—60 drift ashore with substratum (chitinous fragments of Arthropoda). They also enter into empty gemmules and cocoons (Oligochaeta). *Zoothamnium alternans*, occurring on stones on the shore, is detached from the original substratum. This might be caused by the resistance of the substratum to the mechanical action of the waves. There were only a few zooids left in the colonies, while most colonies of *Epistylis*, with the exception of autumn examples, were very vigorous. *Vorticella* cast ashore attached like *Epistylis* (see Group 5, Tab. I). Hypotricha Ciliata are frequently found inside the tubelike fragments the exuviae of Arthropoda larvae, together with other Infusoria of various systematical standing (Group No 7). All these Infusoria seem to originate in the littoral, inhabiting shore waters, though the ones attached to floating chitinous remnants may have drifted ashore from the open water (neustotripton).

The delicate body of most Infusoria disintegrates quickly after death, this being very likely the reason that all the Ciliata Protozoa were alive.

Coelenterata. Gemmules of fresh-water sponges, were frequent. The majority of them belong to *Spongilla fragilis*, which is quite common on stones in the shallow water, those of *S. Carteri* being rare. Most gemmules are empty, fragments seldom seen. On one occasion a small piece of sponge was found with a few spicules and some binding material.

Not one hydra individual was found in its typical form, only degenerate (?) ones: closed tubes of small size, without tentacles (autumn samples, 1942). Judging from the nematocysts they belong to *Pelmatohydra oligactis* PALL., a species very common in our lake. Hydra in a similar condition is not rare in benthos samples collected in the shore waters. On one occasion a freshly broken piece was found from the aboral part of the body.

Turbellaria. A few free living flatworms, representing two species not yet identified, found alive in about a third of the samples. Their cocoons are enumerated in Group 15.

Nematoda. Live round-worms are very frequent in samples taken either immediately at the water's edge or at about 1.5 m distance from it. They were exceedingly numerous in samples collected in the autumn (Nos 7, 8 d). Sometimes they are the only animals in the drift. Nematods inhabit the coatings on macrovegetation or on any kind of submerged objects („Aufwuchs“) in great abundance. Disturbed by wave action, its constituents disperse throughout the water. The worms found ashore, might be freed in this way.

Nematoda seem to be quite resistant, surviving in drifts far from the water's edge. Further investigation is, however, desirable, to decide whether all the forms found are truly aquatic or amphibiotic. Hygrophil terrestrial species might also be present. The worms found in great abundance were about *Punctodora* size, with the exception of a few large forms (*Dorylaimus?*).

Rotatoria. Freely swimming forms, those crawling about among the debris or creeping like leeches, as well as those of sedentary type, were found alive. In sample No. 1, collected after stormy days, a few pelagic forms (*Keratella cochlearis*, *Conochilus*) were present.

Annelida. Oligochaeta occur in almost every other sample (F = 46%) though with few individuals. Among them *Nais*, *Stylaria* and *Aelosoma* could be recognised, species common among the macrovegetation in the littoral. The cases of their cocoons are highly resistant.

Arthropoda. This well represented group included few live specimens, but there were plenty of fragments. This peculiarity is perhaps in connection with the high resistance of chitinous material. Within the group Crustacea, Insecta and Hydracarina could be recognised. In the Crustacea a few specific identifications could also be made. On many occasions it was impossible to establish the proper systematical place of the fragments. Group 40 („Arthropoda“) was introduced for such cases.

Tardigrada. In the summer and autumn collections of 1942, many specimens of the water bear, *Macrobiotus macronyx*, were found, but during the following year it was scarce. In a sample taken at the end of October, 1942, there were 71 individuals/cm³, 27% of which were in the process of moulting with eggs. Eggs enveloped in the cast skin were found separately. This species lives in great population in the detritus covered bottom of shore water of section „A“. During the study of the mud fauna, one example with 16 eggs was found in the mud (January 24 th, 1947). The water was covered by a layer of ice 25 cm thick, the temperature of the bottom was 3 C° (inverse temperature). Other members of the biocoenosis of the benthos were *Micronecta*, *Ectinosoma Edwardsii* and *Macronyx laticornis*, all of them abundant, while *Alona affinis* and chironomid larvae were scarce. Plant life was represented chiefly by Diatoms, Schizophyceae (*Oscillatoria*, *Gomphosphaeria*, *Lyngbya*) and *Cosmarium*, which were scarce. The mud, due to the long-lasting ice cover, had a blackish colour. (The lake was frozen from the middle of November, 1946).

Cladocera. One of the most common elements in drift samples are Cladocera and their remnants. (F = 80.7%). Only 5 samples were negative. This material constitutes a considerable volume too. Living (F=46%) and dead specimens (F = 11.5%) as well as ephippia

with eggs ($F=34.6\%$) and empty ones were found, fragments of shells being very common. *Iliocryptus* (*I. agilis* KURZ and another sp. not casting its shell when moulting), *Alona quadrangularis affinis* and *Monospilus dispar* could be identified. As to ephippia with eggs, those of *Alona*, *Acroperus harpae*, *Monospilus*, *Rhynchotalona rostrata* and *Leydigia acanthocercoides* could be distinguished. All the species mentioned were reported from Kis-öböl bay, some of them inhabiting the muddy bottom of the open water off its shores too. These were found at the bottom of the shallow water among floating detritus, as well as in detritus cast ashore. (SEBESTYÉN 1947, 1948). *Iliocryptus*, *Alona*, *Rhynchotalona* and *Monospilus* are common in the bottom among detritus in shore water off section „A“ too).

During late autumn and early spring the free shells of Cladocera are badly damaged, but in some cases specific identification was possible. *Alona affinis* and some striped valves (*Acroperus*?, *Rhynchotalona*?) were the most common among the remnants. A few exceedingly large valves in all probability belong to *Eurycercus lamellatus*, which has been recorded from the bay also (SEBESTYÉN 1948). In the case of *Monospilus* it could not be elucidated, whether the empty shells were empty ephippia or the skin of dead specimens. Ephippia in general had been found as late as May and as early as August. The presence of dead specimens of *Monospilus* and *Iliocryptus* in an autumn sample (No. 21, October 16th, 1943) might mean the end of their life cycle at the close of the favourable season. Of pelagic species only *Leptodora* (one dead specimen) was recorded.

Ostracoda. Living specimens scarce, empty shells — partly broken — very frequent and numerous. Specific identification was not made.

Copepoda. In this group *Cyclops* occurred the most frequently in summer and early autumn, 1942. They were not found the following year. Green epizoon were attached to the October specimens. Group No. 26 (Copepods not classified) was made up mostly of Harpacticidae, while the nauplii are enumerated separately. One dead individual of *Diaptomus* was found. Both *Cyclops* and Harpacticidae are common in the shore waters, while *Diaptomus* is a member of the plankton.

Of the higher Crustaceans inhabiting the lake only *Corophium* could be recognised. Though this Amphipode is very common in the littoral, no alive specimens were found. This very likely has something to do with the fact that this form is semi-sedentary, though it is a very good swimmer. Its exuviae may occasionally be found in great masses in the shore waters, but in the samples investigated remnants were rather scarce. The tube-like case of *Corophium* in a condition permitting recognition was found only in one sample.

Group 28, Crustacea, might include fragments of any of the groups already mentioned. In this group the Crustaceans were enumerated, the systematical standing of which could not be established.

Insects. Larvae of Ephemeridae, Diptera, Trichoptera and Rhynchota were recognised. The Ephemeridae are rare and not numerous. The Chironomida larvae and pupae are grouped separately from the other Diptera. Their occurrence is rare and the individual number

is low. Their fragments are more frequent. It must be noted though, it was impossible not to enumerate part of them with the Diptera (Group Diptera, Insects and Arthropoda, Groups 32, 35, 39). The prothoracal horns of the midget pupa (*Protenthes* and other species) are very resistant and, as floating objects, they were mostly uninjured. The presence of these air sacs in drifts is known from earlier investigations (ENTZ SEBESTYÉN, and SZABÓ, p. 24, 35, 47). The larval skin and fragments very likely belong to *Cryptochironomus*, and *Microchironomus* etc, species common in the bottom of the Kis-öböl bay.

Trichoptera. Living „caddisworms“ were very scarce in the samples, empty cases more frequent (Hydroptilidae, Leptoceridae).

Hemiptera. Only dead individuals of *Micronecta* and a few of their cast skin were recorded. These minute water bugs are occasionally common in shore waters, inhabiting only „deep“ waters during the daytime and dispersing all over at night.

Hydracarina. A few larvae and adult specimens of water mites were present, though seldom. Fragments of their egg masses were found, as well as remnants of the gelatinous envelope surrounding the eggs.

Mollusca. Shells of *Dreissena* larvae, both in the veliger and sphaerium phase, were very frequent. This indicates the great loss taking place at the larval stage of this mussel. The few living specimens were mostly in the sphaerium phase. Very frequent constituents of the detritus are pieces of byssus thread. The great, mechanical shock breaks the thread, leaving the surface undamaged. The shell of the glochidium larva (Unionidae) was scarce, and no living specimens were found. Though Gastropoda are rather well represented in the littoral, remnants of only two species could be recognised, viz. the corneous operculum and the gelatinous case of the singly laid eggs of *Lithoglyphus naticoides*, a very common form in our lake. Fragments of the gelatinous envelope of the egg mass of *Bythinia* are scarce. With the fragments of mollusk shells (Group 46) two young *Dreissena*, one *Lithoglyphus* and a fragment of the terrestrial form, *Cyclostoma elegans*, were enumerated.

Bryozoa. Broken pieces of empty tubes are fairly common. Statoblasts both free and stationary are in most cases empty. It is to be noted that one statoblast of *Lophopus* was found, a species not known hitherto in the lake.

Fishscales, mostly corroded, few.

In Group 38, under the title „eggs“ are enumerated those which could not be placed with certainty in any systematical group.

About half of the groups (Nos 16—39) belong to the Arthropoda. Most of the elements originate from the littoral and benthos and many inhabit the coatings. Even the structure of the drift material occasionally bears some resemblance to that of the coating. Only a few elements originate in the open water, these being constituents of the plankton and neuston. Plankton organisms were cast ashore after stormy days. (see sample No. 1). All the elements found, originate in the lake itself (home-produced elements). Using the terminology introduced by ENTZ, SEBESTYÉN and SZABÓ (l. c. p. 31) the great majority of the elements might be considered true constituents of drifts („echte Driftelemente“).

Terrestrial elements.

Allochthonous elements are mostly terrestrial („secundäre Drift-elemente“ l. c. p. 32). The pollen of Coniferae growing in the neighbourhood is rather common. Hairs of *Verbascum* and *Hyppophae* were seldom found. Fruits and seeds are of Compositae and other plants of mostly unknown origin. Along the shore in November, 1942, the fallen leaves of the poplar trees cast ashore by the waves accumulated in great abundance. Their fragments mingle very likely with the autochthonous plant debris.

It is hard to tell whether the few feathers found are those of water fowl or are blown into the water and later cast ashore. The origin of minute scales of some Lepidoptera is also unknown.

*

Because field investigations as well as the collection of samples extended over one year, — judging from the condition of organisms washed ashore, — some idea could be gained of certain events in the life of the lake.

The appearance of ehippial females of *Alona affinis* and the presence of quite a few dead specimens of *Iliocryptus* in some of the autumn samples show that the life cycle of these species came to an end at the close of the favourable season. *Macrobiotus* with eggs could be found throughout the year, showing that reproduction is not limited to a certain season, and that the species in question is eurythermous.

Forms distinguished by a high number of offspring, perish in great numbers in their early stages of development, a great loss taking place in the veliger phase of the *Dreissena* larva, somewhat less during the following larval phase, called sphaerium.

When the water level is falling organisms inhabiting the organic sediment on flat shores are left dry. They survive as long as some water remains among the particles. Detritus left on shore in such way, could not be considered as true drift, though the destiny of its microfauna is similar to that of drifts. However, a difference exists between them viz. the construction of the original biocoenosis could be recognised in the first case, while in the material washed ashore, the selective power of the wave action might change its structure.

The most resistant animal substances seem to be chitin and spongiolin, but even in the case of these, a mechanical destruction, through the dislodging force of the waves, prepare them for the activities of specific bacteria which play a rôle in the decomposition of such substances.

CONCLUDING REMARKS

Formation and material of detritus drifts were investigated in an appropriate section of the shores of the Tihany peninsula, Lake Balaton.

Field observations and qualitative and quantitative laboratory analysis of 35 samples collected from June, 1942, to April, 1944, were involved in the study, followed by an evaluation of the data gained from systematical and ecological points of view. The aim was to elucidate 1) the origin of the various plant and animal constituents in the

drifts, 2) the process of fragmentation, and 3) the rôle and significance of detritus drifts in the cycle of matter in Lake Balaton.

The bulk of the samples is made up of organic particles.

The origin of the organic particles is threefold: 1) fragments of macrovegetation; 2) dispersed elements of the coating of various substrata detached by the waves; 3) organic debris of the bottom of the littoral.

With the fragments of higher vegetation other plants of low systematical rank mingle, such as mosses, fungi and algae, filamentous forms being the most frequent among the latter.

Data on animal constituents belonging to 49 groups (not of equal systematical value however) were united in a Table showing the presence and individual numbers of the various animal constituents (alive, dead, fragments) in each sample: frequency of distribution calculated in %, maximal and average individual numbers of all the material investigated quantitatively are also given. About half the groups belong to Arthropoda. Most of the animals originate in the littoral and benthos, many inhabit the coating. Only a few elements are from the pelagic region.

Beside these autochthonous ingredients some of terrestrial origin might also be found. The origin of seeds and fruits is largely unknown.

Condition of the bodies of plants and animals differs according to the length of time they have been detritus constituents. The particles represent various stages of mechanical disturbance and chemical decomposition. Part of the plant debris is of turfy appearance.

All these constituents have come under the rule of wave action, which disperses them in the medium and when the dislodging force is sufficient, they may be washed ashore where the topography is suitable.

The selective power of wave action takes part in the gathering of the particles and their disposal on the shore, though in this process the shape, size and specific gravity of each ingredient plays a rôle too. The locomotion of an active organism might come into play but only in the case of very gentle motion of the water.

The most frequent size of the plant debris is about 0.5—5.0 mm, besides which finely distributed particles are also present. Sedimentation of such fine particles is exceedingly slow, and this makes the transportation of the fine detritus into the free waters possible.

Though fragmentation of the macrovegetation takes place gradually, it seems that there is a gap in size between coarse and fine detritus. It seems also that fine detritus may be formed at any stage of fragmentation. The matter of size however should be approached only by collecting many exact numerical data on the material.

The detritus drifted ashore lies there for a longer period, it dries, becomes fragile, and may break up gradually to fine particles under various mechanical influences and might be carried away by the wind or washed into the water immediately.

Fine detritus which remains in the shore water, might be consumed by members of the benthos. Most of the coarse detritus remains in the littoral and as bottom sediment forms a biotope for a characteristic biocoenosis made up of various microorganisms. (A thorough study of this biocoenosis will follow in the near future.) Coarse detritus might

serve as food too, but this question needs special investigation. Most of the fine particles are transported to the open water district, and might form an essential part of the seston from a trophical point of view. Benthic forms might feed upon it, when sunk.

Through the effect of wave action plant and animal bodies might become subject to fragmentation before reaching the end of their life cycle and the organic substance represented in them, by the intervention of detritus formation, detritus feeders and their consumers etc., may be transformed into live matter again, delaying the process of complete decomposition.

July 21, 1948, Tihany.

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К ВОПРОСУ О ТЕЧЕНИИ ДЕТРИТА В ОЗЕРЕ БАЛАТОНЕ

Автор: ОЛЬГА ШЕБЕШТЬЕН

РЕЗЮМЕ

Мы исследовали формацию и состав детрита около подходящей части берега полуострова Тихань в озере Балатон.

Основой для данных исследований послужили наблюдения в поле, далее качественный и количественный лабораторный анализ 35 проб, забранных с июня 1942 г. по апрель 1944 г.

Далее произведена оценка данных со систематической и экологической точек зрения.

Нельзя наших исследований являлось:

1. Выяснение происхождения различных видов флоры и фауны в течениях.
2. Процессы фрагментации.
3. Выяснить роль, значения и влияние течения детрита на процессы в обмене веществ в озере Балатоне.

Главную часть проб составляют органические частицы. Эти частицы происходят из трех источников:

1. Фрагменты макроvegetации.
2. Дисперсные частицы, оторванные волнами от поверхности разных субстратов.
3. Органический нанос со дна побережья.

Фрагменты более развитой вегетации смешиваются с растениями более низкой систематической категории, как мхи, грибы и водоросли. Среди последних чаще всего встречаются нитевидные формы. В таблице собраны данные относительно органических составных частей, принадлежащих к 49 группам (различных систематических категорий). Эта таблица указывает на наличие и число разных органических составных частей (живых, мертвых, частиц) в каждой отдельной пробе. Там же приведены частота их распределения в %-ах, далее, максимальное и среднее число всех исследованных материалов. Приблизительно половина всех групп принадлежит к членистоногим. Чаще всего животные происходят из воды побережья и бентоса, многие однако живут на поверхностной оболочке. Только небольшое число составных частей, найденных после бури, происходит из пелагической области. Кроме этих автохтонных составных частей, иногда встречаются и частицы почвенного происхождения. Происхождение семян и фруктов по большей части неизвестно.

Состояние тел растений и животных различно в зависимости от срока пребывания в детрите. На этих частицах наблюдать разные стадии механического размельчения и химического разложения. Известная часть растительного детрита имеет торфяной состав.

Все эти составные части подвержены действию волн, которые рассеивают их в среде, а если сила размещения достаточна, волны вымывают их на побережье, на места соответствующей топографии.

Динамическая сила действия волн оказывает влияние на группировку частиц и на их распределение по побережью, хотя в этом процессе и форма, размер и удельный вес отдельных составных частей играет известную роль. При очень слабом движении воды и движение живого организма участвует в этом процессе.

Размер растительного детрита колеблется чаще всего от 0,5—5 мм., кроме того встречаются и более мелкие частицы.

Седиментация таких мелких частиц происходит крайне медленно и это делает возможным перемещение мелкого детрита в открытую воду.

Несмотря на то, что размельчение макроvegetации происходит постепенно, очевидно имеется пробел в размерах между очень мелким и крупным детритом.

Очевидно мелкий детрит возникает в каждой стадии размельчения. Вопрос о размерах, однако, можно решать только путем исследования многочисленных достоверных данных.

Детрит, вынесенный водой на побережье, вследствие долгого пребывания на берегу, высыхает, становится более ломким и — под влиянием различных факторов постепенно размельчается до самых мелких частиц, откуда ветер и вода впоследствии удаляют его.

Мелкий детрит, оставшийся в воде побережья, употребляется членами бентоса. Большая часть крупного детрита остается на побережье, или в виде осадка на дне. Он там образует биотоп для характерного биоценоза, состоящего из разных микроорганизмов. (Подробное исследование этого биоценоза вскоре будет произведено.) Крупный детрит может служить и в качестве питательного материала, но этот вопрос требует дальнейшего изучения.

Главная часть мелких частиц выносятся в открытую воду и там с трофической точки зрения составляет существенную часть сестона. Формы бентоса могут пользоваться этими частицами, когда они опускаются на дно.

Вследствие действия волн, растительные и животные тела могут подвергаться размельчению — еще не окончив полный цикл своей жизни, а их органический материал, вследствие формации детрита, действия производителей и потребителей детрита и т. д. может опять превращаться в органические вещества, отсрочивая таким образом процесс полного разложения.

31-го июля 1948 г. д. Тихань.

EXPERIMENTS IN THE ARTIFICIAL INCUBATION OF *LUCIOPERCA SANDRA* CUV. ET VAL. EGGS

BY

ELEK WOYNÁROVICH (Budapest) and BÉLA ENTZ (Tihany)

From the Hungarian Biological Research Institute, Tihany, Lake Balaton

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In the aim of adding continuously to the supply of *Lucioperca sandra* CUV. ET VAL. in Lake Balaton, the Alsóörs *Lucioperca* Incubation Station was built, in 1949. The mission of this station is to hatch the *Lucioperca* eggs spawned on artificial nests laid out in the *Lucioperca* spawning grounds of Lake Balaton, in places protected from mud and the depredations of fish and insects. The incubating larvae stay in the nursery basins, until they are 5—7 days old. During this time they consume most of their yolk.

The ripening of the eggs deposited in the nests takes place in constantly changing water. The eggs ripe for hatching are transferred to a basin with standing water, where they hatch out in a short time. The *Lucioperca* larvae pursue a pelagic mode of life until they are about 3 days old and develop here for at least 5 days. The water in the nursery basins cannot be changed, because the current of water flowing off would press the larvae against the enclosing grills and destroy them, as they are very sensitive to mechanical influences.

Incubation of the eggs, as we have already said, should take place in changing water. The eggs, attached to the hairy fibres of the „nests“ (ENTZ and WOYNÁROVICH 1948, p. 35) get sufficient oxygen only if they get a generous water current. This makes the incubation considerably expensive, as it means pumping the water by electric power.

To lower these expenses and to increase the reliability and efficiency of the hatching, in 1947—1949 we worked out a process for ripening the eggs out of water. In the following pages we describe one of the methods, suitable for the hatching of eggs in large quantities.

Based on experiments made in 1947—48, we have communicated already in two papers (ENTZ and WOYNÁROVICH, 1947 and 1948) a practicable way of hatching *Lucioperca* eggs which takes place without water but in a vapourous atmosphere where the surface of the eggs cannot dry out (Souvorov, 1939).

Experiments carried out at the Tihany Biological Research Institute in 1948 proved that a vapour atmosphere chamber could easily be constructed in small dimensions up to about half a cubic meter. In this case the moisture on the eggs can be controlled only by spraying them at least three times a day with a sprinkler.

Incubation of nests in large quantities by this method is complicated and not sufficiently certain, considering that if the hatching chamber should lose 100% of its vapour saturation the water adhering to the surface of the eggs would also evaporate and the eggs would die.

In 1948 we had tried out and in 1949 we perfected a method, for ripening the *Lucioperca* eggs under a fine spray. With this method, nests covered with several hundred eggs could be hatched at a time with technical precision and precise hatching temperature, and thereby the duration of the incubation varied almost at will.

The apparatus used for this method is a sprinkler provided with three heads, as employed in agriculture for watering beets and other hoed plants. The diameter of the openings of the sprinkler heads was 0.5 mm. Water from these narrow openings is distributed in such fine, mist-like particles that drops of it falling on the skin can scarcely be felt. These three sprinkler heads spray an area of about 5–6 m², so that the nets ranged in rows and one above the other get all sufficient moisture. The sprinklers were connected with a rubber hose to a water tap. For the arrangement to work there must be a pressure of at least half an atmosphere in the pipes. If the pressure should be less, it can be increased with a low-powered compressor.

The water consumption of this spray provided with a triple, very fine sprinkler head, did not exceed 20–40 l an hour. This is such a small quantity that no difficulties were encountered in warming it to the optimum of 20°C.

We can summarise the course of ripening and hatching out the eggs as follows. Every second day we brought in nests covered with eggs from the *Lucioperca* spawning grounds in Lake Balaton. After their arrival we examined them, to establish the degree of development of the embryos. This examination takes about half a minute per nest. Grouping the nests according to degree of development we established how long it would presumably take for the eggs to hatch with the temperature given. We also carefully observed whether there were damaged or mildewed eggs among them. The nests where *Lucioperca* eggs were mixed with those of roach (*Leuciscus rutilus* L.) were treated separately, for during shipment, the larger roach eggs were very often badly injured and became extremely mouldy during the ripening.

The examined nests (Figure 1), arranged in groups as above, were hung on hooks beside and above one another, on a framework in the spraying chamber (Figure 2). On our scaffolds we could place 120–150 nests at a time.

The spraying was only interrupted for treatment and control three times daily, in each case for about 10–15 minutes. It could be seen that if the spraying was turned off every quarter of an hour no harm was done to the eggs.

When the eggs had about reached hatching time — previously established — we ascertained from a few samples that they were ripe. The nests were put into water for hatching. This could be accelerated by two means: 1) by exposing the eggs to the heat of the sun for 2–4 minutes; 2) by putting them for half an hour into water at 20–27°C after which they reached their destination in the nursery basin at a temperature of about 20°C. In this case 90–95% of the eggs hatched

inside 15—20 minutes. Drying in the sun produced no after effects on the young.*)

In the spraying chamber with an average temperature of 15.5—16° C (measurements 12 times a day, max 21° C, min. 11.5° C**), the eggs always ripened three days sooner than the control material kept in an aquarium with running Balaton water, though when they were brought in they could have been at most 48 hours in the Balaton and most of them were at an entirely initial grade of development, which is when the germinal disc grows entirely or about 3/4ths around the yolk.

A certain definite amount of heat is necessary for fish eggs to ripen. This amount is a certain number of days multiplied by their average temperature (in° C). According to UNGER (1939 p. 735) in the case of *Lucioperca* this is 95—120° C (German „Tagesgrad“). This we controlled by aquarium hatching experiments of our own. But in the sprayed eggs the time of ripening is considerably shorter, compared with the control hatched in an aquarium. According to our estimations the acceleration amounts to 40—50%. We consider the cause of the speedier development to be the greater oxygen provision and the effect of direct sunlight. This is supported by the fact that the eggs at the bottom of the nest, to which no sunlight penetrated and which were also less favourably supplied with oxygen, remained appreciably behind in development. But further experiments are necessary to establish the correctness of this supposition.

The effect of direct sunlight also manifested itself in other ways. In the eggs exposed to light, the eye of the embryo is pigmented black and glistening; guanine crystals also appear, whereas in individuals hatched in water the coloration of the eyes begins only after about 12 hours after hatching.

Hatching of the eggs kept in the sprinkling chamber can be delayed for 3—4 hours. If we do not put the eggs ripe for hatching into the water, in 6—12 hours the larvae begin to emerge in the spraying chamber. They drop down in the drops of water which gather on the fibers of the nest. These larvae are also viable. Experience shows that it is nonetheless better if the eggs ripe for hatching are put into water in time.

We controlled the eggs several times daily, as to whether there were dead or mildewed ones among them. In nests in which the eggs were not injured during shipment (the small *Lucioperca* eggs are very resistant and are injured by only very rough treatment), we never observed mortality and mildew.

If an egg perished it could easily be observed by the empty shell remaining behind.

* By drying nearly ripened eggs for 5—10 minutes in the heat of the sun a premature hatching can be brought about. The prematurely hatched larvae are incapable of swimming vertically as the normal ones do immediately after emergence; instead they wriggle on the bottom amidst uncoordinated tail-flappings. The individuals which hatched less than half a day less than the normal time, grow into normal larvae without any greater degree of mortality (according to our 1948 observations).

** The temperature varied thus, because the hatching, for lack of other, more suitable place, was carried out in a greenhouse, where it was warm by day and cool at night. The framework needs only to be protected by a roof.

Extensive mildew was usually seen in those nests where there were roaches, which are easily injured in transport, among the *Lucioperca* eggs. The overpowering mildew on the injured roach eggs — which developed abundantly under spraying — spread over the healthy *Lucioperca* eggs too.

The hatched *Lucioperca* larvae were put into an aquarium with standing water aerated with compressed air. In each 40 l aquarium we put 20—30 thousand larvae and in a 100 l aquarium 40—60 thousand. We calculated the number of larvae by carefully stirring the water in the aquarium, then counting the larvae in samples of known content.

If no trouble occurred in the aerating system there was very little mortality among the larvae, scarcely to be expressed in %. The dead larvae are white and are soon betrayed by their immobility.

At the age of 5—7 days we put the larvae into the lake. At this age their yolk-sacs are to a great degree absorbed. They are vigorous, swim like fish and are able to protect themselves. There is now hope for the survival of a greater percentage of them.

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ОПЫТЫ ИСКУССТВЕННОЙ ИНКУБАЦИИ LUCIOPERCA SANDRA CUV. ET VAL

Авторы: ЭЛЕК ВОЙНАРОВИЧ и БЕЛА ЭНЦ

РЕЗЮМЕ

Мы выработали новый метод высживания, породного для яиц *Lucioperca sandra* Cuv. et Val. в большом количестве, и подходящего для целей рыболовства. Сущность метода следующая: мы держим повешенные в рамках яйцевые „гнезда“ на воздухе до момента созревания, действуя на них тонкой водяной пылью, температурой в 20° С. Процесс инкубации может быть ускорен выставлением зрелых яиц на солнце в течение 2—4 минут и держа их полчаса в воде, темп. в 20—27° С. прежде чем класть их в сажалку. Молодь там выращивается в течении 5—7 дней и потом выпускаются в свободную воду. Во время выращивания количество их никогда не должно превышать 600—800 на литр, даже в хорошо проветриванном аквариуме.



Fig. 1. Nest with the spawn of *Lucioperca sandra*.

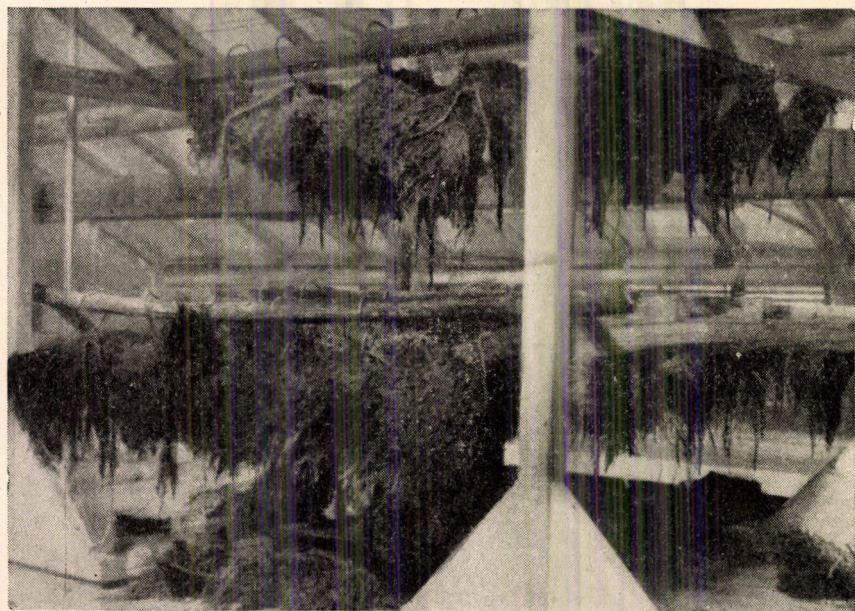
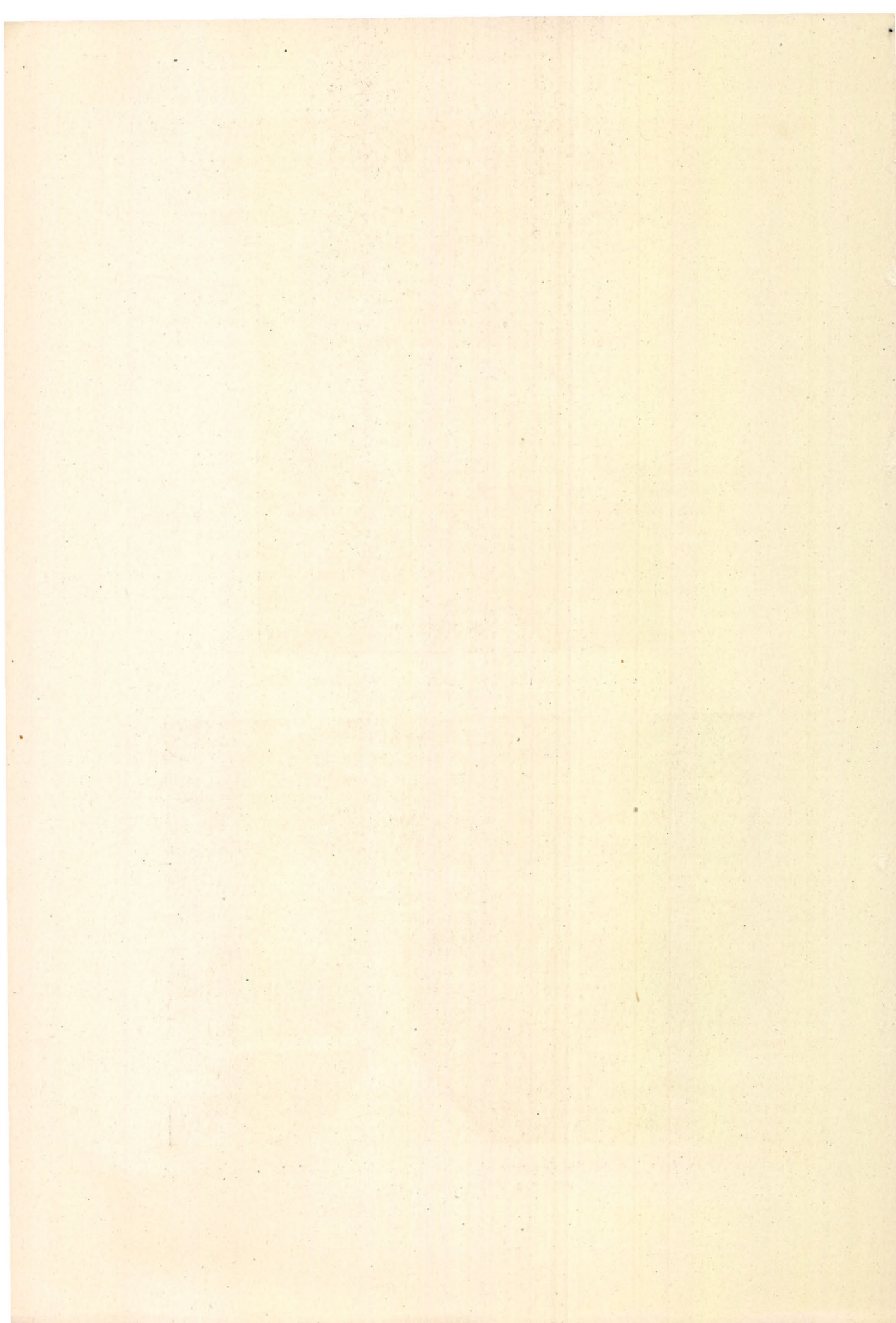


Fig. 2. Nests, hanging on the framework, where the ripening of the eggs takes place under a continuous spray.



SOME PHYSICAL AND CHEMICAL CONDITIONS OF THE WATER OF LAKE BALATON, INVESTIGATED FROM SEPTEMBER 1948, TO APRIL 1949. (TEMPERATURE, TRANSPARENCY, DISSOLVED OXYGEN, pH AND ORGANIC SUBSTANCES)

BY

BELA ENTZ

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In modern limnological research the study of the physical and chemical conditions of the water plays a constantly growing part, as these conditions and their variations influence decisively the formation, continuity and changes in the living world of the water. Among these decisive factors are the movement of the water, its temperature, light conditions, total salt concentration, oxygen content, pH, organic substances, the maximum or minimum presence of numerous dissolved inorganic ions etc.

Much research has been devoted to the study of these factors in Lake Balaton (ENTZ, G. and SEBESTYÉN, 1946:219—255) but this work was not carried out throughout all the seasons, most of it being done in summer, and furthermore most of it took only one of the factors into consideration. As the different factors and their changes do not act singly on the different organisms but together and even reciprocally*) (ÖSTERLIND, 1947, L. D. TOWNSEND and H. CHEYNE, 1944, WELCH, 1935), it seemed desirable to undertake systematic investigations along these lines in Lake Balaton. The first part of my investigations, from the end of September, 1948, to April 1949, were principally devoted to the temperature, transparency, pH, dissolved oxygen and dissolved organic substances, their seasonal changes, and the possible relations existing among these factors.

Samples were collected in two places: 1.) In the open water in front of the Hungarian Biological Research Institute at about 250 m from the shore, in water 3 m deep; 2.) In the „Kút“, the deepest part of Lake Balaton, near the Tihany ferry, in water 10 m deep. We took the water samples at distances of 1 m, advancing from the surface to the bottom, with a Ruttner vessel. The collected material was brought to the laboratory in vessels with polished glass stoppers and worked up in the shortest possible time.

* THIENEMANN 1939 p. 271—272: „18. Alle Einzelfaktoren eines Biotops wie auch des gesamten Lebensraumes stehen in engster Wechselwirkung miteinander; daher wirkt ihre Gesamtheit wiederum als übergeordneter Faktor — „lokaler Einheitsfaktor“ (FRIEDERICHs) für Einzelbiotop als „Holocoen“ (FRIEDERICHs) für den gesamten Lebensraum (Weltzusammenhang) ...“

TEMPERATURE

A thermometer with a scale marked at 0.1°C intervals, installed in the Ruttner vessel, indicated the temperature. As appears from Table I. and Figure 1, the temperature of the water dropped gradually from $16\text{--}18^{\circ}\text{C}$ in September, to $1\text{--}2^{\circ}\text{C}$ at the end of November and oscillated thereabout until it froze. There was no appreciable difference in the temperature at any distance from the surface to the bottom, so that we cannot speak of temperature stratification in either of the collecting places, in front of the Institute or in the Kút. Slight temporary differences in temperature occurred between surface and bottom in the former spot (e. g. September 28th 1.5°C and October 19th 0.6°C) whereas during the same time, under the same circumstances, the greatest difference observed in the Kút was 0.3°C . This is probably closely connected with the almost constant strong current existing in the Kút, amounting at the time of our collections to $10\text{--}20\text{ m/min}$. With the formation of ice a reversed temperature stratification* occurred, which gradually became more pronounced with the warming of the water which, as we know, takes place under the ice (ENTZ, G. and SEBESTYÉN, 1946:239). Whereas at Collecting place I. on December 14th, the day it froze, the difference between surface and bottom water was 0.0°C , on December 29th it was 1.0°C , and by January 10th had risen to 3.0°C . At the same time, a similar stratification occurred in the Kút (on January 4th 1.5°C). On the breaking up of the ice the stratification diminished again, and ceased on its disappearance, in both places (January 22nd 0.1°C). In the meantime the water cooled to a uniform $1\text{--}2^{\circ}\text{C}$. After this, no similar prolonged temperature stratification was observed. At one time, when the lake froze in again there was, on March 12th, a difference in temperature between surface and bottom water (1.2°C) but it ceased after a few days, when the ice melted.** The conditions of temperature on March 23rd were interesting. At that time, after several days of blustering storm, the morning temperature was uniformly 2.7°C . In the afternoon, with quiet sunny weather, a great warmth set in. It began to heat the surface of the very troubled water, which reached 3.1°C , while at the bottom the temperature remained at 2.7°C . This paradoxical condition ceased on the following day, and from then on, the water became gradually warmer and was at the beginning of April $10\text{--}12^{\circ}\text{C}$, at the end of April $18\text{--}20^{\circ}\text{C}$. This very decided and rapid heating, means that raising the temperature of the whole water volume of the lake requires 36.10^{12} calories, which represents the consumption of 4,500,000 tons of the best coal.

* By stratification here and in the following I do not mean stratification as generally used in the limnology, occurring in deep lakes, but merely the „micro-stratification“ evidenced in small differences occurring from time to time in the shoal water of Lake Balaton.

** It is to be noted that the ice does not often break up and then form again in Lake Balaton (see ENTZ and SEBESTYÉN, 1946 239).

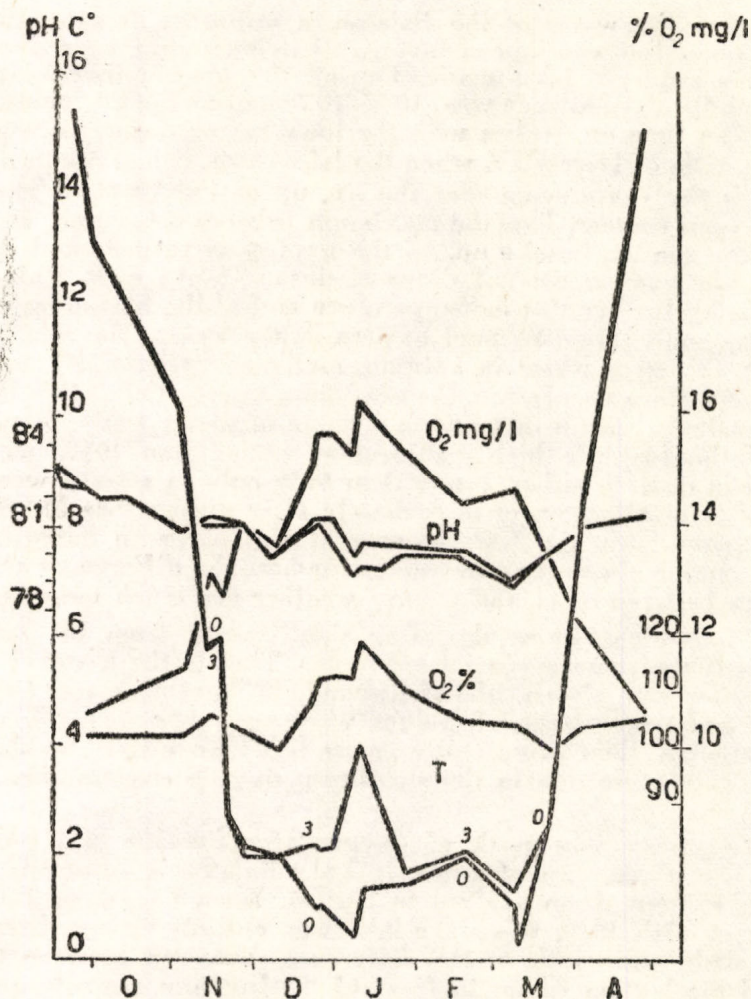


Fig. 1. Changes in temperature, pH and dissolved oxygen content of the water of Lake Balaton from October 1948, to April 1949, at Tihany in front of the Biological Research Institute at 250 m from the shore. The pH graph (7.8—8.4) here and there consists of a double line, when there was an appreciable difference in the values measured at the same time and place between surface and bottom. The double line represents the outside values. The double line of the temperature graph T (16—0° C) expresses the difference on November 19, but especially from December 14 to March 13, again between surface (0 m) and bottom (3 m). Where there is a single line no difference in temperature could be observed between surface and bottom. The O₂ content is expressed in mg/l (10—16) and in %sat saturation.

DISSOLVED OXYGEN CONTENT

Determination of the oxygen content of the water was made by MAUCHA's method (1945). As MÜLLER (1929), MALDURA (1931), CSEGEZY (1938), DOBY and JACZÓ (1939), SZABÓ (1930), and other investigators

have shown, the water of the Balaton is saturated or super-saturated with oxygen. But continuous investigations extending over the whole year have not yet been made. During the present investigation the amount of dissolved oxygen was 10.5–10.7 mg/l at the beginning of October. From then on, it rose with the lowering of the temperature, and by the middle of December, when the lake froze, it had attained 13–14 mg/l. This rise continued under the ice, up to 15–16 mg/l. The maximum oxygen content, like the maximum relative saturation, is reached just before the ice breaks up. As the ice begins to melt and then disappears, the oxygen content drops again to 13–14 mg/l. This continues with the further rise in temperature and at the beginning of April there was only 11–12 mg/l oxygen in the water. The relative saturation in the open water in autumn, oscillated between 93 and 107%. When the surface was frozen, the saturation rose to 120–125% but after the ice melted it again dropped to a value of about 100%. Generally in front of the Institute higher saturation values than 103% were only obtained in quiet weather, lower than 99% only in stormy weather, in violently agitated water, or immediately after storms. (See SZABÓ l. c. p. 492). Apparently in the Kút the current also plays an important part in the formation of oxygen saturation, for here the differences appearing elsewhere between quiet and stormy weather are much more indistinct.

I found conditions deviating significantly from the saturation values, only under quite special conditions. Thus in the Kis-öböl — near the shore — large shoals of fish assemble in November and December. In their midst the saturation values were very low (85–50, or even 30%). But here there were really „more fish than water“, so that these extreme values are due to the significant oxygen consumption of the fish.

We can scarcely speak of oxygen stratification in the different depths. The whole mass of water in Lake Balaton is uniformly saturated with oxygen, from surface to bottom. From December 14th 1948, to January 13th 1949, when the lake was entirely frozen there developed a slight stratification; the difference, however, between the surface and the bottom values in front of the Institute, scarcely amounted to 0.1–0.8 mg/l of oxygen. After the ice began to break up here and there, but in water samples taken from under the ice, more oxygen occurred near the bottom than on the surface. After the final melting of the ice, the oxygen distribution became again completely uniform. On two occasions less oxygen was found in the Kút near the bottom than on the surface. This, however may be considered a merely transitory state of affairs, because while, for example, the oxygen distribution observed on November 11 was on the surface: 11.52 mg/l=100%, and on the bottom 10.84 mg/l=93.6%, the following day there was again a completely uniform distribution. But all these divergent values in respect to depth differ so little from one another, that they can have only the very slightest effect or none at all on the depth distribution of the living organisms.

Measurement of diurnal variations were made twice, on March 12–13th, in a lively storm in cloudy weather and on April 6–7th, in quiet sunny weather. On both occasions the collections were made every 4 hours and the water samples were taken from the surface. The diur-

nal variation was less in stormy weather than in the quiet, sunny weather (See Figure 4). In both cases the oxygen content decreased from 10 to 14 hrs. and mounted in the afternoon from 14 to 18 hrs. From 18 hrs until morning in quiet weather there was a gradual decrease, whereas in stormy weather after 22 hrs at night a slow increase set in. In quiet weather in the open water with less diurnal change there was on an average less oxygen present than in the Kis-öböl at the same time. There, at a distance of 4—5 m from the shore, with greater changes, the values fall between those obtained in the open water and in the reed. The most extreme values were obtained among the broken stubble of last year's reed, thickly overgrown with the organism which live in its coating. Peak values in all three collection places were obtained at 18 hrs. in quiet weather. The daily variation values reached, and even exceeded the differences existing between the different depths at the same times and places.

LIGHT CONDITIONS

We have at our disposition a number of literary data on the light-transmitting capacity of Balaton water, from different periods. A good part of these are no more than measurements with a Secchi disc. The other more accurate measurements were all made in July and August (GÄRTNER, 1929, LUDÁNY-PÁTER, 1929, ULLYOTT and KNIGHT, 1938). All the investigations showed, that the water of Lake Balaton is very turbid and its transparency can change radically in a very short time — primarily on account of the wind — so that the light conditions in the lake are exceptionally variable. This circumstance and the further one that light is an essential factor in water habitats, makes a detailed study of the problem desirable (BIRGE and JUDAY, 1933, SAUBERER, 1941, UTTERBACK, 1941, BURR, 1941). I myself approached the question in several ways. I measured the transparency with a Secchi disc, I also determined the turbidity indirectly with a Pulfrich photometer, and recently began investigations with the photoelectric method.

The transparency values as measured with the Secchi disc, from the end of September to the end of November varied between 70—170 cm in a wind of less than 4 m/sec. Between November 19 and 22 there were three completely windless days. The transparency then reached almost 200 cm. A violent storm which followed, on November 24, again reduced the transparency to 20—30 cm. The values measured at other similar times of severe storms likewise moved around 20—30 cm. In the winter under the ice there was a constant, gradual sedimentation of the floating particles. The transparency thus gradually increased and on January 13 in front of the Institute extended to the bottom, (275 cm) and in the Kút at the same period, was 354 cm. After the ice broke up, the transparency again diminished. This decrease was especially striking at the beginning of April, when during 5—6 days of almost completely windless weather the water kept a milky turbidity and the transparency never rose above 40—60 cm.

Parallel with this I began measurements similar to GÄRTNER's (1929) with a Pulfrich photometer. In this investigation I worked up the samples within one or at the most two hours, and to avoid as far as possible the settling of the sediment, reversed the bottles several times

every 15–20 minutes. Contrary to GÄRTNER (1929:187) I guarded against a „thorough shaking“, as it is my experience that, especially in very turbid water, where there are large floating particles, the particles themselves are thus shaken to bits and we get a significantly greater turbidity than the actually existing one (e. g. a 5% transparency instead of 20%). I used a 5 cm long cuvette for the measurements and distilled water as comparative fluid. I also used a yellowish-green filter for the measurements. (No. S. 57 Zeiss). The results are percentage values, which express what quantity of light progresses through the water under investigation, as compared with distilled water. The values obtained are approximately identical with the Secchi disc data (Figure 2).

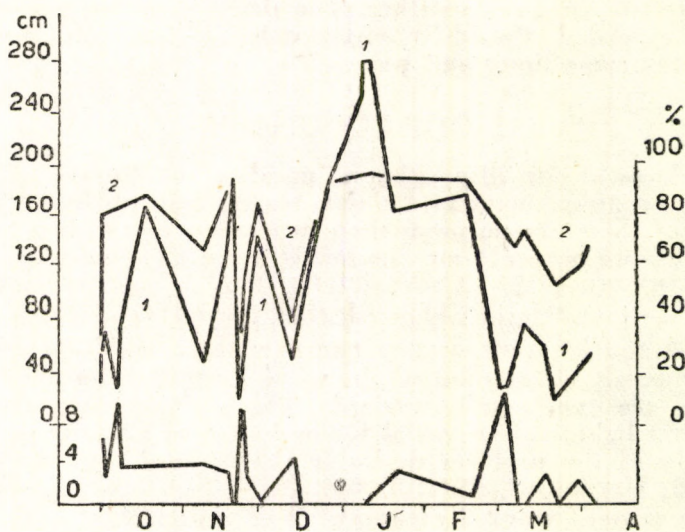


Fig. 2. In Graph 1 appear, in cm, the transparency values as measured with a Secchi disc. In Graph 2 are given the transparency values as measured with a Pulfrich Stepphotometer. The curve at the bottom shows the wind force measured at collecting time, in m/sec. On windless days and, naturally, under the ice the wind force was 0, so the curve falls within the abscissa axis.

In quiet autumn weather the surface transparency varied between 80–88%, in winter under the ice in consequence of the constant settling, it rose to 96% decreased again in spring, so that at the beginning of April, even in quiet weather, it was only 60–80%. From the surface to the bottom in quiet autumn and winter weather the transparency normally decreased by 1–3%, more rarely by 7–8%, but in spring, during the greater turbidity, 20 and even 30% differences in transparency were obtained between surface and bottom. That floating particles subside in spring much more slowly is probably due — aside from chemical conditions — to the strong vertical current arising in consequence of the difference in density of the various layers, caused by the vigorous warming up in the daytime and extreme cooling at night, which constantly stirs the water up. In storms, during the whole period of the investigation, the transparency was 15–20%.

A good deal of the particles which cause the turbidity dissolves in diluted hydrochloric acid. (MÜLLER 1929 p. 151). As second measurement in this investigation, I dropped 0.5 ml 10% hydrochloric acid into the samples. The values thus obtained were higher than the results obtained with the original samples by 5–15% in quiet autumn weather, 1–5% higher than in winter under the ice, 20–30% higher in quiet spring weather, and in general during storms 30–50% higher. In the samples treated with hydrochloric acid the transparency decreases from surface to bottom by 1–4% in the autumn and by about 10% in the spring.

I will not digress here to the photoelectric measurements begun in the spring, but will discuss them in a later publication.

I carried out several sedimentation experiments during storms (Figure 3). From these it appears that the settling of floating particles, given identical turbidity, is the same in November, March and May. Thus, with an initial transparency of about 20%, it increased to 52–65% in 2 hours, 64–73% in 4 hours, 74–82% in 8 hours, 70–86% in 12 hours, and after 24 hours' settling was 86–90%. Hence the distribution as to size of the floating particles agrees, largely speaking in all these samples.

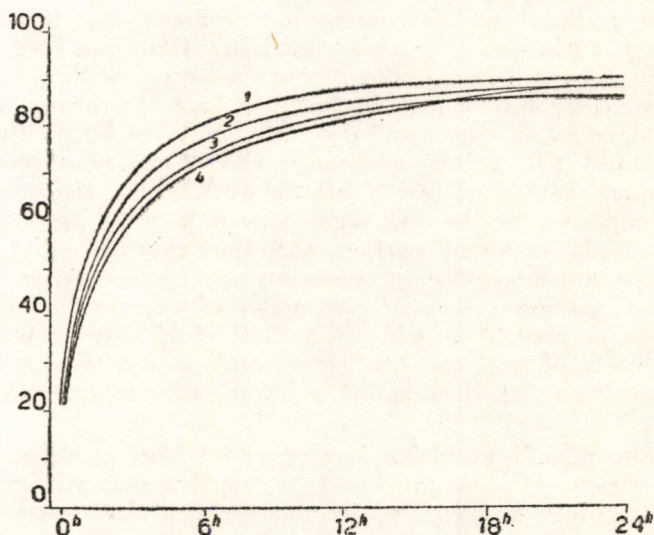


Fig. 3. Results of the sedimentation experiments. The curves show the %/cm values at the different times, measured with a Stepphotometer. Date of samples: 1. 10–5–1949; 2. 25–11–1948; 3. 5–3–1949; 4. 24–11–1948.

pH CONDITIONS

pH determinations were made by the MAUCHA method (MAUCHA, 1940, 1945). I myself modified this method slightly. I made two measurements, during which I changed the eprouvettes used for comparison. I took the mean value of the two measurements as final result. This was necessary because the diameters of the different eprouvettes, the

thickness of their walls, differences in shade, etc., affect comparisons of colour differently. Thus there were differences amounting to as much as 0.1 pH units in the same samples. On the other hand, by twice measuring the water sample, using several different eprouvettes, the mean value obtained showed at most a difference of 0.01—0.02 pH unit. Besides this I measured the pH with a Pulfrich photometer and a Sonntagh electric pH measurer. But in the present investigations the MAUCHA method proved the most suitable, for speed and accuracy, and is also best for field investigations.

Several particulars as to the pH of Balaton water are given in the literature. MÜLLER got a pH of 8.62 in the open water (1929:151) DOBY and JACZÓ found pH values between 7.8 and 8.9 in the littoral during investigations made only in the favourable season (1939:33). According to later measurements (MAUCHA, SEBESTYÉN, verbal communications) the pH value varies to some extent throughout the year. It likewise varies throughout the day (MALDURA, 1931).

From the present investigations it was found that the pH of the water of the Balaton continuously decreases from autumn until the beginning of March, till the disappearance of the last ice covering, with some relapses (September 27th pH=8.37, March 12th pH=7.88) and from then on again gradually rises (April 6 pH=8.13). (See Figure 1). The close parallel which appears between seasonal temperature variations and pH changes is interesting. Thus, until the first half of November both decrease decidedly. From then on, with relatively small variations, we find low values in both, in fact the lowest temperature and pH data occur on the same day, March 12th. From then on, both temperature and pH values gradually rise. Another interesting relationship, when there was a fairly strong and lasting temperature stratification forming under the ice there was a parallel, fairly significant difference in pH between surface and bottom (0.05—0.11 pH units). This is all the more worthy of mention as under experimental conditions a rise in temperature of the water of 10 or even 30° C never caused a greater change in pH than 0.01—0.02 units, which is still within the limits of experimental error, and only a rise in temperature of 40° C caused an appreciable (0.1 pH unit) difference (using MAUCHA's method).

The diurnal pH variation in stormy weather at the end of March was almost completely insignificant (0.03 pH unit), whereas on April 6th, in quiet, sunny weather, at the same place there was a difference of 0.11 units, in the values measured. On this occasion a close connection was shown between the amount of dissolved oxygen and the pH (See Figure 4), a phenomenon similar to which was also observed by CZERNY (1948:48).

It is possible that the seasonal changes in the transparency of the water of the Balaton are also connected with the seasonal pH variations. (MESCHKAT, 1934 p. 442). Sedimentation tests showed, that if I reduced the pH of settling turbid water from 8.1 to 7.8 by adding diluted hydrochloric acid to it, there was no significant change in the speed of sedimentation. But on further acidification to pH 7.4, the sedimentation was definitely accelerated. More detailed investigation is necessary however, to clear up this question.

I also determined the dissolved organic contents by MAUCHA's method (1945). They showed that the oxygen consumption of the organic material gave values between 1.575—3.23 O_2 mg per liter, the mean value being about 2.5 mg. The values changed constantly, now dimin-

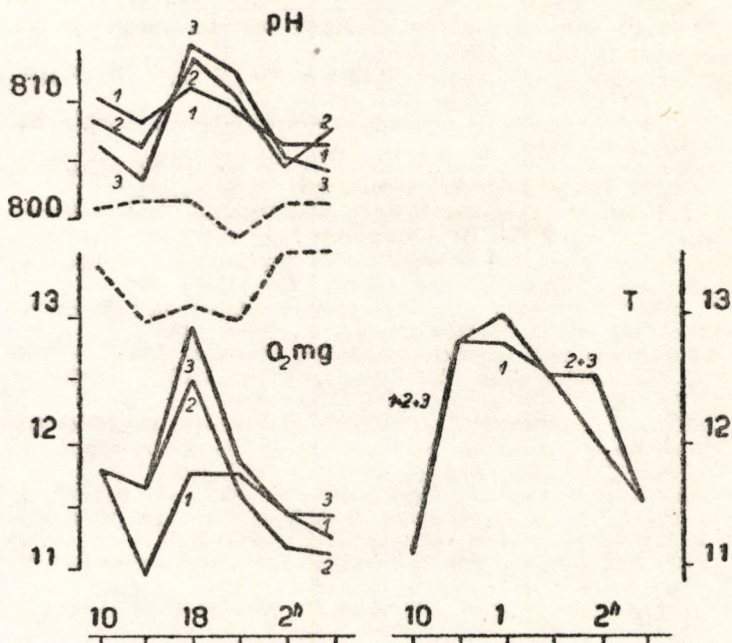


Fig. 4. Graphs showing the pH, O_2 (mg/l), and temperature ($^{\circ}$ C) data obtained in diurnal investigations on April 6—7, 1949 and March 12—13. 1. Open water, 2. Interior of Kis-öböl, 3. Last year's reed.

ishing, now increasing according to depth and it was impossible to show a possible relationship with other factors (see Table I.).

Continuation of the investigations and their extension to other important factors, as well as knowledge of their closer relationship to the biology of living organisms, is a task for the future.

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НЕКОТОРЫЕ ФИЗИЧЕСКИЕ И ХИМИЧЕСКИЕ УСЛОВИЯ ВОДЫ ОЗЕРА БАЛАТОНА; ИССЛЕДОВАННЫЕ С СЕНТЯБРЯ 1948 г-а ДО АПРЕЛЯ 1949 г-а

(Температура; прозрачность; содержание кислорода; pH и органические вещества)

Автор: БЕЛА ЭНЦ

РЕЗЮМЕ

С осени 1948 года до весны 1949 года я исследовал температуру, прозрачность, pH, содержание кислорода и органических веществ воды в глубине 3 м., около восточного берега полуострова Тихань и в глубине 10 м у „Кут“-а. Я ставил себе задачу, установить определенные сезонные изменения или-же изменения соответствующие разным глубинам, а также установить связь между различными факторами.

Вода озера от поверхности до дна являлась насыщенной или перенасыщенной кислородом. Минимум был 93% максимум 126%. Насыщение достигло наименьшую степень во время бури а большую степень в тихую погоду. Самая высокая степень насыщения встречалась зимой, под льдом.

Прозрачность, начиная с осени (70—170 см. Secchi-диск, 80—88% на фото-метре Pulfrich-а) постепенно увеличивалась и достигла наивысшую степень под льдом (354 см., 96%). Весной, когда вода стала более теплой, прозрачность резко уменьшилась (40—60 см., 60—80%). Большая часть пловучих частиц, являющихся причиной мутности растворяются в разбавленной соляной кислоте.

Путем небольшой модификации метода определения pH пригодного и в полевых условиях мы могли определить pH с точностью ± 0.015 .

pH постепенно уменьшился с 8,38 (сентябрь) до 7,88 к концу зимы. В начале апреля, когда вода стала более теплой pH опять поднялся до 8,10—8,15.

В общем pH изменился в прямой пропорции с температурой, а прозрачность и содержание кислорода изменились в обратной пропорции с температурой.

TABLE I.

Changes in transparency, pH, and organic matter content of Balaton water from Sept. 27, 1948 to April 2, 1949.

Date	Wind m/sec.	Transpa- rency Secchi disc.	Transparency with 0/0 in natural cond				Stufen photometer 0/0 with HCl				pH					Organic substance			
			0	1	2	2.75	0	1	2	2.75	0	1	2	2.75	3	0	1	2	2.75*
27. 9	4.5	72	80	79	76.5	75	93	91	90	90	8.37	8.38	8.37	8.34					
28. 9	2.1	97.5	87	85	82	79	95	94	92	93	8.27	8.28	8.26	8.25					
29. 9	1	130	86.5	85	85	81	95	94	94	93									
1.10	6.4	30	24	23	23	19	57	56	56	57									
2.10	2.0	72	81	77	75	73	86.5	86	85.5	85									
8.10	9.0	20					56				8.22								
9.10	3.3	74	84	85	84	84	91	92	91	91	8.20	8.20	8.20	8.20					
19.10	2.2	170	88	88	88	82	93	92	91	92	8.20	8.20	8.20	8.20					
10.11	3.7	45	64	64	63	60	87	87	87	86	8.08	8.08	8.08	8.08					
19.11	3.0	125	87	85	83.5	81.5	92.5	92	92	93	8.13	8.13	8.10	8.10					
22.11	2.0	192	88.5	87.5	88	86	94.5	92	92	93	8.13	8.12	8.10	8.10					
25.11	8.0	20	19	19	19	19	59	59	59	59	8.10	8.10	8.0	8.10					
26.11	2.2	50	56	56	55	53	83	85	84	80	8.10	8.10	8.10	8.10					
1.12	0.0	145	86.5	86	84.5	84.5	94.5	94	92	90	8.10	8.10	8.10	8.10					
14.12	4.5	50									7.98	7.98	7.98	7.98	8.04				
27.12	—	185	91	91	90	90	96	95	94	94	8.10	8.11	8.10	8.10					
29.12	—	195	91.5	91	90	90	96	96	96	94	8.10	8.10	8.11	8.11					
3. 1	—	215	95	92	91	90	99.5	97	96	95.5	8.03	8.10	8.11	8.09	8.10				
10. 1	—	250	96.5	94.5	90.5	90.5	97	96	96	94	7.91	7.97	7.98	7.98	8.02				
13. 1	—	275	96.5	96.5	94.5	94	99	98	97	95.5	7.95	8.01	8.03	8.02	8.06	3.12	2.74	2.74	2.74
22. 1	3.0	160	94	91.5	92	89.5	95	95	96	94	8.00	7.95	7.97	8.03		2.76	2.49	2.29	
19. 2	1.0	140	92	92	89.5	89	96.5	95	94	93.5	7.99	7.98	8.01	7.99	7.96	1.58	1.58	1.58	1.66
5. 3	11.0	20	20				68.5												
9. 3	—		66	55	38.5		87	81.5	71.5		7.90	7.88	7.88		7.68				
12. 3	—	75	73	71	72	71	89	88	88	87	7.91	7.93	7.92	7.92	7.96	2.69	2.84	3.00	3.07
23. 3	0.0	40	50	46	42		81	79	80	71	8.01	8.00	8.00	8.00		2.71	2.33	2.33	3.08
2. 4	2.0	43	58	56	56	56	82	81	81	81.5	8.07	8.07	8.07	8.06	8.04	2.24	2.31	2.54	2.61

* depths of water in m

TABLE II.

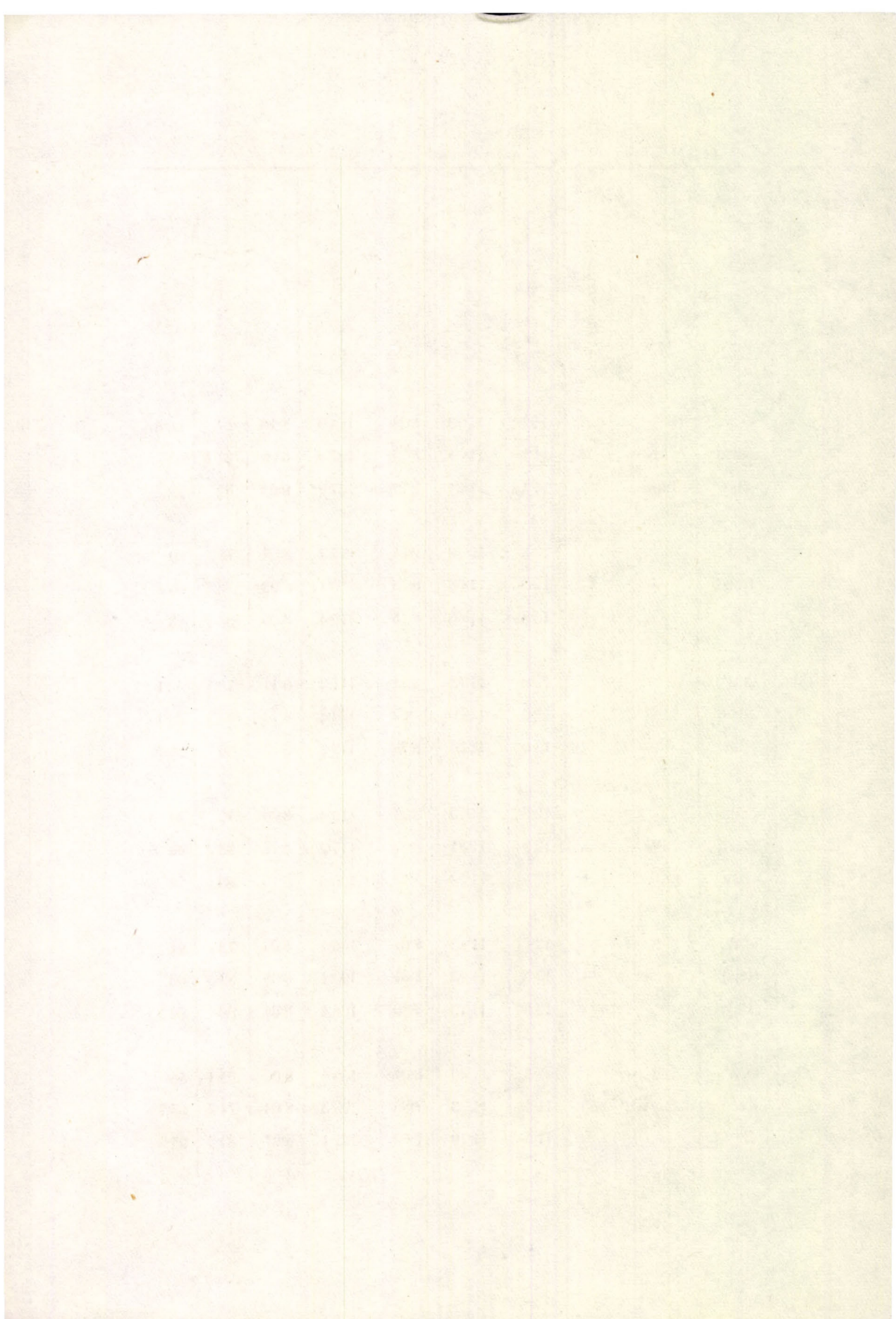
Changes in temperature and oxygen saturation of Balaton water, September 27, 1948 to April 2, 1949.

Date	Wind m/sec.	Temperature °C					O ₂ mg/l					O ₂ % saturation.				
		m 0	1	2	2.75	3	0	1	2	2.75	3	0	1	2	2.75	3*
27. 9	4.5	16.5	16.4	16.4	16.4	16.4										
28. 9	2.1	16.9	16.9	16.8	16.7	16.7										
1.10	6.4	15.7	15.7	15.7	15.7	15.7										
2.10	2.0	15.6	15.5	15.4	15.2											
9.10	3.3	13.2	13.2	13.2	13.2		10.54	10.60	10.70	10.60		101.1	101.4	102.3	101.4	
19.10	2.2	13.2	13.0	12.8	12.6											
10.11	3.7	10.2	10.2	10.1	10.0		11.36	11.36	11.36	11.36		101.3	101.3	101.3	101.3	
19.11	3.0	5.9	5.9	5.8	5.8		13.22	13.10	13.16	12.99		106.3	105.3	105.5	104.3	
22.11	2.0	6.0	5.9	5.9	5.9											
24.11	9.0	6.0	6.0	6.0	6.0		12.70	12.70	12.70	12.70		102.8	102.8	102.8	102.8	
26.11	2.2	2.6	2.7	2.7	2.7		13.47	13.47	13.47	13.47		99.4	99.4	99.4	99.4	
1.12	0.0	2.0	2.0	2.0	2.1	2.8	13.67	14.42	13.98	14.17		99.3	104.7	101.5	103.1	
14.12	4.5	2.0	2.0	2.0	2.0		13.63	13.57	13.57		13.45	99.0	98.6	98.6		97.7
27.12	—	1.0	1.4	1.4	2.2		15.26	15.14	15.02		15.08	107.8	108.1	106.7		111.4
29.12	—	1.1	1.2	1.5	2.1	2.1	15.94	15.94	15.44	15.24	13.76	112.7	113.2	110.6	111.0	100.2
3. 1	—	0.9	1.4	1.5	2.0	2.1	16.13	15.79	15.60	15.30	15.34	113.6	112.8	110.9	111.9	116.0
10. 1	—	0.5	2.2	2.8	3.3	3.5	14.60	15.42	15.50	15.71		101.7	112.6	115.0	118.1	
13. 1	—	1.4	1.5	2.0	3.6	4.0	14.79	16.78	16.40	16.70	16.09	105.5	120.0	119.1	126.5	123.2
22. 1	3.0	1.7	1.6	1.6	1.6	1.6										
29. 1	—	1.5	1.6	1.6	1.6		15.69	15.35	15.00	15.38		112.3	110.0	107.7	110.4	
19. 2	1.0	2.0	2.1	2.1	2.1		14.15	14.52	14.52	14.15		102.8	105.7	105.7	103.0	
9. 3	—	1.1	1.2	1.2			14.39	14.84	14.58			101.9	105.1	103.8		
12. 3	—	0.4	0.5	1.0	1.4	1.6	14.43	14.73	14.47	14.62	14.62	100.2	102.6	102.2	104.4	104.9
23. 3	0.0	3.1	2.9	2.9	2.8	2.7	13.35	13.42	13.27	13.35	12.65	99.8	99.8	98.7	99.0	93.6
2. 4	2.0	8.2	8.2	8.2	8.1	7.9	12.15	12.19	12.14	12.12	11.74	103.6	104.0	103.5	102.9	99.3

* depths in m.

TABLE III.
Measurements of diurnal variations, April 6—7, 1949.

Time of collection	Place of collection	Direction and velocity of wind	Transparency Secchi disc	Temperature	O ₂ mg/l	O ₂ ml/l	O ₂ % saturation	pH	Transparency Pulfrieh	
									natural cond	+ HCl
10hr	O.W.			11.1	11.73	8.21	106.9	8.10	67	88.5
	Reed	N	55	11.1	11.81	8.27	107.9	8.06	81.2	93
	Bay	1m/sec		11.1	11.81	8.27	107.9	8.08	82	93
14hr	O.W.			12.8	10.90	7.63	103.2	8.08	78	89
	Reed	—	60	12.8	11.68	8.18	110.7	8.03	76.7	90.8
	Bay			12.8	11.65	8.15	110.4	8.06	82.7	93
18hr	O.W.			12.8	11.73	8.21	111.2	8.11	78.7	92.1
	Reed	—	55	13.0	12.89	9.02	122.8	8.14	84.2	93.1
	Bay			13.0	12.56	8.79	119.6	8.13	84	94.75
22hr	O.W.			12.5	11.73	8.21	110.4	8.09	72	92
	Reed	SW	—	12.5	11.81	8.27	111.2	8.12	83.2	93
	Bay	4m/sec		12.5	11.64	8.15	109.6	8.10	89	98
2hr	O.W.	S		12.0	11.43	8.01	106.5	8.06	73	91
	Reed	1m/sec	—	12.5	11.43	8.01	109.1	8.05	83	95
	Bay			12.5	11.15	7.80	106.4	8.04	89	96.5
6hr	O.W.	S		11.5	11.40	8.04	105.6	8.06	65.1	88
	Reed	3.5m/sec	50	11.5	11.23	7.86	103.3	8.04	74.2	88.7
	Bay			11.5	11.10	7.69	101.1	8.07	85.5	95.5



AUTUMN AND WINTER SHOALS OF FISH IN THE SHORE ZONES OF LAKE BALATON IN 1947—1949.

BY

BÉLA ENTZ

From the Hungarian Biological Research Institute, Tihany, Lake Balaton

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With 10 Figures and 4 Tables in the text.

APPEARANCE OF THE AUTUMN SHOALS

According to numerous observations, fishery data and the information of LISSMANN (1933:86—92), in the autumn in sheltered places along the shores of Lake Balaton, chiefly in bays and among the reed, immense shoals of fish, consisting of many hundred thousands, assemble. I made a study of such gigantic shoals from October 1947, to January 1948 and from November 1948, to January 1949. The investigations were made at Tihany in the Kis-öböl bay, near the Biological Research Institute and in its immediate neighbourhood.

The first large shoals, consisting according to my observations almost exclusively of bleak (*Alburnus lucidus*), appeared in the middle of October 1947. This was in quiet weather, at about 5—15 m from the shore. They passed in a 5—10 m wide band parallel with the shore. At evening in quiet weather the noise of the masses of little fish in these shoals, jumping out of the water and falling back again, could be heard at a distance of 200 meters from the shore. At the end of October the shoals disappeared and reappeared towards the end of November, but this time in the bay, directly along the shore. The immense shoal remained sluggishly, in one place more or less, and the fish no longer jumped out of the water. It settled down in the midst of a cca 15×15 m patch of reed at the entrance of the Kis-öböl and in the about 80—120 cm deep sheltered water behind it. In this area the water seemed quite black from above owing to the millions of small fish swarming there. The shoal disappeared during storms but in quiet weather reappeared at the same place. The fish stayed in this area, with short interruptions, constantly in large quantities, until the lake froze.

From the end of November 1948, until the middle of December the situation was exactly the same as it had been the previous year.

In spite of its constant presence, the appearance of the shoal slowly but constantly changed, as many fish wandered away from it and other new ones joined it, so that the whole immense mass formed a dynamic rather than a static unit. Between November 20—30 1948, the huge shoal was composed almost exclusively of bleak. Between December 4—12 great numbers of bream had joined it (chiefly *Abramis brama*, *Scardinius erithrophthalmus* and *Leuciscus rutilus*). But after December 12th, with the disappearance of the other species, the whole again consisted almost exclusively of bleak. By the time it froze, December 14th, the number of bleaks had also greatly diminished and only a few

hundred specimens swam about under the ice in small groups in place of the immense autumn shoals. Under the ice at several kms from the shore I observed mighty shoals of bleak but after the ice melted they all dispersed and new ones appeared at spawning time only.

The purpose of the investigations was to get an insight into the life conditions of the great shoals. That is, to ascertain their composition as to species, the sizes and ages of the different species; to make observations on the distribution of the shoals and their structure, and to study the time of their formation, duration, disappearance.

METHODS

The collections were made partly from the shore, partly from a boat. A net of about 40 cm diameter was used for collecting, which on

Fig. 1.

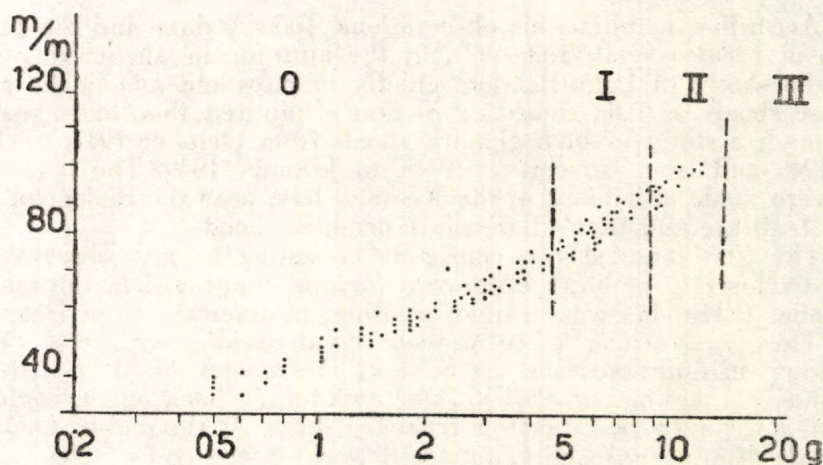
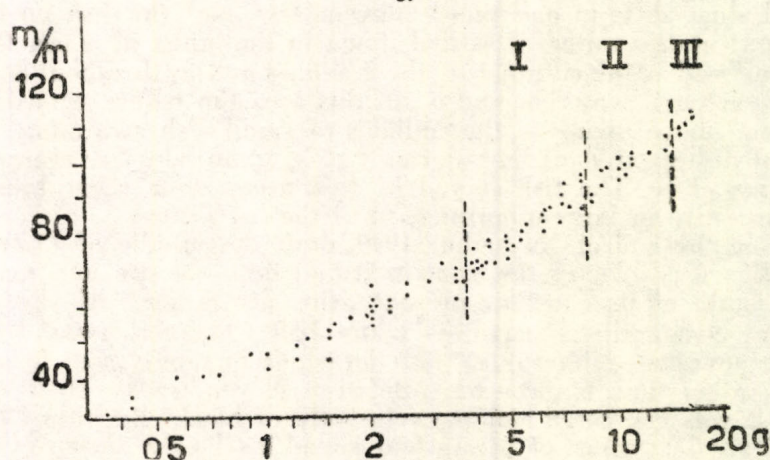


Fig. 2.



Figs. 1 and 2. Ratio of standard length (mm) and weight (g) of bleak for 1947/48 (Fig. 1) and 1948/49 (Fig. 2). The different age groups are indicated by the broken vertical lines. O = fry of age group O, I = two years, II = three years, III = four-year old specimens.

Fig. 3.

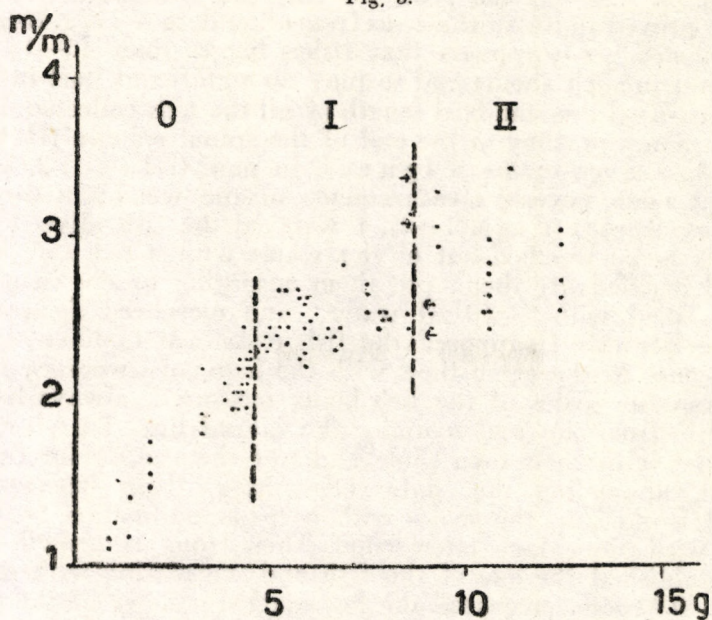
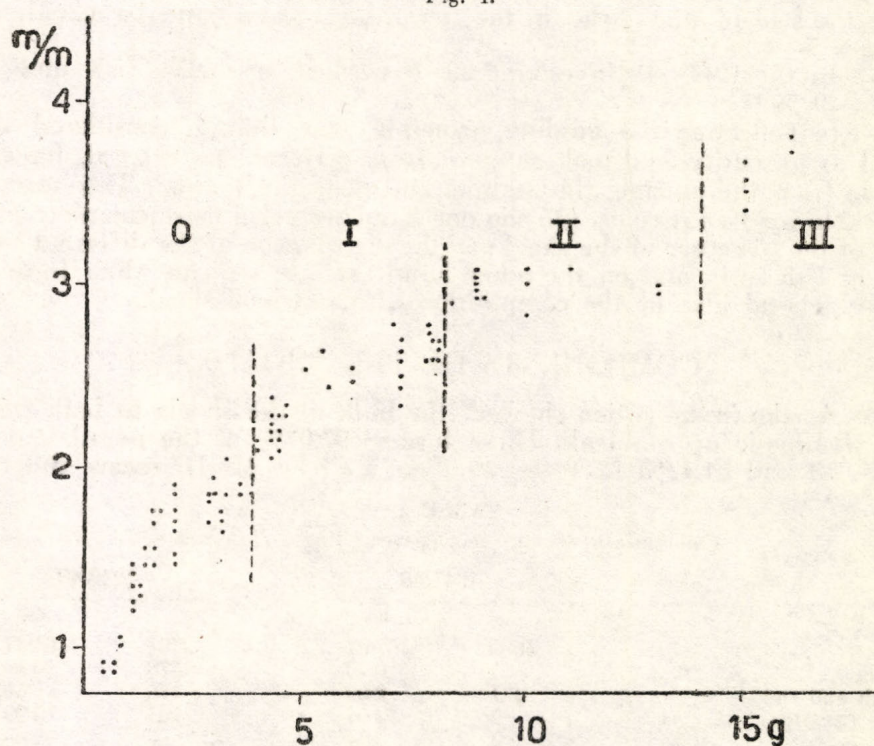


Fig. 4.



Figs. 3 and 4. Ratio of weight (g) of bleak and horizontal diameter (mm) of scales. The age groups are indicated as in Figures 1 and 2. The specimens marked with arrows do not belong to the group where they appear, but to the next one. All data are averages calculated from several scales. Figure 3 is for 1947/48, Figure 4 for 1948/49.

account of its size was not good for catching fish larger than 25–30 cm. Yet it proved quite suitable, as from other data — e. g. fishing with finemeshed nets — it appears that fishes bigger than 15–16 cm are rarely found in such shoals and so play no significant part in them.

I measured the standard length of all the fish collected, i. e. from the closed mouth-opening to the end of the spinal column (HUGH, 1942). This length is given in the Figures, in mm. (Figs. 1, 2, 5–9). Besides this I made several measurements of the weight in each group, arranged by length. (Figs. 1–2). I weighed the fish alive. I took the individuals to be weighed out of the water with a net and, after the water had trickled off them, put them according to size in a measuring vessel filled with 5–50 ml water, and measured them according to volume. For this I supposed the fish examined to have a specific weight of one. At the same time with the help of tweezers I took a sample from the scales of the fish being measured, always behind the pectoral fin, from the region under the lateral line. I pasted the scales on paper with their own slime and put them aside for further investigation, appending the data concerning them (species, length, weight). I worked up the scales with a 20×magnification by transillumination with binocular microscope. Then from its growth rings (annuli) I established the age of the fish and, measuring with an exactitude of ± 0.02 mm, measured the horizontal diameter of the scale and the growth of previous years as shown by the rings. From the latter data the size of the fish in the preceding years can be calculated (Figs. 3–4).

In the 1947–48 investigations I worked up 4834 fish and in 1948–49 5093.

In collecting the guiding principle was that I considered the shoal as an entity and took samples from different parts of it, for example from the outside, the middle, and near the bottom. This seemed desirable for two reasons. On the one hand we get a more complete picture of the structure of the shoal and the distribution of the different species of fish in it, and on the other hand because we can thus form a fairly general idea of the composition of the whole shoal.

COMPONENTS OF THE SHOALS

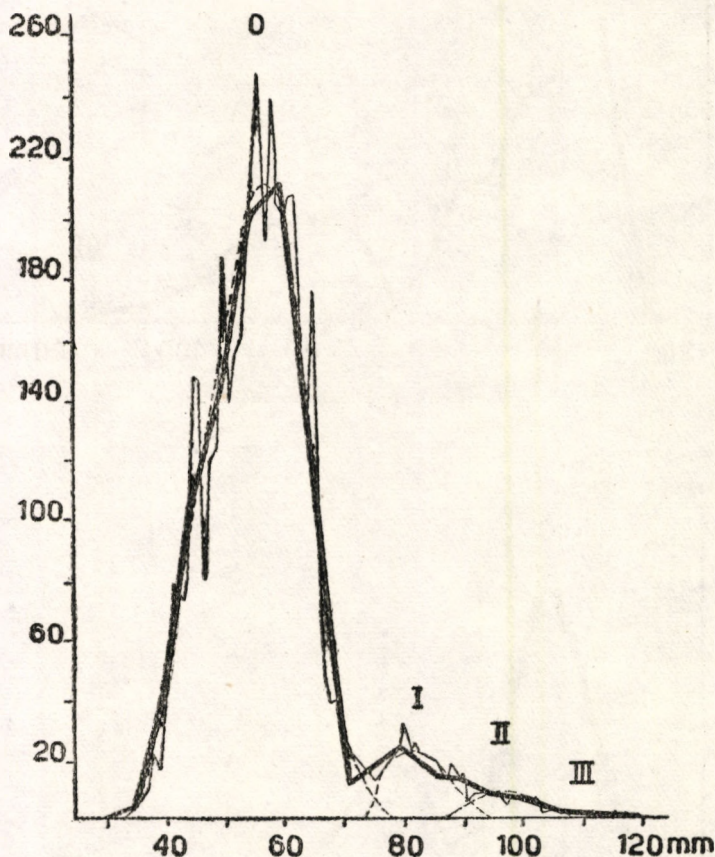
As the investigation showed, the bulk of the shoals in both periods was made up of bleak. These formed 97.07% of the population in 1947–48 and 61.47% in 1948–49 (See Table I). It seems that in

TABLE I.
Components of the shoals, according to species.

	1947/48		1948/49	
		%		%
Bleak	4680	97.07	3131	61.47
Bream	33	0.70	1578	30.98
Roach and rudd	101	2.09	178	3.50
Pope (Acerina)	2	0.04	203	3.99
Rhodeus	2	0.04	—	—
Aspius	3	0.06	2	0.04
Perch	—	—	1	0.02
Total	4834	100.00	5093	100.00

1947—48 the rôle of the other species was quite subordinate to the predominating majority of bleak. The roach (*Scardinius erithrophthalmus* and *Leuciscus rutilus*) predominated in the minority species (101 specimens=2.09%) while at the same period there were only a few specimens of bream (*Abramis brama*). Of other species there occurred only sporadic *Acerina cernua*, *Rhodeus amarus*, *Blicca björkna* and *Aspius rapax*. The shoals had a relatively more varied composition in 1948—49. Besides the bleak there were bream in considerable numbers (*Abramis brama* among them now and then *Blicca björkna*), with about 1570 specimens (31%), roaches (*Scardinius erithrophthalmus* and *Leuciscus rutilus*) 178 specimens=3.5%, and *Acerina cernua*, 203 specimens=4%. It was interesting to note that in both seasons there was a remarkable lack of predaceous fishes. Among almost 10,000 fish there were only 5 young *Aspius rapax* of the first growing season (age group O) and one perch (*Perca fluviatilis*) to represent the predaceous.

Fig. 5—9.

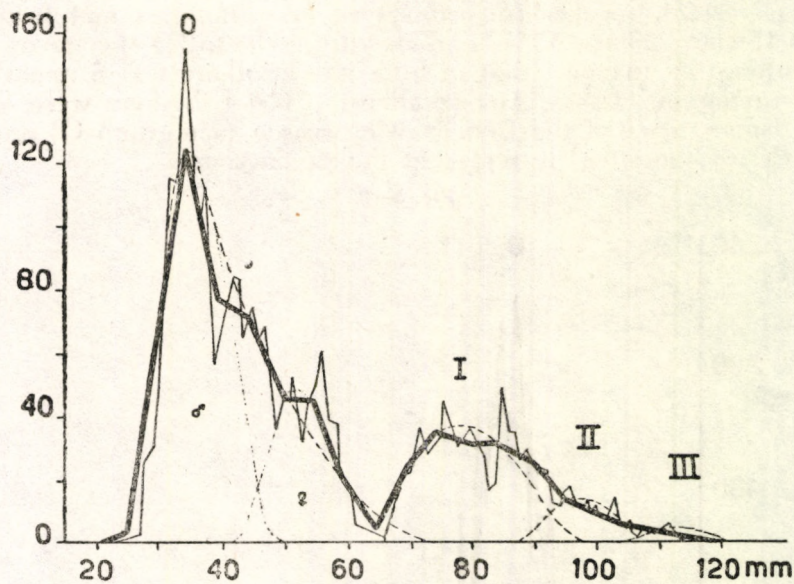


5. Bleak population 1947/48.

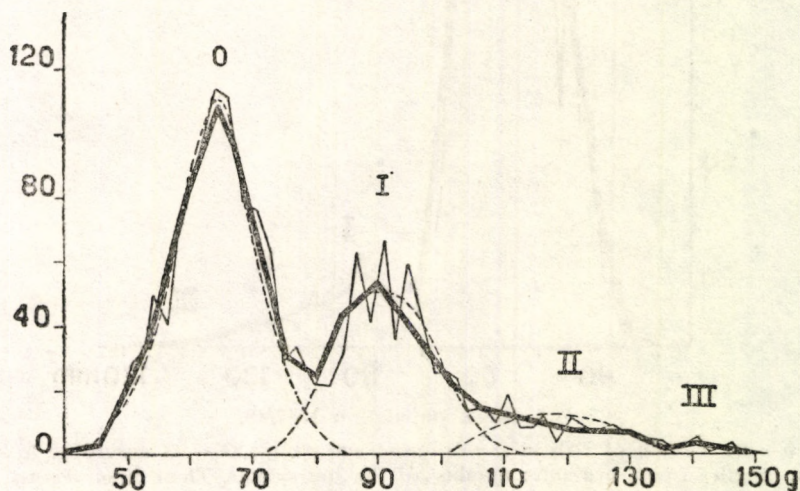
Figs. 5—9. Length of fish in the different age groups O—III according to species. Abscissa: length in mm, ordinate: number of the individuals. Thick line: average values per 5 mm; thin line: average values per 2 mm. Dotted line in Fig. 5 and 6 is the distribution curve of the two biotypes (♀ and ♂) of bleak. For figs. 6—9 see p. 88—89.

If we investigate the age of the fishes in these populations, we find the following: Among the bleak, more than 94% of the individuals were fry of one summer (age group O), there were only 5,5% of second year specimens (=age group I), and the still older comprised scarcely 0.3%. Conversely in 1948—49 more than a fourth of the bleaks were of age group I and there were even 10% of those still older.

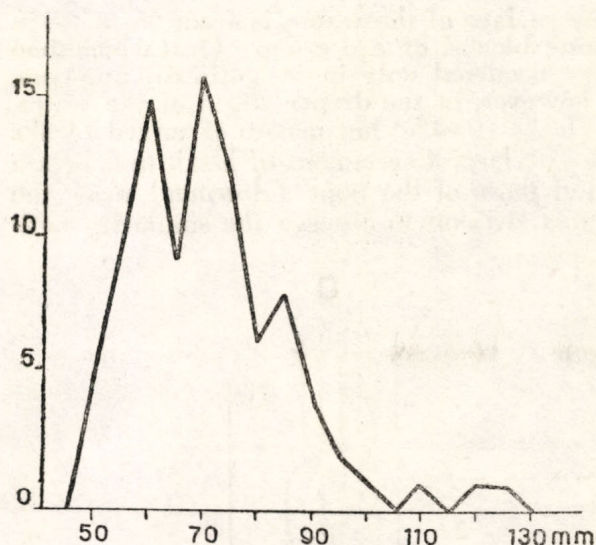
A similar phenomenon was to be seen in the bream. In 1947—48 scarcely 1.5% of the bream were in their second year, all the others



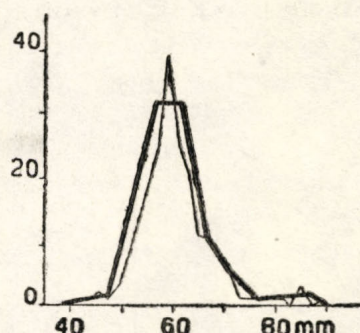
6. Bleak population 1948/49.



7. *Abramis brama* population 1948/49.



8. *Scardinius erithrophthalmus* and
Leuciscus rutilus population 1948/49.



9. *Acerina cernua* population
1948/49.

were young fry of age group O. In 1948—49, on the other hand, nearly half of the specimens examined were more than a year old, in their 2—4 year (=age groups. I. and II.) (Table II).

TABLE II.
Distribution of bleak according to age groups O—III.

1947/48			1948/49	
		0/0		0/0
O	4408	94.2	2016	64
I	258	5.5	814	26
II	14	0.3	246	8
III	—	—	55	2
Total	4680	100.0	3131	100

It is interesting to compare in the December 1948 collections the data for the surface and lower depths of the shoal respectively with those for its interior. It can be seen in Table III that the top of the shoals,

TABLE III.
Distribution of bleak and breams in the shoal according to age groups O—IV and size.

Alburnus lucidus						Abramis brama			
Surface of large shoal	Date	0	I	II	III	0	I	II	III
	XII. 3	138	1	—	—	—	—	—	—
	8	851	1	—	—	—	—	—	—
	14	470	12	—	—	3	—	—	—
Interior of large shoal	XII-4	12	55	14	—	39	162	35	—
	5	17	183	61	14	232	100	13	2
		3	174	61	14	59	53	—	—
Length, mm		25—68	69—91	89—105	106—	40—85	75—110	100—130	130—

at about 20—40 cm below the surface of the water, is from 96 to 100% composed of 32—60 mm young bleaks, of age group O, at which time there were no bream, or they occurred only in insignificant numbers. In the middle of the shoal, however, in the deeper strata of the water, there were very few young bleaks (1—4%) but masses of mixed bleaks and bream several years old. The largest specimens of bleak and bream occurred near the bottom, and those of the pope (*Acerinae*) near the shore (see Figure 10). It was striking to observe the similarity with

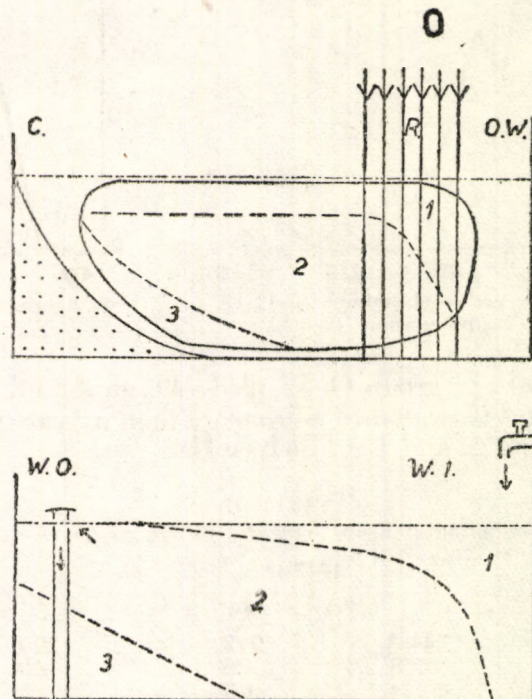


Fig. 10. Disposition of the fish in the bleak population investigated in the Kis-öböl (upper graph) and in the aquarium (lower graph). O W = open water; C = shore; R = reed; W I = water inflow, W O = water outflow, 1 = 1 year bleak, 2 = 1—4 year old roaches (*Abramis brama*, *Leuciscus rutilus*, *Scardinius erithrophthalmus*, etc.)

which the fish arranged themselves within the shoal, both in natural and under experimental aquarium conditions. Thus on December 10th I put into a 50 l aquarium 400 young bleaks, 200 bleaks of two years or more, 100 breams of one and two years, and 30 *Acerinae*. After a few hours the fish took up the positions shown in Figure 1. The levels of the 1 year old bleaks formed a spheroid surface towards the light and the inflowing water, the older ones mixed with the bream were in the middle, and the *Acerinae* in the darkest part (farthest from the water inflow). This was not a transitory situation, but was maintained for several weeks.

Summing up the data on bleak populations in the different collections and grouping them according to year, we get Figures 1—9 and Tables I—IV.

Figures 1—6 and Table IV show that in the average the

TABLE IV.

Relation between age (Groups O—III), diameter of scale, weight and length of bleak. The last column gives the length of the individuals occurring in greatest numbers.

	Scale, diam, in mm		Weight, in gs.		Length, in mm		Maximum in length, in mm	
	1947/48	1948/49	1947/48	1948/49	1947/48	1948/49	1947/48	1948/49
O	1-2-2	0-9-2-1	0-6-4-4	0-3-3-8	31-77	25-71	56	36
I	2-2-2-8	2-1-2-7	4-4-9-0	3-9-8-1	75-95	69-96	80	76
II	2-4-3-4	2-8-3-1	8-5-12-3	8-3-13	89-102	88-106	98	98
III	—	3-4-3-9	22	15-0-18	115	106-116	112	112

bleaks were more developed and larger in 1947—48 (Fig. 5.) than in 1948—49 (Fig. 6). It furthermore appears that the bleaks of age group O are quite distinct in respect to dimensions from those of age group I. The boundary between age groups I. and II. was not so distinct and because of the small numbers of the data the difference between age groups II and III could only be approximated.

Investigating the 1948—49 *Abramis* population (see Figure 7) we find a similar distinction as to size among those of different years. Here too, those of one year are in the majority as compared with the older ones. In the same way the young fry of one year also dominate among the roach (see Figure 8) and the *Acerinae* (see Figure 9).

The few young predaceous *Aspius rapax* occurring sporadically were without exception fry of age group O.

Among all the fish occurring in these immense populations, without respect to species, the young fry of age group O, 3—7 cm in length, dominated. The number of fish of age group I was significantly smaller and the number of those older still decreased still more according to age. There were scarcely more than 250 (2.5%) specimens of three years or more among the nearly 10,000 fish examined.

The length of the *Abramis* and *Acerina* populations gives typical distribution curves (Figs. 7, 9). Thus, for 1948—49 in *Abramis brama* of O years $M=64$ mm, $D=64.5$ mm, $\sigma=13.7$ and $S=0.03$, i. e. the distribution was almost completely symmetrical. In *Acerina cernua* of O years $M=60.06$, $D=60$ mm, $\sigma=6.1$ and $S=0.1$, that is, here too the situation is quite similar.

In the bleak population, especially in the O group, the course of the curves is highly asymmetric. In 1947—48 $M=55.05$, $D=58$, $\sigma=15.47$, and $S=0.1584$. In 1948—49 $M=41$, $D=35$, $\sigma=8.36$ and $S=0.807$. As we know, one of the causes of asymmetry is that the population is not uniform but covers two or more biotypes. According to LISSMANN there is a distinct difference in size between males and females of the same age (LISSMANN, 1933). Taking this and the data of different separate collections into consideration, we can distinguish two biotypes in Figures 5 and 6, which probably express distribution according to sex. The curves of these biotypes are entirely symmetrical and of a structure simi-

* In the data M = means value, D = place of greatest density, σ = standard deviation, μ = standard error, and S = index of symmetry, which is positive if the curve is asymmetric on the right side and negative if asymmetric on the left side (WEBER 1948:86).

lar to the general distribution curves. If we accept the distribution of the sexes according to such biotypes, we get the following values:

	M ♂ mm σ		M ♀ mm σ	
1947—48	44.4	3.48	57.5	12.2
1948—49	35.5	4.15	53	11.6

A significative difference can be established between the two biotypes in the years above. In 1947—48 $\mu=0.565$ and $M \text{ ♀} - M \text{ ♂} = 13.1$. In 1948—49 $\mu=0.7146$ and at that time $M \text{ ♀} - M \text{ ♂} = 17.5$; i. e. the difference in both cases is a statistically significant difference. The separate data for the ♂ ♂ and ♀ ♀ biotypes during the two years was similar, that is, the σ values stood close to one another — only in the first year the whole population was somewhat more developed on the average than in the second year, probably on account of more favourable conditions. From the standpoint of size, besides the great difference apparent between the two years, i. e., the evident difference in development, much can be explained by difference in the distribution of sexes. Naturally in order to clear up the question completely more investigations on population and anatomy are necessary.

It is an interesting question how these shoals of fish come about. In other words, what are the causes which, on the one hand, lead to the formation of the immense autumn shoals and, on the other hand, what determines their choice of grouping places. Fundamentally we can distinguish internal and external factors among the causes. The internal causes, which are very important, from many standpoints of decisive significance (e. g. effects of different hormones, etc.) I did not consider during these studies. Among the external conditions I investigated first the temperature and the effect of wave action, which LISSMANN (l. c. p. 87) cites as decisive factors. According to my measurements, the protection of the bay is not as important from the standpoint of temperature as LISSMANN says, if we consider that in the autumn all the water of the Balaton cools off almost uniformly from surface to bottom (ENTZ, 1949, in the press).

Protection against the strong wave action undoubtedly plays an important part, all the more so because the fish, massed together in the shoals are very inactive; they usually float sluggishly, almost motionless in one place in the water. According to observation, at times when violent waves broke into the bay, the shoal disappeared and only formed in the old place when the water was quiet again.

It is perhaps worthy of notice that the shoals formed and drew near to the shore at the time when the transparency of the water was greatly increased, in the autumn. It is also possible that the small fry in the more transparent water escaped to the neighbourhood of the shore and sought for safety from predatory fish by uniting in shoals. Apparently confirming this hypothesis is the fact that second-year or older predaceous fish do not occur at all in these immense shoals. This again calls attention to the possibility that the absence of the larger predaceous fish may be due to some immediate cause. In order to clear up this problem I began some investigations of the conditions reigning in the interior of the shoals.

First and foremost the immense density of the shoals was remarkable. It was typical, for example, that when the shoal was disturbed and trying to escape, it often became so crowded that quantities of small fish were thrust completely out of the water, on to the backs of the others, and wriggled there in the air as if they were on dry land. Owing to this great density the absorbed oxygen content of the water, which at 10—15 m from the shoal was $\pm 100\%$, dropped to 80—50 or even 31% in the middle of the shoal (December, 1948). In pH value too some bias towards the acidic occurred from the open water to the interior of the shoal, but it scarcely amounted to 0.02—0.05 pH unit and therefore was probably quite without significance. This assembling of the fish in a small place, over a long period is made possible, as we know, by many factors. For example, they feed scarcely or not at all; because of the low temperature and their almost complete immobility their metabolism is probably very low, etc.

The average annual variations in size and the distribution of sexes within the shoals, the effect exercised by outside conditions on the formation and maintenance of the shoals, as well as the occurrence of similar large shoals in other parts of the Balaton, will form the subjects of further investigations.

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ОСЕННИЕ И ЗИМНИЕ СТАИ РЫБ В БЕРЕГОВЫХ ПОЯСАХ ОЗЕРА БАЛАТОНАВ 1947—1949 ГГ

Автор: БЕЛА ЭНЦ

РЕЗЮМЕ

1. Во время осеннего исследования береговых стай рыб, я обследовал 10 000 рыб возрастом от 1 года до 5-ти лет (возрастные группы от 0—IV) на основании стандартной длины, веса и образца чешуи.

2. Чешуи, приклеенные собственной слизью к бумаге, я откладывал для обследования, совместно с относящимися к ним данными.

3. На поверхности и краях громадные стаи рыб состоят из однолетних уклеек, в середине или внутри из 2—4 летних уклеек и 1—4 летних лещей; а на дне вблизи берега преобладают окуни. (*Acerina*)

4. Применением действия света и тока воды, мы получили такое-же распределение в аквариуме.

5. Рыбы образуют хорошо отличающиеся по возрастам популяции. У уклеек встречаются каждый год два биотипа, что вероятно следует отнести к их половому диморфизму: меньший ♂ и больший ♀.

6. Длина и вес тела, диаметр чешуи и возраст пропорциональны и рыбу можно отличать по возрасту на основании любого из этих данных.

7. Примечательными чертами являются большая густота громадных стай, почти полное отсутствие хищных рыб среди них и слабое насыщение кислородом внутри отдельных стай.

QUANTITATIVE AND QUALITATIVE INVESTIGATION OF THE SALTATORIA ON THE TIHANY PENINSULA

BY

BARNABÁS NAGY (Debrecen)

(From the Hungarian Biological Research Institute, Tihany, and the Debrecen University Zoological Institute, Debrecen, under a Home Research Stipendium from the Minister of Education.)

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The present paper is intended to be a modest continuation of the biocenotic studies which are slowly gaining ground in this country; in it I offer a part of the results formulated from quantitative and qualitative collections made during the summer of 1947 on the Tihany peninsula (Lake Balaton, Western Hungary). My investigations are concerned only with a group of insects of agrobiological and biocenotic significance, with the *Saltatoria* sub-order of Orthoptera. I published a complete list of the Orthoptera observed on the peninsula in Volume 18 of this periodical (NAGY, 1948). As the *Saltatoria* form only a small part of the animal associations here it was endeavoured — pursuing the aim of PALMGREN (1928) — to make the methods and the results in such a way that they could some day be related and compared with investigations bearing on other groups of the association and, finally, that a synthesis could be made of the detailed results relating to the different groups.

Of the 50 species of *Saltatoria* observed on the peninsula (I included the *Mantis religiosa*) 46 figure in the surveys, belonging almost entirely to the Acrididae family, and therefore herbivorous. The partially predaceous Tettigoniidae and the mixed-feeding Gryllidae families, though in nutrition, ecology and other respects belonging to other groups, are also given with the Acrididae family which form the great majority, more significant agrobiologically, in order to give a united and comprehensive picture of the rôle of the *Saltatoria*.

The starting point for my investigations — as in my research along similar lines in the Hortobágy puszta (NAGY, 1944, 1947) — was the vegetation, which is one of the most important factors in the habitat of the animal community. The vegetation — which itself is of course an organic part of the biocenosis — served as a basis in ecological and biocenotic investigations of a much more motile group of animals, the birds (PALMGREN, 1930, UDVARDY, 1947), but we also find it in the studies of several authors dealing with Orthoptera (VESTAL, 1933, KOZMINSKI, 1925, NEFEDOV, 1933, BALOGH and LOKSA, 1948, etc.). In survey work demarcation of the habitats can most easily and practically be made on the basis of plant societies (associations, sub-associations, facies). This work was facilitated by the floristic and plant sociological literature on the

Tihany peninsula (Soó, 1930, 1931, 1932 I, 1934) and plant geographical maps (Soó, 1932, II; UDVARDY, 1947), besides which the kind cooperation of dr. LAJOS FELFÖLDY on several occasions helped in identifying the plant communities.

Determination of the abundance (=density in individuals), which causes so much difficulty in animal associations, was made with the quadrat method I had already employed, following F. OKLAND (1929), in the Hortobágy (NAGY, 1944), and which BALOGH, (1947) applied successfully in establishing the abundance of *Saltatoria* insects.

The field work schedule was as follows: in places which seemed uniform as to vegetation, without disturbing the animals, I placed the 10×1 m (=10 m²) squares of yarn, and counted the *Saltatoria* seen in them. In one survey area 3–6 squares (=30–60 m²), at an average distance of 10–30 m from one another, generally seemed enough to establish the abundance, in fact, it can be said in general that the density value never varied to any decisive extent after counting 1–2 squares. In some of the less extensive habitats I had to be satisfied with the count from two squares, or even one.

Because of the great motility of most of the *Saltatoria*, the count of the animals found in the squares cannot be combined with their immediate collection. To obtain the species composition of the *Saltatoria* populations (German, Bestand) as well as the numerical relations of the species to one another, I made collections with an insect net. Finally I prepared more detailed notes, with numbers which corresponded to those on the formaline bottles, of the habitat and district (see appendix, p. 116.).

The 43 surveys and collections (of which only 6 were qualitative) made from July 22nd to August 21st, 1947, produced 4625 animals, which means an average of 107 per survey.

The Tihany peninsula proved especially suitable for carrying out comparative investigations, as its ± 12 km² area I could examine all the habitats which are important from the standpoint of *Saltatoria*, such as wheatfields (already in stubble), pastures, slopes with „steppe“¹ park forests, mesophile and hygrophile meadows.

In evaluating the collected and identified material the following characteristics were observed:

Abundance (A) means the number of specimens of *Saltatoria* falling to a unit of area (in this paper 1 hectare = 10,000 m² = 2,471 acres), data which I obtained by calculating the average density of the survey squares in terms of hectares (Table VI).

Production (P) means the live weight of the animals per unit of area (likewise calculated in hectares). It is to be noted that I obtained the data on the weight of the different species as well as the *Saltatoria* population per hectare by laboratory measurements and calculations. The animals were taken home in a fresh, living state and weighed according to species and sex on analytical balances. The average weight of several animals of the same species and sex served for the later establishment of the weight of the *Saltatoria* population surveyed, and from that the weight per hectare (Table VII). The larvae figured separately, and as far as possible according to species or sex (per genus) in the weight calculations, divided into two groups in respect to average weight (Development phases I–III and IV–V); in the absence of measurements (or only 1–2 measurements) the weight of some larvae is given by estimation in parenthesis in Table II. I believe that the above method is suitable both practically and in respect to accuracy.

Besides the A and P data, which have absolute values, and from the standpoint of production are very important, the following characteristics of relative value throw light on the species constituents of the *Saltatoria* population, distribution of the species, their connections with different types of habitats, and on the ecological conditions and requirements of the *Saltatoria* populations and species in general.

¹ steppe = (Hungarian „sztyep“) xerothermous plant association of the S and SE slopes of the Magyarközéphegység mountains. (See Soó, 1940 p. 24).

Dominancy means the species distribution of the Saltatoria populations, expressed in %. The dominance based on the number of individuals (*DI*), is obtained from net-collected material (Table III). Weight dominance (*DG*) means the share of the weight of specimens belonging to one species in the Saltatoria population in question, likewise expressed in % (Table IV). The *DG* values, though they differ significantly from those of *DI*, chiefly only in the Saltatoria populations containing many small larvae, throw light on the comparative ecological significance of the Saltatoria species in the different biotopes.

The Constancy (*K*) value answers the question of the regularity of the occurrence of any species, the constance in the Saltatoria group in question. Thus all, or at least nearly all the species occurring in the survey, which belong to the type investigated (1 distinguished altogether 6 types) were constant, whereas those occurring in only 1–2 surveys were accessory (accidental). This interpretation of constancy corresponds to the idea of „local constancy“. The degree of constancy was expressed as in plant sociology (FELFÖLDY, 1943, p. 79–80): The species in question is present in 80–100% (= *K* Grade 5); in 60–80% (= Grade 4); in 40–60% (= Grade 3); in 20–40% (= Grade 2); in 0–20% (= Grade 1) of the surveys belonging to the population group.

Fidelity (*F*) expresses the close or lax connection of the species in the Saltatoria population groups to the biotope-types, that is, in reality it gives the degree of ecological plasticity („eurytope“ and „stenotope“ species). I indicate the *F* in the same way as the degree of constancy: If the surveys of the Saltatoria population group investigated total occurrence of the species in question is 80–100% (= *F* Grade 5); 60–80% (= Grade 4); 40–60% (= Grade 3); 20–40% (= Grade 2); 0–20% (= Grade 1).

The percentual distribution of *K* and *F* degrees of the Saltatoria population group is illustrated in Figure 1 diagrams K and F respectively.

For better evaluation of the relation between the population and the vegetation and of the characteristics noted above, and for calculating the *K* and *F* values, it is expedient to range the results of the different surveys in groups. The *DI* and *DG* data proved to be the most suitable as basis for the grouping, but in addition to the Saltatoria, I took into consideration the vegetation, as the most important constituent of the biocenosis, which for the Saltatoria — and certainly for all the animal populations as well — is the most essential part of the habitat. In classifying I naturally took into consideration the qualitative (species) differences among the Saltatoria. In one Saltatoria population group (*SPG*) as a result of the classification carried out in this way, were included the surveys made in localities with more or less similar vegetation in which, besides general qualitative (species) agreement, the dominant species (the *DI* or *DG* value above 10%) were the same. The *SPG* thus established (see below) served thereafter for various comparisons and for calculating the *K* and *F* values.

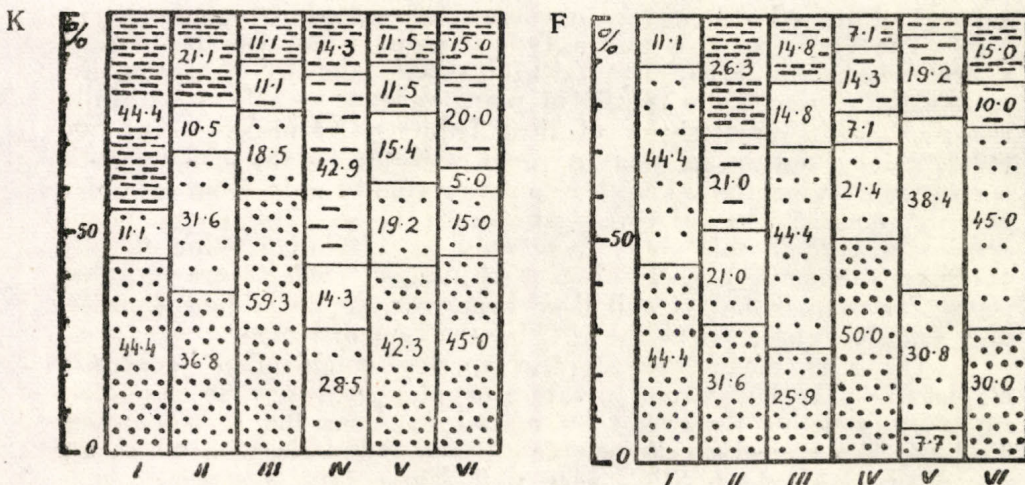


Fig. 1. Diagram showing degrees (1–5) and percentual values of Constancy (left) and Fidelity (right) of Saltatoria Population Groups I–VI.

QUALITATIVE AND RELATIVE QUANTITATIVE (DOMINANCY) CONDITIONS IN THE SALTATORIA POPULATIONS, IN RELATION TO THEIR HABITATS

The SPGs established on the basis of the principles given above and named from their most important species are the following:

- I. *Stauroderus bicolor* — *mollis* population group (on stubble).
- II. *Stauroderus bicolor* — *mollis* — *Omocestus petraeus* population group (on slopes with steppe and pastures formed on such places).
- III. *Stauroderus bicolor* — *mollis* — *Stenobothrus crassipes* population group (in habitats of transitional type).
- IV. *Stauroderus bicolor* — *mollis* — *Gomphocerus rufus* population group (in park forests).
- V. *Chortippus* population group (in mesophile meadows).
- VI. *Mecosthetus* population group (in hygrophile meadows).

The habitats of the first four belong to xeroleimon areas (dry hilly belt), the last two to hygroleimon (flat land meadows).

Looking through the surveys (Tables III—VIII), which were made in the most diverse habitats, we can see that the Saltatoria PG therein consist in general of 8—10 species. Many species occur in habitats which are often quite different ecologically, others again are restricted to a few surveys, some form an overwhelming majority of the populations (dominants), others occur with only one or two specimens (recedents). If we take under more minute examination the SPGs in which are included populations of kindred type, we can see that, besides the dominant species — which are naturally present in all the surveys appertaining to the group, i. e. constants — other, less or not at all dominant species can be more or less constant. Therefore besides the low *DI* and *DG*%, some other species can still occur regularly in the SPGs, i. e. as constants, while we may also see examples where a species showing a high *DI* and *DG*% in one or two surveys of the SPG is merely a chance (accessory) occurrence.

The degree of *F* is also a typical value which can be used in characterising the SPG. The faithful species (locally characteristic) — like the characteristic species of plant societies — reflect faithfully the ecological characteristics of their habitats. Naturally — as Soó (1945) pointed out in relation to plant societies — the characteristic species can be determined with complete certainty only from extensive and thorough sociological investigations; so the so-called characteristic species as used in this study have only local, relative value (locally characteristic species), — in absence of data of such nature on other areas, for comparison — still they bring out the individual (species) and ecological character of the SPG for the type of biotope.

Using as model the „typical species combination“ generally employed in the Hungarian literature on plant sociology, to characterise plant societies, there can be assembled from the accompanying Tables the typical species-combinations of Saltatoria with which we can characterise the 6 SPGs very well. These typical species-combinations thus contain those important and characteristic species of the SPGs which appear with high *DI* and *DG* values (above 10%, in

large type), or *K* (5.4 values spaced-out type), or *F* (5.4 values, species marked with*).

In the following we turn to the characterisation of the 6 *SPGs*.

I. *Stauroderus bicolor-mollis* population group (in stubble).

Even from the few surveys at our disposal, the exceptional poverty of species of the *Saltatoria* populations can be seen, the great constancy of the majority of the species and the enormous dominance of *Stauroderus bicolor-mollis* (average *DI*: 87.4%), such as we never found anywhere else among the dominant species. All these circumstances contribute to the great monotony and homogeneity of this *SPG*. There are no locally characteristic species: the *Saltatoria* of which the population is comprised can therefore be found in the other *SPGs*, too, so that the character of this *SPG* is in reality of negative nature, in contrast to the others. It is to be noted that, due to the presence of species of large size (*Calliptamus*, *Oedipoda*) the *DG%* is here the most essentially modified as compared with the *DI%*, so that owing to their considerable weight they count as dominant, though their *DI%* is relatively small. Typical species combination of this *SPG* is:

STAURODERUS BICOLOR-MOLLIS
CALLIPTAMUS ITALICUS
OEDIPODA COERULESCENS
Gryllus desertus.

This *SPG* occurs in the stubble of harvested wheatfields. These biotopes spread over variously exposed and inclined slopes, have very sparse vegetation, for the most part *Polygonum aviculare* — *Stachys annua* or *Setaria glauca* — with *Stachys annua* communities (from the sociological survey of L. FÉLFDY). The average height of the vegetation was 5—15—20 cm, cover 60—90%, sparse in nature; its condition was generally good, in some localities getting a little dry.

The self-dependent, autochthonous nature of this *SPG* is questionable, a thing we had already suspected in the absence of locally characteristic species. It is probably formed after the harvest in the combination we have mentioned, of *Saltatoria* individuals from grassy spaces along the neighbouring paths, from pastures, slopes with steppe assn., meadows, in consequence of immigration, as I was also able to show in the Óhat-pusztá (in the middle of the Nagy-Alföld Plain) in localities of similar type (NAGY, 1943 II).

II. *Stauroderus bicolor-mollis* — *Omocestus petraeus* population group (on slopes with steppe assn. and pastures formed on such places).

Saltatoria populations of fairly varied composition as to species belonging in this group, most of them xerophile forms, as to quantity *Stauroderus bicolor-mollis* and *Omocestus petraeus* provide the most (combined *DI* = 73%), the other species figuring with uniformly low

* The *Stauroderus bicolor* and *mollis* species, difficult to distinguish and connected by their transitional forms, are everywhere treated together.

dominance. On dwarf grass pasture the tiny *Gomphocerus maculatus* gets a still significant dominance.

The *Metrioptera affinis* was exceptionally remarkable in the 31st survey, *DI*: present in 11.1%, — unusually large for a predaceous species — which, in view of its large size is 24.3% in *DG*. These animals are very fond of habitats with tall grass — but not moist nor vaporous — and of small undergrowths, and in the present case 10—30 (—40) cm vegetation was actually the highest in these surveys. The attraction exercised by relatively high vegetation on the large predaceous Orthoptera is also seen in survey 31, from the presence of the praying mantis, *Decticus verruciporus* and *Metrioptera grisea*. Thus the total for predaceous Orthoptera in this survey was *DI*: 17.9%, *DG*: 57.4%, which is an uniquely high value for the peninsula. Considering the very low individual density (Table VI.) in this locality and the low percentage of larvae (Figure 2) as compared with other similar localities, the chief cause must be sought in the exceptionally high dominance of predaceous Orthoptera. We see similar conditions in the second survey.

The less constant and numerous accessory species (Figure 1) also show the variability of the *SPGs* which again means the ecological variety of the habitats dealt with here. The multitude of locally characteristic species for conditions on the peninsula throws a sharp light on the comparatively closed nature, sociologically, of the *SPGs* and of the habitats located on slopes with steppe assn. of the peninsula. The following are typical species combinations for this *SPG*:

- STAURODERUS BICOLOR-MOLLIS
- * OMOCESTUS PETRAEUS
- OEDIPODA COERULESCENS
- * Stenobothrus nigromaculatus
- * Gomphocerus maculatus
- * Doclostaurus crucigerus brevicollis
- * Oedaleus nigrofasciatus
- * Acrida turrita
- * Metrioptera affinis
- * Metrioptera grisea
- * Oecanthus pellucens

The occurrence of the *Stauroderus bicolor-mollis* — *Omocestus petraeus* population group is linked the slopes with steppe assn. on the Tihany peninsula, but not only in places covered with the original plant societies (*Festuca sulcata* — *Stipa joannis* — *Carex humilis* association complex) which are now limited to fairly small and fragmentary growths, but everywhere in meadows, (*Cynodon* — *Lolium* — *Andropogon* assn.) forming in consequence of anthropogenic-zoogenic influences. Besides these, many transitional types can be found between places with their original and those with secondary vegetation, all of them excellent habitats for the *SPGs* under discussion. The height of the vegetation on the *Festuca* meadows (— *Cynodon*, *Andropogon* or — *Carex*) is 3—5—7 cm: in the more undisturbed localities (*Festuca* — *Stipa* — *Carex*, *Festuca-Stipa* assns.) 5—7—15 (—30—40) cm, the cover being 60—95%; inclined to be dense at the

lower turf level and of a more sparse nature in the upper; in July it was already half dried. These habitats are on exposed slopes, hilltops (generally at a height of 130—200 m above sea level).

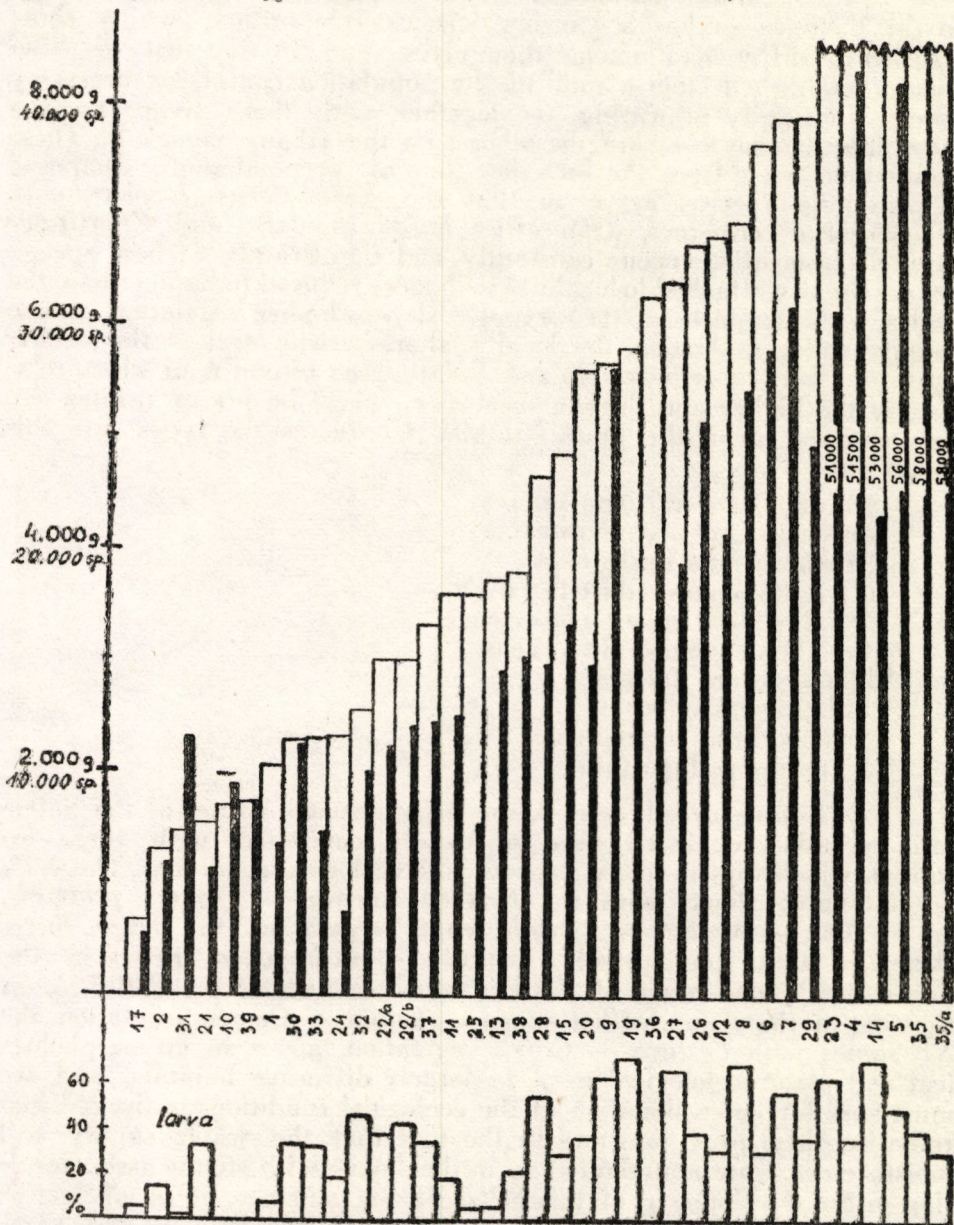


Fig. 2. Above: Values for Abundance and Production per hectare in surveys Nos. 1—39. — Below: Percentage of Larvae in the *Saltatoria* Population in habitats Nos. 1—39. — Abscissa: Nos. of surveys (see Appendix on p. 116) ordinate: Numbers of individuals and fresh weights of *Saltatoria* per hectare and percentage of Larvae, respectively.

III. *Stauroderus bicolor-mollis* — *Stenobothrus crassipes* population group (in localities of transitional type).

The Saltatoria population which belongs here — corresponding to the biotopes — has a varying species composition, which show significant differences among themselves, and in the list of SPG species established from a total of the population containing accessory species constantly appearing — together with those living on the mesophile meadows — are the richest on the Tihany peninsula. These populations aside from the fact that they are preponderantly composed of xerophile species, agree in that the *Stauroderus bicolor-mollis*, *Stenobothrus crassipes*, *Omocestus haemorrhoidalis* and *Chortippus declivus* associations occur constantly and significantly. These species are apparently attached to localities with more reduced radiation than the slopes with steppe assn. (less exposed slopes, higher vegetation, sparse canopy foliage). Among the locally characteristic species the occurrence of *Phaneroptera falcata* and *Ephippigera vitium* is in close relation to the higher and thicker vegetation, where bushes of various size are scattered about the grass stratum. Characteristic types for this group are:

STAURODERUS BICOLOR-MOLLIS
 OMOCESTUS HAEMORRHOIDALIS
 STENOBOTHRUS CRASSIPES
 Chortippus declivus
 Oedipoda coerulescens
 Calliptamus italicus
 * Phaneroptera falcata
 * Ephippigera vitium
 * Stenobothrus stigmaticus
 * Stauroderus biguttulus

As I have already stated, the heterogeneous nature of the Saltatoria populations listed here is closely connected with these localities, which vary in many respects as to ecological conditions. The thick vegetations of slopes with the *Festuca sulcata* — *Festuca pratensis*, or. *Festuca* — *Melica* — *Agrostis tenuis* vegetation, the large forest clearings with undisturbed *Festuca* — *Andropogon* grasses in the *Festucetum pseudovinae* of the flat land meadows of the Külső-tó, on the foot of the slopes with *Festuca* — *Salvia* — *Ononis* vegetation, the NE slopes with *Festuca* — *Carex* vegetation, mean, in geomorphological and plant sociological respects, largely differing habitats, and we must seek for an explanation of the ecological conditions in the reduced radiation (heat provision) and in the fact that the water supply and moisture are more abundant than in the slopes with steppe assn., resulting in the development of this SPG. In its structure, it is of transitional character, between the populations of hygroleimon and xeroleimon areas, though the latter predominantly leaves its mark on the species composition.

IV. *Stauroderus bicolor-mollis* — *Gomphocerus rufus* population group (in park forests).

Relatively poor in species — somewhat more abundant than in stubble — though it is to be expected that further investigations will

raise the number of species. With regard to the species components and dominance, the *Pezotettix giornae*, *Omocestus rufipes* and, more particularly, *Gomphocerus rufus* are the most typical; the shadow-loving nature of the two latter appears clearly from the Table. The presence of foliage in the structure of the biotope is of the greatest significance to the association in general and thus to the Saltatoria populations here, and quite certainly the reduced radiation is the chief cause for the absence of several xerophile species.

I consider it probable that in localities of this type the Saltatoria can make fullest use of the radiation. The sunny patches — as I found elsewhere in respect to *Stauroderus* and *Chortippus* species — can be sought in 1—2 minutes from the shady parts, at a distance of 5—10 m. It can thus be supposed that most of the animals can follow the sunny parts at pleasure, constantly wandering with the sun but can retire into the shade or half-shade of the sparse foliage when there is excessive and therefore injurious radiation. It is hence comprehensible that in these biotopes species with high thermal needs (*Oedipoda coerulescens*, *Stenobothrus crassipes*, *Chortippus declivus*, *Mantis religiosa*) occur indeed in quantities, while at the same time the half-shadow-loving species (*Gomphocerus rufus*, *Omocestus rufipes*) are also considerable in number. The reduced significance of the *K* and *F* values given is due to the small number of surveys, but even so the great homogeneity of the SPGs is apparent (many constants); the number of euryoecic species is very large, that of the locally characteristic species, however, only a fifth of all the species (Figure 1). Typical species combination:

STAURODERUS BICOLOR-MOLLIS

*GOMPHOCERUS RUFUS

Pezotettix giornae

Chortippus declivus

Stenobothrus crassipes

*Rhacocleis germanica

Mantis religiosa

*Omocestus rufipes

This SPG occurs in park forest (*Quercetum stepposum*) on slopes gently inclining towards NE and NW situated on the SW borders of the Tihany peninsula. The small continuous clearings and the lack of shrubbery stratum make possible the development of this SPG fairly poor in species (but the most abundant in the whole peninsula in individual numbers.) The grass level is 3—5 (—8—15) cm high, 100% covered, half dried. The cover of foliage canopy is 30—50%. This SPG is practically speaking of no consequence, as there are so few habitats of this kind on the peninsula.

V. *Chortippus* population group (mesophile meadows).

This SPG is the most abundant in species, the most varied in composition. The appearance of four *Chortippus* species gives its character, one or another of them predominating according to the ecological condition of the habitats and the „environmental resistance” in general. The populations of the survey can naturally be classified ecologically within the group; in the Saltatoria populations of localities with higher and denser vegetation, generally more moist, the more and more

constant presence of *Acrydium subulatum*, *Conocephalus fuscus*, *Mecosthetus grossus* species takes us on to the next group to be discussed, the *Mecosthetus* population group.

In investigating the dominance whether we consider the populations of the different surveys or all the *SPGs* combined, it can be seen that in general 2—3 or even 4 species jointly have a predominant rôle. We seldom find this trait in the *SPGs* treated so far. This as well as the *K* data, show that this *SPG* — together with the *Mecosthetus* population group — is more balanced than the others; the percentual participation of the species grows gradually towards the classes of lower constancy, which to a certain extent means a *SPG* of varied composition, but having at the same time homogeneity — though to a smaller extent. The percentage of stenoecic and euryoecic species is equally low, though it assures a still considerable amount of locally characteristic species for the *SPG*, corresponding to the abundance of species. The characteristic type of composition is:

- * *Chortippus dorsatus*
- Chortippus elegans*
- Chortippus parallelus*
- Chortippus declivus*
- * *Aeolopus thalassinus*
- Stauroderus bicolor-mollis*
- * *Chrysochraon dispar*
- * *Homocoryphus nitidulus*
- * *Conocephalus dorsalis*
- * *Metrioptera vittata*

This *SPG* is to be found, widely distributed in different types of mesophile — in some cases hygrophile — meadows with medium high grass, primarily in localities covered with stands of *Agrostis alba* — (*Deschampsia caespitosa*) — *Carex distans* vegetation complex (Soó, 1932 I, 1934), and in moist alkali meadows (*Agrostis alba* — *Aster panonicus* assn.). At the time of the investigation the height of the vegetation was about 7—10—15 (—30—40) cm, cover (90—) 95—100%, of a dense bladed foliated nature, in a good green condition. These localities are utilized agriculturally, as they are mown.

As can be seen from Tables III and IV, the distribution of the Saltatoria species in these biotopes is modified, not so much by plant sociological conditions as through them, by the height of the vegetation, its cover, density, and by local topographical conditions (contact with various habitats). As these localities are very extensive (marshy meadows and mown meadows on the Külső-tó, the Ujlaki rét, Rátai csáva, Diósi rét), the *Chortippus* population group comes into more considerable account, not only in agrobiological respects but also in respect to the effect exercised on the other Saltatoria populations through territorial contact.

VI. *Mecosthetus* population group (in hygrophile meadows).

Populations of medium species abundance, composed almost exclusively of hydrophile species — mostly phytophilous, indeed phytoecious, in which the *Mecosthetus grossus* predominates, the *Chortippus* species also having a considerable rôle. The accessory species figure as

in the *Chortippus* population group, but the rôle of the constant ones is more important; this circumstance with the relatively low number of species means a more homogeneous population group than in the foregoing SPG. The percentage ratio of the euryoecic is very high, coming after the stubble habitats.

In characterising the type of this SPG I also included as dominant the three species of *Chortippus* (*Ch. dorsatus*, *parallelus* and *longicornis*) the *DI* and *DG* values of which did not quite reach 10%. But as in these populations there were very many *Chortippus* larvae which are difficult to identify as to species (*DI*: 13.2%, *DG*: 8.5%), these species can in practice all be treated as dominants, though certainly their larvae do not occur in equal proportions. So the typical species combination is:

- * *Mecosthetus grossus*
- * *Chortippus longicornis*
- Chortippus dorsatus*
- Chortippus parallelus*
- Conocephalus fuscus*
- Chortippus elegans*
- Acrydium subulatum*
- * *Parapleurus alliaceus*
- * *Metrioptera roeselii*
- * *Pteronemobius heydeni*

This SPG is linked in its dispersal to the most moist meadows of the peninsula, partly to the moister points of localities covered with an *Agrostis alba* — *Deschampsia caespitosa* — *Carex distans* complex, to *Magnocaricetum*. Just as in the *Chortippus* population group, the formation of the *Saltatoria* population here is regulated not so much by the composition of the association as by the physiognomical aspects of the locality, chiefly the structure of the vegetation. Thus, for example, in localities covered with typical communities of *Schoenoplectus* and *Phragmites*, except for one or two stray specimens, *Saltatoria* populations do not form, but none the less the *Mecosthetus* population group can be found in the habitat of the 10th survey which is covered with a mixed *Schoenoplectus* — *Phragmites* — *Agrostis* — *Juncus* community formed as a consequence of reclamation) though with low individual density and a dominance which contrasts to the others, for in the otherwise relatively high (up to 120 cm) grass stratum there are parts here and there which are only 20—60 cm. high.

The vegetation of the habitats of the *Mecosthetus* population group is in general 7—25—40 (—60) cm. in height, 100% covered, of a dense bladed type, and due to the damp soil was still a lush green in the middle of August.

ABSOLUTE QUANTITATIVE CONDITIONS

Abundance

No matter how slight the reproductive force of a species may be, it will increase to a considerable extent under favourable circumstances. But unrestricted reproduction has biotic and abiotic limits, which come forward as environmental resistance. It can be seen from Table VI that the *Saltatoria* species inhabit the different localities in widely differing densities (abundance). It is evident that for any species, the greatest density will occur in the most favourable localities, and that in unfavourable biotopes they will occur in small numbers per unit of area.

The many different factors acting on the habitat have the closest reciprocal effect on one another (THIENEMANN, 1941). Factors offering optimum conditions can be spoilt by other, unfavourable ones, and the existence of any species in the habitat is determined by the factor which most closely approximates the pessimum (HESSE, 1924, compare LIEBIG „Gesetz vom Minimum!!). Thus, for example, it is of no avail for the habitat to be favourable for a species from an auto-ecological standpoint, if at the same time the structure of the biocenosis is not propitious to it (large number of enemies, parasites, competitors).

But the different factors of the habitat act in their entirety (FRIEDERICH: „lokaler Einheitsfaktor“); the effect of one single factor can be analysed only by thorough laboratory and field observation or experiments, and the extent of the environmental resistance of a species can in practice be expressed by the density, by its A . We may therefore say that the environmental resistance diminishes parallel with the A . Naturally we can be content with these data only until we can replace them with others, more nearly corresponding to reality. Detailed and fundamental elucidation of the biotic potential, that is of the reproductive force of the species — in connection with which there is still much to be investigated, in respect to the *Saltatoria* — can serve with further modifications to estimate better the environmental resistance.

The following species appear with greatest density: *Stauroderus bicolor-mollis*, *Chortippus elegans*, *Ch. parallelus*, *Omocestus haemorrhoidalis*, *O. petraeus*, *Gomphocerus rufus*, *Mecosthetus grossus*, occurring in the territory of several of the surveys with more than 5000 specimens per hectare, among them the *Stauroderus bicolor-mollis*, *Omocestus haemorrhoidalis*, *Chortippus parallelus* and *Mecosthetus grossus* species exceeding in places 20,000 specimens per hectare. The species of such great abundance are all herbivorous; the predaceous species are present in low A , in general well below 1000 specimens per hectare. Surveys relatively rich in predaceous *Metrioptera* specimens (e. g. Surveys 31 and 2) have a low total density and the percentage of larvae is small — due certainly to their predaceous activities.

Study of the abundance of the SPGs (Table VIII) — the averages calculated from the A of the surveys — does not help us much in clearing up the A values. Within the same SPG, and therefore with the same qualitative and relative quantitative composition, significant differences in A can be observed (Table VI). But deducting the relatively few extreme values, the A of two-thirds of the surveys mo-

ved around 10,000—40,000/ha at the time of the investigation. The number of specimens per hectare calculated in the average of the *SPGs* is 28,875. The two chief habitat types xeroleimon and hygroleimon stand fairly close to one another. In the xeroleimon the *A* value is 32,046/ha, or 23,395 if we omit the exceptionally high *A* data (58,000/ha) for the *Stauroderus bicolor-mollis* — *Gomphocerus rufus* population group which is territorially of limited significance, and on hygroleimon areas 25,705/ha. But we must also take into consideration here that on xeroleimon areas the surveys were generally made about 1—2 weeks later, and we must credit the decrease to the xeroleimon territories.

With the advance of the vegetative period the decrease in *A* is significant. In sandy localities near Budapest Saltatoria *A* was 90,000 and 20,000/ha in July and August respectively (BALOGH and LOKSA, 1948), hence in the course of one month it diminished to less than one-fourth. Here, however, we must remember that BALOGH and LOKSA, restricted their investigations, though they were periodic, exclusively to a single biotope type and from them we get no information about the seasonal wanderings taking place during the vegetation period, or about the possible changes of biotope. In order to demonstrate temporal changes in *A*, periodical investigations extending over all the local biotope types are needed. I myself found a 63% reduction in *A* in the course of three weeks in the Külső-tó meadow (surveys 4 and 58). Such a significant decrease warns us that *A* data taken at remote dates, can be compared only with reservations.

Though I have no numerical data on the other animals there, the above data themselves prove the uniformly significant rôle of the Saltatoria in the types of habitat investigated. The *A* data for July and August in the sandy localities mentioned above (*Fumana vulgaris* — *Festuca vaginata* — *Cladonia foliacea* — *magyarica* phytosociation) denote 13.6 and 5.3 *DI*% respectively of the Saltatoria inhabitants in the whole Arthropoda population (BALOGH and LOKSA, 1948), which again means 62.4 and 72.8 *DG*% respectively, i. e. in weight more than two thirds of the whole Arthropod population.

More investigations are needed to clear up the connection between *A* and the number of species in the surveys. But on the basis of those existing up to now, it can be said that a relatively high number of species is not necessarily coupled with great *A*, though in surveys with great *A* the number of species was generally large.

On the basis of the 37 quantitative surveys of the relationship between *A* and the amount (covering, height) and condition of the vegetation the following can be stated: in stubble i. e. in habitat type with the least vegetative yield — brought about by secondary artificial conditions — *A* increases with the amount of vegetation. From this we cannot conclude without going any further, that the green substances serving for food are present as a minimum factor. In any case, this can also play a part, but a sparse stand of vegetation with a low degree of covering, still offers sufficient food for 1—3 Saltatoria individuals per m². With higher and thicker vegetation on the stubble field, other ecological factors besides food conditions very likely improve too, to a considerable extent (microclimate, protection). To some extent this is also true of the *A* of the Saltatoria on the most xerophile steppe assn., especially in respect to the covering the vegetation offers.

In habitat types of less exposed slopes, mesophile and hygrophile meadows where the vegetative covering is nearly everywhere above 90—95%, the height of the vegetation is significant in the development of A . From the Tables and a list of the localities of the surveys, it can be said that at the time of the investigation the greatest A was found in those habitats, the physiognomically (analysis of the substrata) and floristically various plant covering of which was 3—5—7 (—15—20) cm on the xeroleimon areas and 7—15—20 (—40) cm on the hygroleimon, with a covering of 90—95 and 95—100% respectively (e. g. surveys 23, 14, 35, 4, 5, 29, 26, 7). The greater, higher vegetation on the mesophile, and still more on the hygrophile meadows restricts the A of the *Saltatoria* populations (e. g. surveys 17, 10, 33 and 2). The data from surveys 8 and 9 are interesting in this connection. They were made in the same plant association, except that one of them was on a part which had been mown, i. e. on area with vegetation artificially lowered. In localities with mown grass (survey 8) with approximately the same maximum height of vegetation as mentioned above the A is naturally greater than in biotopes which are less favourable, because of their high and dense vegetation (survey 9), though in a floristic-sociological sense the vegetation was the same in both places. The difference is also apparent in the percentage of undeveloped animals, which generally increases with the A .

As I have already stated (p 105), in closed stands of *Schoenoplectus* and *Phragmites* there are no *Saltatoria* except a few stray and scattered specimens. The *Saltatoria* populations which may appear on the borders of localities with such vegetation are certainly of only secondary significance and are explained as migrators from neighbouring biotopes with more considerable A .

On xeroleimon areas, aside from the quantitative and qualitative conditions the general state of the vegetation — which in reality decisively influences the A — the direction of the slope, i. e., its exposition, comes in for consideration. An unfavourable exposure acts unfavourably on the A (e. g. survey 24), evidently because there is less radiation.

There is also less sun at the turf level of the sparse park forest (*Quercetum stepposum*) (surveys 35 and 35a) — as I have pointed out on p. 103 — but this is due not to the exposition but to the presence of a canopy of foliage and therefore the motile *Saltatoria* can counterbalance it. The highest A on this type of biotope (58.00/ha) is kept at a high level by the probably retarded development which occurs in consequence of reduced radiation and hence later hatching of the egg, aside from the possible concurrence of species with different ecological requirements. The higher A of the earlier months falls rapidly with the advance of the vegetation period (BALOGH and LOKSA, 1948). Therefore in park forest habitats, as compared with other types at the same period an early, lagging stadium may be present, though this view is not supported, more particularly by the only fairly large percentage of larvae (31.9 and 40.7%).

The presence of more predaceous *Saltatoria* also pushed the A to a low level (surveys 2 and 31); in these surveys the small percentage of animals in an early stage of development shows that larvae are an easier and more convenient prey for them.

Production

The P values given here indicate the live-weight of the *Saltatoria* per hectare, expressed in gs.

As in the A , we find large extremes in the per-hectare weight values of the surveys. In the localities investigated production moved between values of 555—8344 g/ha. But in the majority of habitats the live weight of the animals amounted to 2000—6000 g/ha and was less than 2000 g/ha in only 9 surveys, exceeding 6000 g/ha in 6 survey areas. P per hectare of the average SPGs was 4083 g. The average for the xeroleimon types of habitat was 4113 g/ha, or if we omit the *Stau-roderus bicolor-mollis* — *Gomphocerus rufus* population group which gives a large yield (7561 g/ha) but is of limited significance territorially: 2964 g/ha. Average P for the hygroleimon type of locality, was 4052 g/ha, 27% more than the xeroleimon which has no park forest. This difference is not a true value, for the surveys in the xeroleimon areas were made a week or two later than in the hygroleimon, and the difference may be attributed at least partially to that — as we know the A falls rapidly with the advance of the vegetation period. It should be noted, however, as is apparent from the Tables appended to the paper by BALOGH and LOKSA (1948) that decreased P follows reduced O only towards the end of the vegetation period. This can evidently be attributed to the growth of the small larvae; their increasing weight replaces the loss in numbers.

Considering particularly the approximately uniform weight of the dominant species the differences in production of the localities largely agree with changes in A . Therefore what has been said in respect to A is mostly true for P as well. But must note that both in the heavy (e. g. *Decticus*, *Oedipoda*, *Calliptamus*, etc.) and in the species of small weight (*Omocestus petraeus*, *Gomphocerus maculatus*, *Acrydium subulatum*, etc.) shifts between A and P values occur, to their advantage or disadvantage. The hygroleimon (types V, VI) species occurring in more considerable numbers (*Chortippus*, *Mecosthetus*) are on the average heavier and larger than the xeroleimon (types I, II, III and IV) *Saltatoria* which occur in the same proportions (*Omocestus*, *Stau-roderus*, *Stenobothrus*; Table II). Leaving type IV (park forest) out of consideration, the 23,395 specimens per hectare on xeroleimon areas mean a P of only 2964 g/ha, as against average data of 25,705 specimens/ha=4052 g/ha in the hygroleimon.

In surveys 35 and 35/a with identical A the P values are 7476 and 7646 g/ha respectively, corresponding with 40.7 and 31.9% larvae. It is evident, that with identical A — and *Saltatoria* populations — the habitat with the smaller percentage of larvae has greater P , but on the other hand it can also be said that generally within the same SPG the greatest P (and A) are found in those *Saltatoria* populations, or habitats, which have the greatest percentage of undeveloped animals.

In viewing the P values of the averages for the SPGs (Table VIII) it is seen that the average P of the SPG is parallel with the height of the vegetation — and what usually accompanies it — the yield in plant material. To this, to a certain extent, the *Stau-roderus bicolor-mollis* population group of the stubble — doubtful in any case in re-

spect to its origin and self-dependence — is an exception. At the end of July and beginning of August on the shortest stubble (having the least yield) and on the slopes with steppe assn (*Stauroderus bicolor-mollis*, and *Stauroderus bicolor-mollis* — *Omocestus petraeus* population group respectively) the *Saltatoria* population has a live weight of 2839 and 2558 g/ha respectively. On less exposed slopes with slightly taller grass, in localities of transitional type (*Stauroderus bicolor-mollis* — *Stenobothrus crassipes* population group) and on mesophile meadows with vegetation of about the same height and quantity (*Chortippus* population group) the *P* is also about uniform: 3494 and 3446 g/ha respectively, nearly 1 kg. more than in the preceding. In the highest grass relatively, of the hygrophile meadows (*Mecosthetus* population group) *P* is 4658 g/ha, in park forest habitats (*Stauroderus bicolor-mollis* — *Gomphoceris rufus* population group) 7561 g/ha. In the latter type of locality, as there is a foliage canopy here too, the vegetation is the highest and the yield the greatest, though the grass level to which the *Saltatoria* are completely bound, is scarcely higher or more voluminous than that of the grass of slopes with steppe assn.

Whether the *Saltatoria P* rising parallel with the height and quantity of the vegetation, is a phenomenon of regular occurrence, or merely a coincidence, must be decided by more detailed research, extending to other regions and types of biotope, where the degree of vegetative yield (production) would also be considered.

NOTES ON OCCURENCE AND ABSOLUTE QUANTITATIVE CONDITIONS OF SOME OF THE MORE IMPORTANT SPECIES

Disregarding the dependence of the sexes on one another and the connection of predatory — prey in relation to the other *Saltatoria* of the few and only rarely important predaceous forms, with the density found on the peninsula the individuals of the *Saltatoria* population are fairly independent of one another. The species populate different types of habitat according to their ecological requirements. This relative independence ceases in exceptional cases — when some species multiplies in consequence of favourable ecological conditions: its density — for the animals stimulate one another by their activity, due to the great *A* and induce to still greater activity (compare UVAROV's migratory-phase theory: KLINGSTEDT, 1939) which, as experimental results have also shown (FAURE, 1932) results in considerable morphological and physiological changes in individuals of the population („gregaria“ = migratory phase). The *Saltatoria* populations are composed of the total populations of the species in the habitats, the qualitative, as well as the relative and absolute quantitative conditions of which we have already surveyed in the foregoing. It can be seen that 1—2—3 species which comprise 70—90% of the population always take the leading rôles. It is therefore necessary in what follows to refer separately to the species which are the most numerous and the most important in respect to production-biology and agrobiology.

Omocestus petraeus. Stenoecic. An animal of slopes (and summits) exposed to much sunlight. In localities with dwarf grass of

Festuca sulcata — *Carex* — *Stipa* (*Andropogon* — *Cynodon*) vegetation, where the sparse upper-level of the grass never exceeds 30 cm. Otherwise there is a correlation between its needs as to height and density of grass. Namely, lower grass and greater coverage have the same value for this species, as the higher grass offering less cover. The vegetation of these biotopes was half dried out. I did not observe them in stubble fields. In higher grass offering more cover they were to be found sporadically (Survey 23) only where this was wedged in between the favourable biotopes noted above (territorial radiating effect). In the area of optimal biotopes the *A* can rise to 8000—14,000 ind./ha, but owing to their small size the *P* is scarcely to be taken into account.

Oedipoda coerulescens. A typical xeroleimon animal. Beginning with stubble fields (here sporadically) on meadows with dwarf grass, on slopes with steppe assn. and peaks, on through to park oak forests, it occurs constantly everywhere. It is a geophile species therefore primarily bound to dwarf grass biotopes, but it also occurs in small numbers (203—547 ind./ha) in xeroleimon places having higher vegetation (surveys 23 and 30). In general, with its small *A*, its importance can be attributed to its large size and eurycoec nature.

Calliptamus italicus. In its eurycoec nature it follows *Stauroderus bicolor-mollis*. It is primarily a xeroleimon animal; it occurs with great constancy but always in small numbers (between 100 and 600 ind. ha), on stubble fields, meadows and slopes with steppe assn. It can also be found, still more sporadically and with less constancy, in some drier types of flat land meadows, chiefly where these localities adjoin xeroleimon areas (surveys 13, 15). Due particularly to the great weight of the female, the *P* is important (average 100—360 g/ha in the *SPGs*).

Stauroderus bicolor-mollis. The two species can be separated with difficulty for there are many transitional forms between them. Here and there, and principally in the moister biotopes, specimens of the *bicolor* type are found. They are xerophile animals, with great ecological plasticity. At the time of the investigations together they were the most frequent and the most numerous of *Saltatoria*, in some localities exceeding 30,000—40,000 ind. ha. In xeroleimon areas their constantly great abundance (averaging in the different biotopes 9473-15, 549-19504-30.873 specimens per hectare is interrupted in three surveys — Nos. 24, 25 and 31 — at which time the *Omocestus petraeus* predominates. Corresponding to the great *A* on xeroleimon areas the *Saltatoria* gives a 50% *P*; in stubble as much as 73%. With a value of 1200—3860 g/ha, it is from the point of view of production the most important *Saltatoria* on the peninsula.

Omocestus haemorrhoidalis. A species of habitat of transitional character between xeroleimon and hygroleimon; its *P* is only here more significant (391 g/ha). Irregularly dispersed. It seems to avoid areas with scanty sunlight (surveys 19, 35, 35/a), as well as those with very short grass and scanty coverage (surveys 21 and 31); it was also absent in stubble fields.

Stenobothrus crassipes. In its ecological pretensions it is about the same as the *Omocestus haemorrhoidalis* species. It appears in

transitional areas between xeroleimon and hygroleimon, therefore in the more enclosed and higher grass xeroleimon habitats (surveys 26, 22/b, 36, etc.) and in the drier types of cultivated meadows (surveys 1, 13, 12, etc.) with great constancy and considerable A (2800/ha). In spite of its ecological relationship to the *Omocestus haemorrhoidalis*, there is one important difference, that *Stenobothrus crassipes* can put up with a good deal of shade (surveys 35, 35 a).

Gomphocerus rufus. A species fond of half-shady places, therefore very numerous in oak park-forest localities (surveys 35 and 35/a), (9213 specimens/ha = 850 g/ha average), but here too they reach greater A in the shadier parts of the borders of the woods. A stenoeic species, does not occur elsewhere than in the types of habitats mentioned.

Pezotettix giornae. Particular in respect to vegetation. Absent in stubble slopes with steppe, at best occurs in grasses containing more luxuriant, higher plants (surveys 23, 14) and above all in *Salvia*. *Salvia* and lavender are its favourite foods. Equally considerable in the more open and the shadier parts of the oak park-forest (on an average of 3587 specimens/ha, or 361 g/ha). It reaches its greatest density (in some places above 5000 specimens/ha) in 10—30 cm high grasses, affording complete cover.

Chortippus species. The combined *Chortippus* species are nearly always the most important in the Saltatoria populations of mesophile meadows, as I have already pointed out on another occasion (NAGY, 1943 II). They figure in the hygrophile meadows of the peninsula with an average of 14,000 specimens and on mesophile meadows with 15,000 per hectare, which — though there were great numbers of young larvae — represents a considerable amount of weight (1730 and 2080 g/ha respectively). The *Chortippus* species are therefore present in the Saltatoria populations of the meadows — as A and P values — in more than 50%. Exact evaluation according to species is difficult and uncertain, on account of the many small larvae.

Chortippus declivus. The most xerophile *Chortippus* species; very large, ecological plasticity nearly approximating that of *Stauroderus bicolor-mollis*. On slopes with steppe assn. and hygrophile meadows it is scarce, but considerable in areas of transitional type, as well as in the drier types of mesophile meadows.

Chortippus dorsatus. Stenoeic, constant meadow species. It was the least important of the *Chortippus* species.

Chortippus parallelus. A species constant to the hygroleimon with slightly greater plasticity than the preceding, manifested chiefly in that it also occurs in the drier types of mesophile meadows (surveys 14, 1, 2 and 13), though not regularly, in large numbers. In P it proved the most important of the *Chortippus*: 659 g/ha in mesophile meadows, 551 g/ha in hygrophile.

Chortippus elegans. A species important principally in mesophile meadows, with almost the same ecological plasticity as the preceding. It is found particularly in localities overgrown with alkali vegetation (*Agrostis alba* — *Aster pannonicus*).

Chortippus longicornis. Stenoeic grasshopper, typical of enclosed habitats with fairly high (20—40 cm) grass, with great and

constant moisture (land which even in August is watery, swampy, marshy). Surveys 8 and 9 are good examples of the effect of the height of the vegetation in creating *A*. In 7—25—30 cm grass of a biotope with this kind of vegetation mown previously there were 3994 specimens per hectare; in unmown 35—40 (—50) cm grass there were 1946. In hygrophile meadows (type VI) the average was 2558 specimens/ha = 377 g/ha.

Mecosthetus grossus. Stenoecic, constant grasshopper in hygrophile meadows—though showing large variations in density according to locality. The most important species of *Saltatoria* in the hygrophile meadows, owing to its great average *A* (10,226/ha) and considerable *P* (2326 g/ha).

In the following Table are given the ecological plasticity and average *A*, also for species not described above:

TABLE I.

The *Saltatoria* species of the Tihany peninsula grouped according to their ecological plasticity and average *A* for 1947.

Degree of plasticity	Great <i>A</i> , above 5000 ind./ha	Medium <i>A</i> , 1000—5000 ind./ha	Small <i>A</i> below 1000 ind./ha
stenoecic species	Omoc. pert., Gomph. rufus, Mecosth.	Gomph. macul., Doc. cr. brev., St. stigm., Ch. dors., longic., Omoc. rufip., Rhacocleis	Acrida, Oedaleus, Sta. bigutt., St. nigrom., Parapleurus, Chrysoch- raon, Leptophyes, Phaneroptera, Metr. grisea, affinis, vittata, roeseli, Con. dors., Homocoryphus, Oecan- thus, Pteronemobius, Ephippigera
species with fair ecol. plasticity.	Omoc. haemorrh.	Oedipoda, Con. fuscus	Acryd. bipunct., St. li- neatus, Liogryllus, Mantis
euryoecic species	Ch. parall., eleg., Sta. bicolor- mollis	Acryd. subul., St. cras- sip., Aeolop. thalass., Pezotettix, Ch. decl.	Calliptamus, Decticus, Gryll. desertus

CIRITICAL SUMMARY OF THE RESULTS

In habitats of different type and extent on the Tihany peninsula I made 43 surveys, 6 of them qualitative, lasting over one month, to discover the quantitative and qualitative distribution of *Saltatoria* insects. The vegetation served as basis for demarcating the habitats. To ascertain quantities I used the square band method covering $10 \times 1 \text{ m}^2$ at a time; the data on qualitative distribution were obtained by identifying 4625 specimens collected with a net.

The data on density of individuals per survey is presumably somewhat lower than in nature, for some of the animals which remain motionless escape attention. The values for relative quantitative conditions (dominancy) — Tables III and IV — are based on the quantities of *Saltatoria* which got into the net in the habitat in question

and it is probable that individuals of geophile species (e. g. *Gryllus*, *Liogryllus*) and of the most active motile-flying forms get into the sample only in a reduced percentage differing from their true distribution. This occurred noticeably and significantly in the *Aelopus thalassinus* species when the temperature rose above 30° C.

I combined the surveys, taking into consideration the dominant species and the biotope (primarily the vegetation), and in the 6 Saltatoria groups thus obtained it became possible to establish the species more or less faithful to the different population groups (types of biotope) and those regularly occurring in them (constant), then on this basis I could combine the typical combinations of species too showing the characteristic structure of the Saltatoria population groups.

Leaving out of consideration the interspecific relations, the Saltatoria populations established depend strictly on time and place too. Periodical investigations are needed to demonstrate the reciprocal effect of biotopes and their Saltatoria populations in relation to time and place. My own investigations offer something like a static cross-section of the quantitative and qualitative distribution of the Saltatoria in the middle of the vegetation period (end of July, beginning of August) in localities which are the most essential, or to a certain extent important, from the standpoint of the Saltatoria.

From my work in the summer of 1943 — fragments of which only have survived the war — I can state that the species and relative quantitative conditions (and certainly those of abundance and production too) under normal conditions scarcely vary essentially; the dominant species and the qualitative distribution of the species were similar in corresponding localities, for the two years.

I refer to the Tables (III and IV) concerning qualitative and relative quantitative conditions (dominancy), and in order to recapitulate I mention only the following: in xeroleimon areas (stubble fields, dwarf-grass pastures, slopes with steppe assn., oak park-forests) the *Stauroderus bicolor-mollis* generally dominates, sharing dominancy with other species according to the type of biotope. Thus on slopes with steppe assn. and exposed pastures with *Omocestus petraeus* and *Oedipoda coerulescens*; on less exposed slopes and in other habitats of transitional type with *Omocestus haemorrhoidalis* and *Stenobothrus crassipes*; in the oak park-forest (Quercetum stepposum) with the *Gomphocerus rufus* species, whereas in stubble fields (*Setaria-Polygonum-Stachys* assn.) it appears almost as monarch in relation to the *Calliptamus* and *Oedipoda*. Dominance of the *Chortippus* species and *Mecosthetus grossus* is typical in hygroleimon areas (mesophile and hygrophile meadows). Besides the dominant species mentioned here the Saltatoria population groups of xeroleimon areas (types I—IV) as well as hygroleimon (types V—VI) have their own characteristic species — of local type — as can be seen from Table V and from typical combination of species.

The data on density obtained with the square-band method (see appendix), measurement of the live weight of the species (Table II) and the relative quantitative data obtained by collecting with a net (Tables III and IV) make it possible to obtain absolute quantitative data per species and per Saltatoria population, then from their total

we establish the absolute quantitative data per *Saltatoria* population group, i. e. the number of specimens per hectare (Table VI) and the weight quantities at the time of the investigation (Table VII) — that is in the midst of the vegetation period. The abundance and production data belonging to the identical *Saltatoria* population group, as they are based on the results of surveys made at the same, or nearly the same time, can be compared directly: the data obtained from surveys at greater intervals — the original numbering of the surveys also refers to their chronological order — may now be compared with precaution, for the abundance can decline to a considerable extent in 2–3 weeks — production somewhat less — as I have more fully reported.

We find fairly sharp differences in the types of habitat of the *Saltatoria* population groups in regard to species and relative quantitative relations, less so in abundance and production. Extreme values are found the *Saltatoria* population group within the type of habitat, but the average abundance and production data for most groups (types) are fairly near to one another and the existing 10–30–60% differences shown — particularly in respect to abundance — are in all probability less than the quantitative changes occurring during the vegetation period.

The abundance values established during the period of the investigation were the highest in the sparse oak park forest without undergrowth: 58,000 specimens/ha; in localities of transitional character and in hygrophile meadow the averages were 30,552 and 28,375/ha respectively, and in stubble fields, slopes with steppe assn. and mesophile meadows the average density was uniformly low: 21,145 — 18,489, — 23,036 ind./ha). It is to be noted that these abundance values mean only a smaller proportion of the populations considerably diminishing in numbers during the vegetation period. The production values — as the data of BALOGH and LOKSA (1948) have shown — reach their maximum at about the same period (July 17 — August 13), for besides their still considerable abundance, the *Saltatoria* have for the most part developed already. The production value corresponding to the greatest abundance is also greatest in the *Stauroderus bicolor-mollis* — *Gomphocerus rufus* population group (*Quercetum stepposum*): 7561 g/ha; in hygrophile meadows (type VI) 4658 g/ha. In habitats of other types (slopes with steppe, stubble fields, mesophile meadows, transitional types) the live weight was between 2558–3494 g/ha.

In the surveys with great abundance and production the percentage of larvae was always large too (above 30–40%). Development as connected with this, as well as the possibility of there being two generations a year, demand further periodic study.

Production rises parallel with the height (quantity) of the vegetation in habitats favourable to *Saltatoria*.

The *Saltatoria* populations generally achieve the greatest abundance and production in those habitats with physiognomically and floristically varying vegetation, which was 3–5–7 (–15–20) cm in xeroleimon areas and 7–15–20 (–40) cm in hygroleimon areas, with 90–95 and 95–100% coverage respectively.

APPENDIX

Notes on the places surveyed

All the surveys were made on the Tihany peninsula, which projects into Lake Balaton (western Hungary). For lack of space I can give no account of geomorphological nor general climatic and vegetative, etc. conditions. A great many studies on them can be found in earlier volumes of this publication and elsewhere.

Omitting particulars on place and time of the surveys, I give some brief data on the vegetation: in parenthesis () the plants found in greatest quantities in the societies; the height of the vegetation in cm — with the height of the taller sublevels with less cover in () — and the degree of cover in %. I give the original data from the squares (per 10 m²) used to establish abundance (A), the number of specimens of animals taken by insect net and serving as a basis for data on species components and relative quantities, and, finally, the percentage of larvae.

The numbers of the surveys remain as given in the field, so that they correspond to the numbers of the material of the collection conserved separately for each survey, preserved in the Zoological Institute of the University of Debrecen.

1. Külső-tó, July 25, 1947 (10 hrs.) *Festucetum pseudovinae* (*Cynodon*); 5–7 cm, 95–100%, scarcely drying thick grass. In the vicinity: *Agrostis-Aster* assn., *Pastinaca* facies of mesophile meadow (survey 2). A: 9, 18, 9, 8, 7 = 10.2 average. Collected: 80 specimens (8.8% larvae).

2. Northern border of Külső-tó, July 25, 1947 (11 hrs.). *Pastinaca* facies of mesophile meadow (*Daucus*, *Trifolia*, *Lotus corniculatus*); 7–10 (–50–60) cm, 100% — 40% green grass. In vicinity: *Festucetum pseudovinae* (survey 1) ploughed fields. A: 6, 9, 6, 5 = 6.5 average. Collected: 48 specimens. (14.5% larvae).

4. E border of Külső-tó, July 26, 1947 (11 hours) Marshy meadow [roughly *Agrostis alba* — (*Deschampsia caespitosa*) — *Carex distans* complex], covered with coloured, variegated grasses (*Cirsium canum*, *brachycephalum*, *Cichorium*, *Trifolium pratense*, *Ononis*, *Centaurea pannonica*, *Lotus*, *Leonodon autumnalis*, *Achillea*, etc.), in very good green condition: 7–10–15 (–25) cm. 100%. In vicinity: fallow land, *Agrostis-Aster* assn. A: 57, 44, 48 = 51.5 average. Collected: 106 specimens (37.7% larvae).

5. SE border of Külső-tó, July 26, 1947 (12 hrs.) Marshy meadow; like the preceding, only more moist, with lumpy soil; (more *Carex*), 10–15–20 (–35) cm, 100%; in exceptionally good green condition. In the vicinity: drier types of marshy meadow. A: 56. Collected: 157 specimens. (51.6% larvae).

6 SE part of Külső-tó, July 26, 1947 (13 hrs.). *Plantago maritima* facies of *Agrostis alba-Aster pannonicus* assn. (*Cirsium*, *Lotus*, *Carex*), 3–10 cm, 90–95%, drying grass, an area of about 6000 m²; in the vicinity: *Agrostis-Aster* assn. A: 54, 34, 33, 32 = 38.2 average. Collected: 123 specimens (32.2% larvae).

7. S part of Külső-tó, July 29, 1947 (11 hrs.). Very wet type of marshy meadow (*Equisetum*, *Angelica*, *Mentha*, *Epilobium*, *Cirsium*, *Trifolium*, *Achillea*), 7–20 (–40) cm, 100%, lush green grass, wet swampy soil. In the vicinity: drier type of marshy meadow, ploughed fields. A: 33, 46, 39, 40 = 39.5 average. Collected: 244 specimens (57.4% larvae).

8. SW part of Külső-tó, July 29, 1947 (13 hrs.). Sedgy facies of marshy meadow (*Mentha*, *Inula*, *Juncus*). The same as survey 9, except with shorter grass (had been mown long before). 7–25–30 cm, 100%, good green condition. Ground somewhat uneven, very wet. In the vicinity: the same, but not mown (survey 9), and ploughed fields. A: 41, 22, 41 = 34.7 average. Collected: 217 specimens (70.5% larvae).

9. SW part of Külső-tó, July 29, 1947 (14 hrs.). Sedgy facies of marshy meadow (*Juncus*, *Mentha*, *Ranunculus*, *Lythrum*, *Orchis*). Same as preceding but not mown. 35–40 (–50) cm, 100%, thick, fibrous grass. A: 28, 30, 27 = 28.3 average. Collected: 131 specimens (64.1% larvae).

10. Újlaki-rét, July 30, 1947 (12 hrs.). Marsh-marsh meadow complex (*Schoenoplectus Tabernaemontani*, *Typha*, *Phragmites*, *Agrostis*, *Juncus*). A wet strip of ground about 30 m wide, 20–60, 80–120 cm high mosaic of vegetation, in good green condition. In the vicinity: area of following survey (11) and a highway. A: 7, 10 = 8.5 average. Collected: 16 specimens.

11. Újlaki rét, July 40, 1947 (12 hrs.). A small marsh meadow area with homogeneous mown grass (about 200 m²), 20 cm, 100%, in good green condition. A narrow strip wedged in between the areas of surveys 10 and 12. A: 18. Collected: 51 specimens (18.8% larvae).

12. Újlaki-rét, July 30, 1947 (13 hrs.). Mown meadow, homogeneous, fibrous Graminea grass (*Trifolium*), 7–10 (–15), 95–100%, in fairly good condition, somewhat

trampled. Ground 50 cm higher than the preceding (reclaimed) areas (surveys 10, 11). In the vicinity: drier (survey 13) and damper types of meadow (Surveys 10, 11). A: 33, 33 = 34 average. Collected: 240 specimens (31.7% larvae).

13. Ujaki-rét, July 30, 1947 (13 hrs.). Mown meadow, a somewhat drier part and with more varied vegetation (*Agropyrum*, *Cynodon*, *Trifolium*, *Achillea*, *Daucus*, *Pastinaca*), 5—7—10 cm, 80—90%, a drying, narrow-bladed stand. In the vicinity: damper meadow habitats. A: 22, 14, 20 = 18.7 average. Collected: 114 specimens (6.1% larvae).

14. Diósi-rétek (neck of peninsula), August 1, 1947 (10 hrs.). Variegated mown meadow (*Festuca*, *Salvia pratensis*, *Ononis*, *Scabiosa*); 15—25—40 cm, 100%, thick green grass. In the vicinity: ploughed fields (on the slopes of Diós-tető hill), meadow (survey 15). A: 56, 50 = 53 average. Collected: 294 specimens (72.1% larvae).

15. Diósi-rétek, August 1, 1947 (11 hrs.). Mesophile meadow *Daucus-Pastinaca-Cirsium* aspect (*Achillea*, *Centaurea*, *Lotus*, Graminea, *Ranunculus*, *Centaureum*, *Euphrasia*); 20—30 (—40—60) cm, 100%, thick, variegated herbage, in very good condition. In the vicinity: the areas of surveys 14 and 16. A: 28, 14, 31 = 24.3 average. Collected: 153 specimens (30.0% larvae).

16. Diósi-rétek (meadows), August 1, 1947 (12 hrs.). Homogeneous sedgy grass, a small hollow (about 100 m²) in the preceding (15) habitat. 30—40 (—50) cm, 100%, fibrous good green. (Only qualitative collection.) Collected: 63 specimens (14.3% larvae).

17. Diósi-rétek, August 1, 1947 (13 hrs.). Marshy meadow (*Agrostis alba-Carex distans* complex), on lumpy, watery soil here and there with „zsombék” (*Carex*, *Juncus*, *Typha*, *Caltha*, *Alisma*). 40—50—70 cm, 100%, fibrous, homogeneous, green grass. In the vicinity: drier types of meadow (surveys 15 and 16). A: 3, 0, 7, 3 = 3.2 average. Collected: 32 specimens (6.2% larvae).

18. On the E slope of Echo Hill (Viszhang-domb), 140 m above sea level, August 3, 1947 (9 hrs.). Small clearing (about 30 m²) among tall *Acer-Robinia-Sambucus* bushes (*Lamium*, *Leonurus*, *Agropyrum*, *Rosa*, *Clematis*) 30—50 (—70) cm, 100%, bladed-foliated texture. In the vicinity: a wood planted with *Robinia-Acer-Pinus*. (Only qualitative collection.) Collected: 19 specimens (36.8% larvae).

19. On the E slope of Viszhang-domb, 190 m above sea level, August 3, 1949 (9 hrs.). 3—5 m fruit trees with *Festuca sulcata* grass level, 5—10 cm, 80—90% (cover at foliage level: 20%), somewhat dry grass, 10—15° slope. A: 29. Collected: 90 specimens (73.3% larvae).

20. Summit of Óvár, 200 m above sea level, August 3, 1947 (10 hrs.). *Festuca sulcata-Carex humilis* grass (*Scabiosa*, *Salvia*, *Medicago*, *Thymus*), 4—7 (—15 cm, 95—100%, a bladed, drying stand with much moss. About 100 m². In the vicinity: vineyards with hedges of fruit trees. O: 28. Collected: 71 specimens (36.6% larvae).

21. SW 20° slope of Óvár, 160—180 m above sea level, August 3, 1947 (11 hrs.). *Festuca-Cynodon* pasture (*Achillea*, *Andropogon*, *Teucrium*) 3—4 cm, 75—80—90%, half dried, fibrous grass, slightly uneven ground, with scattered stones. An extensive habitat. A: 11, 8, 3, 4, 5 = 7.7 average. Collected: 50 specimens (32% larvae).

22/a. Summit of Óvár, August 3, 1947 (12 hrs.). *Festuca sulcata-Stipa* grass on a 25° S slope (*Xeranthemum*, *Artemisia*); 200 m above sea level, 5—10—15 cm, 60—70%, drying, bunchy grass. In the vicinity: fruit trees, vineyards, as well as other slopes with steppe assn. (surveys 23, 22/b). A: 11, 20, 14 = 15 average; Collected: 36 specimens (38.9% larvae).

22/b. Summit of Óvár, August 3, 1947 (12 hrs.). Same as preceding, except that incline is steeper (5°); 7—15 (—40) cm, 90%, drying grass. In the vicinity: areas of surveys 21, 22/a and 23. A: see preceding. Collected: 49 specimens (42.8% larvae).

23. Summit of Óvár, August 3, 1947 (13 hrs.). *Festuca sulcata* grass, with much *Salvia*, 7—20 (—40) cm, 95—100%, bladed-foliated, grass in good green condition, wedged in between the two previous habitats. All three of small extent (50—200 m²). The last a slope of 3—7°. A: 51. Collected: 241 specimens (62.6% larvae).

24. Kiserdő, a hill 150 m above sea level, August 6, 1947 (9 hrs.). *Festuca sulcata* (-*Stipa*) grass (*Andropogon*, *Euphorbia*, *Thymus*, *Scilla autumnalis*, *Xeranthemum*, *Eryngium*), 2—5 (7—10) cm, 85—90%, fibrous, bunchy, half dry grass. On a small subsidiary NW 7° slope of the principal SE slope. In the vicinity: bushes and orchards. A: 6, 17 = 11.5 average. Collected: 62 specimens (19.3% larvae). The collection was made in a strong N wind.

25. Kiserdő, E 5° slope, 150 m above sea level, August 6, 1947 (10 hrs.). *Festuca-Andropogon* pasture grass (*Artemisia*, *Thymus*, *Scilla autumnalis*); 2—4 (—7) cm,

* „Zsombék” (Hung.) = Bunch of plants forming a hillock on swampy etc. ground.

80—90%, three-quarters dry, bushy grass. Ground surface somewhat disturbed (grubbed up.) About 400 m², in the neighbourhood fruit trees, kitchen gardens. A: 18. Collected: 107 specimens (5.6% larvae).

26. SE slope of Kiserdő, 150—180 above sea level, August 6, 1947 (11 hrs.). — *Festuca* (—*Stipa*) — *Andropogon* grass in an orchard (almond), (*Eryngium*, *Euphorbia*, *Xeranthemum*, *Teucrium*, *Linum*; *Scabiosa*); 3—5 m almond tree foliage-level cover: 20% 2—4—10 (—20—30) cm 90—100%, fibrous, half dry grass, uneven, stony ground. In the vicinity: vineyards. A: 32, 37, 32 = 34.7 average. Collected: 200 specimens (40.0% larvae).

27. Apáti-hegy hill, foot of SE slope, August 10, 1947 (10 hrs.). Stubble (after oats-vetch: *Rubus*, *Convolvulus*, *Stachys*); 15—25 cm. 80—95%, homogeneous, loosely foliated herbage in fairly good condition. In the vicinity: pastures and ploughed fields. A: 38, 42, 31, 28, 21 = 32 average. Collected: 227 specimens (67.8% larvae).

28. Apáti-hegy, SE slope, 140 m above sea level, August 10, 1947 (11 hrs.). *Setaria-Rubus* stubble (*Convolvulus*, *Consolida*, *Cirsium*, *Melilotus*, *Chenopodium*); 10—20 (—30) cm, 70—80%, very sparse, fibrous-foliated drying grass. In the vicinity: stubble of preceding (27.) survey and pasture (survey 29). A: 18, 21, 22, 38, 22, 18 = 23.2 average. Collected: 110 specimens (55.5% larvae).

28/a. Kiserdő, foot of S slope, August 10, 1947 (8 hrs.). *Setaria-Erigeron-Chenopodium* stubble (*Convolvulus*, *Stachys*, *Consolida*); 5—10—30—40 cm, 60—50%, fibrous-foliated grass in fairly good condition. In the vicinity: a path (bordered by abundant *Festuca*), ploughed fields. (Only qualitative collection.) Collected: 36 specimens (13.4% larvae).

28/b. Kiserdő, foot of S slope, August 10, 1947 (8 hrs.). Stubble with *Consolida-Erigeron-Stachys-Sideritis* vegetation (*Nigella*, *Convolvulus*, *Rubus*), 5—10 cm, 60—75%, sparse grass. (Only qualitative collection.) Collected: 46 specimens (34.8% larvae).

29. Apáti-hegy hill, about 160 m above sea level, August 10, 1947 (12 hrs.). *Festuca sulcata* pasture grass (*Prunus spinosa*, *Crataegus* and *Rose* bushes, *Thymus*, *Scabiosa*, *Stipa*, *Eryngium*, *Scilla autumnalis*, *Andropogon*, *Sedum*, *Teucrium*), 5—7 (—10) cm, 90—95%, fibrous-bunchy, drying vegetation. A very extensive habitat. A: 43, 40, 36 = 39.6 average. Collected: 167 specimens (38.3% larvae).

30. Nyereg-hegy hill, N slope, 190 m above sea level, August 10, 1947 (13 hrs.). (*Festuca sulcata*, *Agrostis tenuis*, *Melica ciliata*, *Agropyrum* vegetation (*Eryngium*, *Galium*, *Convolvulus*, *Sedum*, *Hipericum*, *Euphorbia*; *Phleum*); with here and there bushes; 15—30 (—50—60) cm, 95—100%, bladed, shrubby, half dried herbage, on disturbed (by planting) stony ground. 10° slope. In the vicinity bushy, woody slopes. A: 14, 9, 11 = 11.3 average. Collected: 56 specimens (33.9% larvae).

31. Summit of Nyereg-hegy hill, 225 m above sea level, August 10, 1947 (15 hrs.). *Festuca sulcata-Carex humilis-Stipa* grass (*Andropogon*, *Eryngium*, *Euphorbia*, *Scilla autumnalis*, *Iris*, *Artemisia*, *Thymus*, *Sedum*, lichens); 10—30 (—40) cm, 80—85% bladed-shrubby, half dried vegetation, on a S 5° slope; the ground stony-rocky. About 1000 m² in extent. In the neighbourhood shrubby-woody slopes. A: 9, 7, 6 = 7.3 average. Collected: 45 specimens (2.2% larvae).

32. Kiserdő. Foot of SW slope, August 13, 1947 (10 hrs.). Wheat stubble with *Polygonum aviculare-Stachys annua* plant society (*Convolvulus*, *Chenopodium album*, *Rubus*); 3—15 (—20) cm, 80—90%, fibrous-foliated herbage in fairly good condition. About 1 ha in area. In the vicinity the Külső-tó meadow and ploughed fields. A: 12, 13, 19, 7 = 12.7 average. Collected: 53 specimens (47.2% larvae).

33. Rátaí csáva (a small patch of meadow in the W part of the peninsula), August 13, 1947 (11 hrs.). Small marshy meadow (about 100 m²). *Carex* p. p. *Bolboschoenus*?) — *Potentilla reptans* society (*Vicia*, *Cirsium*, *Rorippa*, *Heleocharis*); 15—20—30 (—40) cm, 100—95%, below a foliated, above a fibrous stand, in good green condition. In the vicinity: ploughed fields. A: 12, 4, 20, 10, 11 = 11.4 average. Collected: 155 specimens (32.2% larvae).

34. Gurbicsa-tető summit, August 13, 1947 (13 hrs.). *Quercetum stepposum* (*Festuca*, *Andropogon*, *Plantago*, *Thymus*), 3—5 cm, 100%; fibrous-bushy half dry grass level, with very scattered small bushes. 5—7° N, NE slope. Only qualitative collection. Collected: 70 specimens (25.7% larvae).

34/a. Hosszúhegy, a hill 140 m above sea level, August 13, 1947 (15 hrs.). Mixed broad leaved forest (chiefly *Quercus sessilis*), with scattered trees, small bushes. Grass level in variegated, good condition. Only qualitative collection. Collected: 44 specimens (11.4 larvae).

35. Gurbicsa-tető, 150 m above sea level, August 13, 1947 (14 hrs.). *Quercetum stepposum* (at grass level: *Festuca*, *Poa*, *Plantago*, moss); 3—5 (—7—15) cm, 100%

fibrous, half dry, trampled grass. No shrub level. Oak and elm trees at 5–8 m distance: foliage crown cover 30–50%. About 4 ha in extent, with slight NE slope. In the vicinity forest with shrub stratum. A: 58, 65, 51 = 58 average. Collected (principally in the more open, less shady parts): 113 specimens (40.7% larvae).

35/a. The same as the preceding. Collected in scattered bushes near a shady enclosed forest with shrub stratum: 144 specimens (31.9% larvae).

36. Gurbicsa-tető, 160 m above sea level, August 13, 1947 (15 hrs.). *Festuca-Andropogon* summit clearing surrounded by shrubs and planted pines. (*Euphorbia*, *Thymus*, *Verbascum*, *Nigella*, *Scabiosa*, *Cynodon*, *Achillea*, *Potentilla*) 3–6 (–10–40) cm, 95–100%, fibrous, here and there foliated, half dry grass, on flat land, about 1000 m². A: 28, 28, 38 = 31.3 average (16.4% larvae).

37. Kiserdő foot-slope, August 17, 1947 (8 hrs.). Barley stubble with *Setaria glauca*-*Stachys annua* society (*Convolvulus*, *Medicago*, *Reseda*, *Cirsium*, *Rubus*). 10–15 cm, 80%, grass in fairly good condition. Area of about 1 ha on 3° W slope. In the vicinity: shrubby Kiserdő slope, fallow land, and meadow of Külső-tó. A: 15, 19, 16 = 16.7 average. Collected: 58 specimens (36.2% larvae).

38. Külső-tó, E border, August 17, 1947 (10 hrs.). In the vicinity of area of survey 4. Marshy meadow (roughly *Agrostis alba*-(*Deschampsia caespitosa*)-*Carex distans* complex), with variegated colourful herbage (*Centaurea pannonica*, *Trifolium pratense*, *Cichorium*, *Cirsium*, *Achillea*, *Ranunculus*, *Lotus*, *Inula*, *Plantago*, *Festuca pseudovina*, *Dactylis glomerata*, *Carex*, etc.) about 1 ha in extent. 7–10–15 (–30) cm, 100%, fibrous, somewhat foliated, good green herbage. In the vicinity: ploughed fields, alkali meadow. A: 16, 20, 21 = 19 average. Collected: 161 specimens (21.7% larvae).

39. Middle of Külső-tó, August 17, 1947 (11 hrs.). Alkali marshy meadow with *Agrostis alba*-*Aster pannonicus* plant society (*Agropyrum*, *Lotus*, *Inula*, *Cirsium*, *Phragmites*); 3–5–10 (–15–20) cm, 90–100%, three-fourths dry grass. In the vicinity: marshy meadow of better quality. A: 23 (a patch of *Agrostis*-*Agropyron* vegetation), 7, 6, 5, 8, 8 = 8.7 average. Collected: 18 specimens (no larvae).

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КАЧЕСТВЕННЫЙ И КОЛИЧЕСТВЕННЫЙ АНАЛИЗ СОСТАВА САЛТАТОРИЙ НА ПОЛУОСТРОВЕ ТИХАНЬ

Автор: Др. НАДЬ БАРНАБАШ

КРАТКОЕ ИЗЛОЖЕНИЕ

В течении одного месяца мне удалось сделать 43 снимка (из них только 6 штук количественного характера) на различных по характеру и размеру культурах полуострова Тихань. Снимки сделаны с целью выяснить количественное и качественное распределение насекомого Салтатория. За основу в разграничении культур служит растительность. Для определения количественных связей я применял квадрат сита покрывающего сразу 10 квадр. метров; к данным количественного распределения я добился путем анализа 4625 экземпляров собранных мною сеткой употребляемой на лугах. (конусная сетка.)

Должны предполагать, что данные о сущности особей на снимках немного нищие чем в действительности, потому что часть насекомых, которые по всей вероятности оставались неподвижными, остались вне моего наблюдения. Экземпляры установленные при релятивно-количественных условиях (*determinantialis* 3 и 4 таблицы) из состава культур Салтатории попавших в сетку, основаны на количестве попавших в сетку, и по всей вероятности это геофильные породы (напр. *Gryllus*, *Liogryllus*) и особи самых деятельных — движущих — летающих пород, но процентный состав их среди попавших в сетку низок, не отвечающий действительным условиям. Заметно и значительно повышается % породы *Aeolopus thalassinus*, если мы температуру повысим до 30° С.

Господствующие (*dominans*) породы, а также приняв во внимание биотоп (в первую очередь растительность), я сравнил снимки, сконцентрировал все и в полученных мною 6-ти группах состава Салтатории мог установить породы более или менее связанные (*fidelis*) к некоторым группам состава Салтатории (к типу биотоп) и породы постоянно находящиеся (*konstanta*) в них, потом на этой основе я мог составить и типичные комбинации пород показывающих характерности групп состава Салтатории.

Не принимая во внимание внутреннюю специфическую реляцию установленных составов Салтатории, предполагаем, что они находятся в сильной зависимости от пространства и времени. Для того, чтобы показать условия пространственных и временных взаимодействий биотоп, вернее составов Салтатории, нужны периодические анализы.

Мои собственные анализы, все до одного показывают картину статистического профиля в средней части периода вегетативного размножения. (конец июля, начало августа) в количественном и качественном распределении Салтаторий в тех культурах, которые с точки зрения Салтаторий являются самыми существенными вернее хотя бы до некоторой степени являлись бы существенными.

То, что связь между породами состава в Салтаторий и количественной релятивизацией (можно предполагать, что и абундационная связь и связи внутренней продукции) среди нормальных условий вряд ли изменяется существенно, я мог установить на основе результатов анализа проведенного мною летом в 1943 году, к сожалению от них осталась только незначительная часть по причине военных действий; распределение доминирующих и количественных пород в соответствующих для них культурах было одинаково в течении двух лет.

Насчет качественных, а также количественных релятивных (*dominantialis*) отношений я ссылаюсь на таблицы (3—4 таблицы), подытоживая здесь могу подчеркнуть следующее: в ксеромон-грунте (живня, пастбища с карликовой травой, склоны степей, дубовые парки всеобщее господствующей породой является *stauroderus bicolor-mollis*, которая как тип биотопа объединяется каждый раз с другими породами в доминанте. Так на степных склонах, на экспонированных пастбищах преобладает *Omocestus petraeus*, *Oedipoda coerulescens*, в менее экспонированных и в других переходного типа культурах мы находим *Omocestus haemorrhoidalis*, *stenobothrus crassipes*, в дубовых парках — *Quercetum stepposum* вместе с породой *gompocerus rufus* преобладает, тогда как на живнях господствует *Setaria-Polygonum-atrachis* assz. наравне с *Calliptanus* и *Oedipoda*. На грунте Гидролеймок мезефиль и гидрофиль-лугах) характерны доминанты пород — *Chortippus* и *Mecostethus*. Кроме упомянутых здесь доминирующих пород как в ксеролеймон грунте (I—IV тип.), так и в гидролеймон-грунте (V—VI.) групп состава Салтаторий имеются еще свои-местного характера типичные породы, которые мы можем увидеть на 5-ой таблице, а также в типичных комбинированных породах.

Данные о сгущенности полученные при помощи применения квадратного сита (смотри приложения) примененного для измерения живого веса пород (2 таблица), а также те данные которые были собраны на основе собранного луговой сеткой и установленные таким образом количественные данные (3 и 4 таблицы) дали возможность установить по породам составам Салтаторий, а после подведения итогов групп составов Салтаторий и абсолютно-количественные данные или же число экземпляров приходящихся на один гектар (6 таблица), а также вес (7 таблица) во время анализа, значит в середине периода вегетативного размножения.

Между тождественными данными продукций и абундаций групп ситава Салтатория учитывая, что они основываются на результатах тождественно проведенных снимков в недалеких друг от друга сроках, можно непосредственно произвести сравнение, но между данными полученными по снимкам проведенным в более далеких друг от друга сроках надо проводить сравнения с соответственной осторожностью, потому, что абундация и продукция могла в течении 2—3 недель в значительной мере уменьшиться, на что я и ссылаюсь подробнее. Оставшаяся еще подлинная порядковая нумерация показывает на хронологическую очередность. Замечаемые нами разницы довольно резко проявляющиеся в отношении количественной релятивизации и породистости типов культур групп состава Салтатории мы находим в абундации и продукции гораздо в меньшем количестве.

В группах состава Салтаторий внутри типов культур мы находим ценные экстремы, но в среднем в большей части групп — (типов) данные абундации и продукции относительно, довольно близко стоят друг к другу; имеются 10—30—60% разницы, это особенно относится к абундациям, по всей вероятности являются меньшими чем количественные перемены происходящие во время периода вегетативного размножения.

Установленная во время анализа ценность абундации была самой высокой в безкустарном, дубовом парке (*Quercetum steposum* 58 000 шт.) на г. в культурах переходного характера и в биотопах гидрофильных лугов в среднем: 30 552, точнее — 28 375 шт/г., тогда как на жнивьях, склонах степей и на мезофильных лугах одинаково низкая, там средняя единица сгущенности особей — 21 145, 18 489, 23 036 шт/г.

Надо заметить, что значимость (оценка) абундации в период вегетативного размножения значительно уменьшенного по количеству состава составляют только меньший процент, ценности продукции как это показывают данные И. Балюга и Локса (1948) приблизительно в период VII. 17 — VIII. 13 достигают до их максимальной величины, потому что Салтатории при все еще значительной абундации в своей большей части являются зрелыми. Соответственно самой большой абундации и ценность продукции тоже самая большая в группах состава *Gomphocerus rufus* — *Stauroderus bicolor* — *mollis* — *Quercetum stepposum* (7561 на) г.; на гидрофильных лугах (VI-тип): 4658 на/г. На других типовых культурах (склоны степей, жнивья, мезофильные луга), и в культурах переходного характера ценность была между 2558—3494 на/г.

Продукция Салтатории в благоприятных для нее культурах параллельно повышалась с количественным ростом растительности.

Состав Салтатория достиг самой высокой абундации и продукции в таких культурах, которые были богаты видовым и флористическим разнообразием растительности в которых высота растительности на грунте ксеролеймон 3—5—7 (15—20) на грунте гидролеймон 7—15—20 (40) см. при 90—95, точнее — 95—100% покрытия.

TABLE II.

Fresh weight (in gs) of *Saltatoria* species according to sex and stadium of development (Roman numbers). n = number of individuals weighed; in () estimated values.

Species	i m a g o				l a r v a	
	♂	n	♀	n	♂	♀
<i>Acrida turrita</i>			0,8600	2		
<i>Acrydium subulatum</i>	(0,0400)	—	(0,0700)	—	(0,0300)	(0,0600)
„ <i>bipunctatum</i>	(0,0400)	—	(0,0700)	—	(0,0300)	(0,0600)
<i>Parapleurus alliaceus</i>	0,1165	2	0,4188	2		
<i>Chrysochraon dispar</i>	0,1277	3	0,4800	1		
<i>Stenobothrus lineatus</i>	(0,1500)	—	0,4137	2		
„ <i>crassipes</i>	0,0518	6	0,1149	11		
„ <i>stigmaticus</i>	0,0575	4	0,1127	6		
„ <i>nigromaculatus</i>	0,1100	5	0,2829	10		
<i>Omocestus rufipes</i>	0,0481	7	0,2055	3		
„ <i>haemorrhoidalis</i>	0,0700	2	0,1569	4	(0,0300)	(0,1000)
„ <i>petraeus</i>	0,0455	7	0,0831	8		
<i>Stauroderus biguttulus</i>	(0,0869)	—				
„ <i>bicolor</i> -(mollis)	0,0869	59	0,1638	30	II—III. stad. :	
<i>Chortippus dorsatus</i>	0,0938	46	0,2400	36	(0,0300)	(0,0800)
„ <i>parallelus</i>	0,0993	59	0,2116	40		
„ <i>longicornis</i>	0,0926	46	0,2144	39	IV—V. stad. :	
„ <i>elegans</i>	0,0648	19	0,1660	33	(0,0600)	(0,1600)
„ <i>declivus</i>	0,0724	26	0,2100	27		
<i>Gomphocerus maculatus</i>	0,0600	1	0,0575	6		
„ <i>rufus</i>	0,0883	3	0,2515	7	(0,0600)	(0,1600)
<i>Dociostaurus cr. brevicollis</i>	0,0931	13	0,1859	9		
<i>Mecosthetus grossus</i>	0,1971	17	0,6248	10	(0,08-0,15)	(0,20-0,40)
<i>Aeolopus thalassinus</i>	0,1188	18	0,4244	11	(0,0800)	(0,3000)
<i>Oedipoda coerulescens</i>	0,1780	2	0,5545	5		
<i>Oedaleus nigrofasciatus</i>	0,2850	1	0,6297	3		
<i>Calliptamus italicus</i>	0,1654	2	0,9838	15		
<i>Pezotettix giornai</i>	0,0773	20	0,1319	16	(0,0600)	(0,1000)
<i>Leptophyes albovittata</i>	(0,1500)	—				
<i>Conocephalus fuscus</i>	0,1586	8	0,1853	7	(0,07-0,14)	(0,08-0,15)
„ <i>dorsalis</i>	0,1772	6	0,1870	4	(0,07-0,14)	(0,08-0,15)
<i>Homocoryphus nitidulus</i>	(0,3000)	—	0,3855	2		
<i>Rhacocleis germanica</i>	(0,3500)	—	(0,4000)	—		
<i>Metrioptera grisea</i>	(0,6000)	—	0,6847	3		
„ <i>affinis</i>	0,6312	5	0,7211	3		
„ <i>vittata</i>	(0,2500)	—	(0,3500)	—		
„ <i>roeselii</i>	(0,4000)	—	0,4500	1		
<i>Decticus verrucivorus</i>	1,7314	3	2,4862	4		
<i>Oecanthus pellucens</i>					(0,0600)	
<i>Pteronemobius heydeni</i>					(0,0100)	(0,0150)
<i>Liogryllus campestris</i>					(0,2000)	(0,2000)
<i>Gryllus desertus</i>					0,1252	0,2170
<i>Mantis religiosa</i>	(0,4000)	—	1,4975	4		

TABLE III.
Relative quantitative occurrence (= DI value, in %) of *Saltatoria* species in the different populations of surveys Nos 1—39 (abscissa), as figured from net collected material.

Species		28/a	28.b	27	32	37	24	25	21	31	22/a	29	26	22/b	23	19	30	1	14	36	34	20	35	35/a	34/a	18	39	13	12	11	2	15	38	33	16	6	4	17	10	5	7	8	9				
Acrida turrita									2.0									3.7					0.8		2.3				5.9			0.6	4.3	21.9	1.6	4.8	5.6		3.1	6.2	2.5	3.7	7.8				
Acrydium subulatum																			1.7																												
" bipunctatum																																															
Parapleurus alliaceus																																															
Chrysochraon dispar																																															
Stenobothrus lineatus									2.2				0.5		1.3		12.5	8.8	+		32.9	31.0	7.1	2.7	4.5						2.1					0.8											
" crassipes												5.4	1.0	4.1	2.5	6.7	5.3		5.4	11.7										4.1	0.6																
" stigmaticus																																															
" nigromaculatus							+	2.8	4.4	2.8	0.6	4.0	2.1	0.4						13.3																											
Omocestus rufipes																	5.3	66.3	39.5	9.4	5.7	1.4	5.3	12.5	11.4																						
" haemorrhoidalis							75.8	77.6	24.0	56.5	22.2	14.4	4.0	4.1	3.3		5.3											1.7	0.4		31.3																
" petraeus															0.4																																
Stauroderus biguttulus																1.1																															
" bicolor-mollis		94.5	72.2	82.6	91.2	94.3	89.7	3.2	2.8	32.0	8.9	55.6	70.1	82.0	59.2	86.3	81.1	6.1	42.2	55.7	62.0	65.5	41.0	45.5	26.3			0.9	1.2		8.3	9.8	8.7	9.0	1.6		0.9		9.2								
Chortippus dorsatus																		8.8	3.7																												
" parallelus				1.8																																											
" longicornis																		3.7																													
" elegans									2.0									3.7																													
" declivus										2.2	5.5		0.5	2.0	2.1	7.8	1.8	1.2	8.8	7.0	2.9	1.4	2.7	3.5	6.8		77.8	19.3	12.1	23.5	2.1	12.4	16.8	38.1	12.7	38.2	13.3	9.4	6.2								
Gomphocerus maculatus							11.3	6.5	22.0											0.8																											
" rufus								6.5																																							
Deciostaurus cr. brevicollis																																															
Mecosthetus grossus																																															
Aeolopus thalassinus																		6.3									+			2.0	4.1	0.7	0.7	+		15.4	1.9										
Oedipoda coerulescens		25.0	10.9	4.4	+	5.2	3.2	1.0	+	2.2	8.3	1.2	6.5	12.2	1.6	1.1	1.8			5.4	1.4	2.8	0.9		4.5																						
Oedaleus nigrofasciatus																																															
Calliptamus italicus	5.5	2.8		1.8	1.9	1.7		1.0	8.0	4.4	2.8		1.5		0.5	1.1	1.8		3.1	0.8	1.4		2.7	9.7		26.3	5.6	1.8			0.7		0.7		4.8	8.1	10.4	3.1			3.2						
Pezotettix giornai																																															
Stenobothrus s. lat. larva							6.5	0.9	8.0	2.2		0.5		12.2					31.3			1.4	2.6	2.1																			1.9				
Gomph. mac. seu Omoc. petr. l.								0.9												8.6																											
Omoc. haem. seu rufip. larva																																															
Staurod. seu Omoc. larva																																															
Chortippus larva adeterm.																																															
Leptophyes albovittata															0.4											5.3																					
Phaneroptera falcata															+											+	5.5																				
Conocephalus fuscus																																															
" dorsalis																																															
Homocoryphus nitidulus																																															
Rhacocleis germanica																																															
Metrioptera grisea										2.2		+	+				+	3.6					2.7	4.9	4.5																						
" affinis										11.1		+		2.1																																	
" vittata				+																																											
" roeselii																																															
Decticus verrucivorus				+	1.9					2.3							+																														
Ephippigera vitium																																															
Oecanthus pellucens											2.8																																				
Pteronemobius heydeni																		0.3																													
Liogryllus campestris																																															
Gryllus desertus	+		6.5	0.4	1.9	3.4																																									
Liogr. seu Gryll. larva																																															
Mantis religiosa				0.4						2.3						+	1.1	1.8																													

TABLE IV.
Relative quantitative weight conditions (= DG value, in %) of *Saltatoria* species in the different populations in surveys 1—39 (abscissa).

Species	28	28/a	28/b	27	32	37	24	25	21	31	22/a	29	26	22/b	23	19	30	1	14	36	34	20	35	35/a	34/a	18	39	13	12	11	2	15	38	33	16	6	4	17	10	5	7	8	9			
Acrida turrita Acrydium subulatum " bipunctatum Parapleurus alliaceus Chrysocraon dispar									6·8									1·4	1·0				0·5		0·6					2·5		0·3	1·7	9·6	0·4	1·7	1·8	1·1 14·0	2·0 3·3	0·8 3·6	1·2 1·3	32				
Stenobothrus lineatus " crassipes " stigmaticus " nigromaculatus										2·9		2·8	0·5 0·7	2·9	1·5 1·7	5·1	21·5 3·1	7·0	+ 5·7	7·7 8·2 1·7	22·2	19·5	4·1	1·7	2·5						1·7 1·2	0·6				0·8										
Omocestus rufipes " haemorrhoidalis " petraeus Stauroderus biguttulus " bicolor-mollis							63·3	58·8	11·5	12·3	9·7	16·9 4·5	1·6	2·3 0·6	3·1 0·3	0·9 72·0	1·9	65·5	29·7	7·7	4·5	0·7	6·4	9·7	8·5			1·3	0·1 0·2		14·8															
Chortippus dorsatus " parallelus " longicornis " elegans " declivus				1·4														11·9	7·0									47·2	1·0 19·4	3·4	32·1	56·8 4·5	11·4 30·6	3·6 13·8	64·5 6·7 3·4	4·3	5·8 29·9 ?	27·7		3·6 35·4 3·1 10·2	0·3 4·8 17·3 2·2	0·7 0·9 11·1 1·2	0·8 4·6 1·3			
Gomphocerus maculatus " rufus Doclostaurus cr. brevicollis Mecosthetus grossus							7·1	3·4	7·0											0·4			5·9	16·5	16·9	41·3										11·3	3·0		8·5	24·9	6·3	23·0	29·4	46·5	65·7	81·9
Aelopopus thalassinus Oedipoda coerulescens Oedaleus nigrofasciatus Calliptamus italicus Pezotettix giornai		44·3	38·4	11·1 +	+	19·5	16·4	1·9	+ 24·8 13·3	3·9	17·1	3·5	16·2	32·7	5·0	1·7	6·6	5·6		14·3	6·6	7·3	3·8		16·3		+			1·7	2·7	0·4	1·7	+		18·7	4·1		27·1							
Stenobothrus s. lat. larva Gomph. mac. seu Omoc. petr. l. Omoc. haem. seu rufip. larva Staurod. seu Omoc. larva Chortippus larva adeterm.							6·1	1·1 0·3	2·3	0·6		0·1		1·9					32·7			0·3	1·0	2·0															0·3							
Leptophyes albobittata Phaneroptera falcata Conocephalus fuscus " dorsalis Homocoryphus nitidulus															0·5 +				0·8							9·0 +	4·4						1·9 +	1·6	1·5	22·1 1·0	5·4	10·1	34·1	7·3			+			
Rhacocleis germanica Metrioptera grisea " affinis " vittata " roeselii Decticus verrucivorus Ephippigera vitium				+						4·9 24·2		+	+	8·0			+ 11·7						7·2	14·5	11·8						36·7						3·7 2·9									
Oecanthus pellucens Pteronomobius heydeni Liogryllus campestris Gryllus desertus Liogr. seu Gryll. larva Mantis religiosa	+		8·6	0·8	2·6	4·0					1·1							1·9					2·1		2·9		+					1·0	1·2 10·0	1·1		1·8	2·3 1·8			0·9	+	0·1				

TABLE V.
Average values of individual and weight dominancy (DI and DG [in fat type], in %) and grades of Constancy (K) and Fidelity (F in fat type) of the species in the
Saltatoria Population Groups I—VI (see text, p. 99—105).

Species	I.				II.				III.				IV.				V.				VI.			
	Di	Dg	K	F	Di	Dg	K	F	Di	Dg	K	F	Di	Dg	K	F	Di	Dg	K	F	Di	Dg	K	F
<i>Acerida turrita</i>					0.25	0.85	1	5																
<i>Acrydium subulatum</i>									0.46	0.18	1	1	0.77	0.27	3	1	4.96	1.98	3	3	3.37	1.19	4	2
" <i>bipunctatum</i>									0.21	0.13	1	2					0.04	0.02	1	2	0.52	0.18	1	2
<i>Parapleurus alliaceus</i>																	0.40	1.10	1	2	3.33	3.48	3	4
<i>Chrysochraon dispar</i>																	0.33	0.30	2	4	0.13	0.22	1	2
<i>Stenobothrus lineatus</i>					0.34	0.43	2	2	1.72	2.88	2	3					0.25	0.22	1	2				
" <i>crassipes</i>					1.31	0.81	2	1	13.04	9.01	5	3	4.15	2.09	4	1	0.33	0.12	1	1				
" <i>stigmaticus</i>									1.66	1.02	1	5												
" <i>nigromaculatus</i>					2.09	3.79	5	4	0.15	0.33	2	2												
<i>Omocestus rufipes</i>									0.71	0.56	1	2	7.30	6.07	4	4	0.03	0.08	1	2				
" <i>haemorrhoidalis</i>					2.31	2.41	2	1	15.65	13.57	4	3					2.38	1.16	2	2				
" <i>petraeus</i>					33.74	20.27	5	5	0.05	0.04	1	1												
<i>Stauroderus biguttulus</i>									0.14	0.10	1	5												
" <i>bicolor-mollis</i>	87.42	63.99	5	1	39.22	33.92	5	2	49.94	46.12	5	2	44.57	39.48	5	1	3.50	3.12	4	2	1.03	0.76	1	1
<i>Chortippus dorsatus</i>																	13.57	14.42	4	4	6.15	5.38	4	2
" <i>parallelus</i>	0.30	0.24	1	1					1.56	2.36	2	1					16.38	16.39	5	3	8.75	6.98	4	2
" <i>longicornis</i>																	0.40	0.42	1	1	9.22	8.16	5	5
" <i>elegans</i>					0.25	0.28	1	1	0.46	0.59	1	1					20.03	18.81	5	3	4.48	3.68	5	2
" <i>declivus</i>					1.27	1.21	3	1	4.12	4.63	5	2	3.25	3.17	4	1	12.49	11.95	5	2	1.55	1.62	2	1
<i>Gomphocerus maculatus</i>					4.97	2.18	2	4	0.10	0.04	1	2												
" <i>rufus</i>													22.45	20.14	5	5								
<i>Deciostaurus cr. brevicollis</i>					0.81	1.51	1	5																
<i>Mecosthetus grossus</i>																	2.67	5.35	2	3	31.72	42.16	5	4
<i>Aeolopus thalassinus</i>	0.73	1.85	1	1					0.80	0.70	1	1					2.69	3.30	4	4	3.13	4.52	1	1
<i>Oedipoda coerulescens</i>	6.85	17.04	5	2	4.32	11.45	5	2	1.76	5.19	4	2	1.35	5.03	3	1								
<i>Oedaleus nigrofasciatus</i>					1.00	3.10	1	5																
<i>Calliptamus italicus</i>	2.28	10.54	5	2	1.46	7.92	3	2	0.70	4.56	4	2					0.67	3.70	2	2				
<i>Pezotettix giornai</i>									0.54	0.48	2	1	9.67	8.71	4	2	5.96	3.90	3	3	1.05	0.73	2	1
<i>Stenobothrus s. lat. larva</i>					3.79	1.50			4.09	5.20			1.17	0.74							0.32	0.04		
<i>Gomph. mac. seu Omoc. petr. l.</i>					0.11	0.04																		
<i>Omoc. haem. seu rufip. larva</i>									1.06	0.83														
<i>Staurod. seu Omoc. larva</i>																	0.63	0.50						
<i>Chortippus larva adeterm.</i>																	2.40	1.90			13.22	8.51		
<i>Leptophyes albavittata</i>									0.05	0.06	1	3	1.32	2.26	2	3								
<i>Phaneroptera falcata</i>									+	+	1	5												
<i>Conocephalus fuscus</i>									0.05	0.10	1	1	+	+	2	1	4.13	4.28	3	3	10.03	8.59	4	2
" <i>dorsalis</i>																	0.10	0.12	1	5				
<i>Homocoryphus nitidulus</i>																	0.20	0.53	1	4	0.27	0.55	1	2
<i>Rhacocleis germanica</i>									+	+	1	2	3.02	8.29	4	4								
<i>Metrioptera grisea</i>					0.27	0.61	2	4	0.46	1.45	1	2												
" <i>affinis</i>					1.65	4.03	2	4									0.88	3.08	1	3				
" <i>vittata</i>	+	+	1	2													0.62	0.86	1	4				
" <i>roeselii</i>																					1.25	3.00	1	5
<i>Decticus verrucivorus</i>	0.32	3.44	2	2	0.29	2.20	1	1									0.03	0.60	2	3	+	+	1	1
<i>Ephippigera vitium</i>									+	+	1	5												
<i>Oecanthus pellucens</i>					0.35	0.14	1	5													0.23	0.02	2	5
<i>Pteronemobius heydeni</i>																					0.10	0.14	1	2
<i>Liogryllus campestris</i>									0.04	0.24	1	2	0.20	0.51	2	2	0.27	0.37	1	3	0.07	0.09	1	1
<i>Gryllus desertus</i>	2.03	2.66	5	3									0.57	0.73	2	1	1.20	1.15	3	3				
<i>Liogr. seu Gryll. larva</i>																	0.35	0.22						
<i>Mantis religiosa</i>	0.07	0.24	1	1	0.29	1.32	1	1	0.36	0.69	2	2	0.75	2.42	4	2								

TABLE VI.
Number of individuals of each *Saltatoria* species per hectare (A value) in the different habitats (surveys 1—39) grouped according to the type of population (SPG).

Species	I				II				III				IV		V								VI																
	28	27	32	37	24	25	21	31	22/a	29	26	22/b	23	19	30	1	14	36	20	35	35/a	39	13	12	11	2	15	38	33	6	4	17	10	5	7	8	9		
Acrida turrita							155																																
Acrydium subulatum																382					510								827	2501	1851	2915			101	527	1428	1458	2714
„ bipunctatum																	901											158						406	527	711			
Parapleurus alliaceus																																							
Chrysochraon dispar																												158								324			
Stenobothrus lineatus								163					632		1417												135				310								
„ crassipes										2138		612	1270	1934	607	892	2883	3672	8677	4106	1612						271	158											
„ stigmaticus																		4161																					
„ nigromaculatus						504		326	416	238	1357	306	209					244																					
Omocestus rufipes																				3080	7250																		
„ haemorrhoidalis																																							
„ petraeus					8718	13963	1860	4073	3333	5700	1347	612	1693		607	6757	20914	2939	395							2031													
Stauroderus biguttulus										3086		306	209																										
„ bicolor-mollis	21901	29178	12028	14941	371	504	2480	652	8334	27790	27606	8877	44018	322	7488		3244	13219	17352	37984	23763						541	2385	1653	1029		484		527					
Chortippus dorsatus																																							
„ parallelus		563														892	1982																						
„ longicornis																																							
„ elegans							155																																
„ declivus								163	834		168	306	1056	2256	203	382	4685	2203	395	1537	2013	6777	3603	4107	4235	135	3022	3186	4339	14497	6803	508	527	2850	162	159	215		
																127						484	4258	11193	12001	271		353	5193	1398	2161	17005	1781	7122	3994	1946			
Gomphocerus maculatus					1298	1117	1705											244																					
„ rufus						1177														5133	13294																		
Doclostaurus cr. brevicollis																																							
Mecosthetus grossus																													709	220	1232	7287	203	1071	9985	11818	17732	20547	
Aeolopus thalassinus		1408																																					
Oedipoda coerulescens				862	371	167		163	1250	476	2188	1836	847	322	203	637		1714	790	510						353	271	158	118		5860	973		1598					
Oedaleus nigrofasciatus							620																																
Calliptamus italicus	1263	563	241	287		167	155	326	416		505		209	322	203			244																					
Pezotettix giornai													632				1622			1537	5638	484	327	5243				158	2360	74	3083	5346	101		1781				
Stenobothrus s. lat. larva					742	167	620	163		238		1836					16584		395	1537	1206																		
Gomph. mac. seu Omoc. petr. l.						167																																	
Omoc. haem. seu rufip. larva																																							
Staurod. seu Omoc. larva																																							
Chortippus larva adeterm.																																							
Leptophyes albiovittata													209																										
Concephalus fuscus																																							
„ dorsalis																																							
Homocoryphus nitidulus																																							
Rhacocleis germanica																				1537	2819																		
Metrioptera grisea								163																															
„ elegans								815																															
„ vittata												306																											
„ roeselii																																					</		

TABLE VII.
Total weight of Saltatoria per hectare according to species in the different habitats (surveys 1—39) grouped according to the type of populations (SPG).

Species	I				II								III								IV		V												VI								
	28	27	32	37	24	25	21	31	22/a	29	26	22/b	23	19	30	1	14	36	20	35	35/a	39	13	12	11	2	15	38	33	6	4	17	10	5	7	8	9						
Acerida turrita							77									19	47			36					63		10	53	140	99	146	6	37	64	71	176							
Acrydium subulatum																																6	62	298	81								
” bipunctatum																											20		129														
Parapleurus alliaceus																																											
Chrysochraon dispar																																											
Stenobothrus lineatus							67			141	25	70	95	170	479	95	246	314	578	309	135					20	14	18		46													
” crassipes											39		106		70			334																									
” stigmaticus																		69																									
” nigromaculatus						143		92	118	67	352	87	60																														
Omocestus rufipes																				478	742																						
” haemorrhoidalis																																											
” petraeus					461	914	131	283	214	838	80	57	192		42	883	1286	312	21				37	7		177																	
Stauroides biguttulus																																											
” bicolor-mollis	2255	2892	1313	1828	52	39	367	82	954	3505	3453	1093	5138	28	911		328	1644	2120	4768	2955					57	252	218	153		43		87										
Chortippus dorsatus																																											
” parallelus		56														160	304										1897	345	53	251	486	155		298	39	46							
” longicornis																											150	926	201	2495	2917	72	252	1073	48	259							
” elegans							26									64																											
” declivus								34	118		12	64	135	296	42	27	538	294	21	253	312	1027	432	495	467	22	422	409	531	1990	932	40	112	845	133	603	259						
” declivus																																											
Gomphocerus maculatus					51	53	80											15																									
” rufus																				440	1261																						
Dociostaurus cr. brevicollis						188																																					
Mecosthetus grossus																												341	43	492	2078	35	437	2423	2882	3572	4608						
Aeolopus thalassinus		434														76									42	32	13	50			1083	340		514									
Oedipoda coerulescens				478	119	30		90	379	174	833	788	310	57	148			582	216	285																							
Oedaleus nigrofasciatus							284																																				
Calliptamus italicus	726	439	237	48		166	153	321	410		359		35	317	199			241				476	322				156		72														
Pezotettix giornai													46				134			143	579						368	228		307	411	13		166									
Stenobothrus s. lat. larva					44	17	26	13		7		46					1417			72	153												21										
Gomph. mac. seu Omoc. petr. l.						5																																					
Omoc. haem. seu rufip. larva																		269																									
Staurod. seu Omoc. larva																																											
Chortippus larva adeterm.																																											
Leptophyes albiovittata													31																														
Conocephalus fuscus																	33						77																				
” dorsalis																																											
Homocoryphus nitidulus																																											
Rhacocleis germanica																				539	1108																						
Metrioptera grisea								112																																			
” affinis								558				193																															
” vittata																																											
” roeselii																																											
Decticus verrucivorus				416				405																																			
Oecanthus pellucens									25																																		
Pteronemobius heydeni																																											
Liogryllus campestris																25				154																							
Gryllus desertus																																											
Liogr. seu Gryll. larva		30	52	98																																							
Mantis religiosa		56						244													403																						
Total weight	2981	3908	2019	2452	728	1553	1144	2302	2218	4953	5153	2413	6167	3336	2233	1348	4333	4073	2965	7476	7646	1736	2910	4157	2488	1197	3341	3026	1459	5799	8344	559	1895	8243	6194	5435	5623						

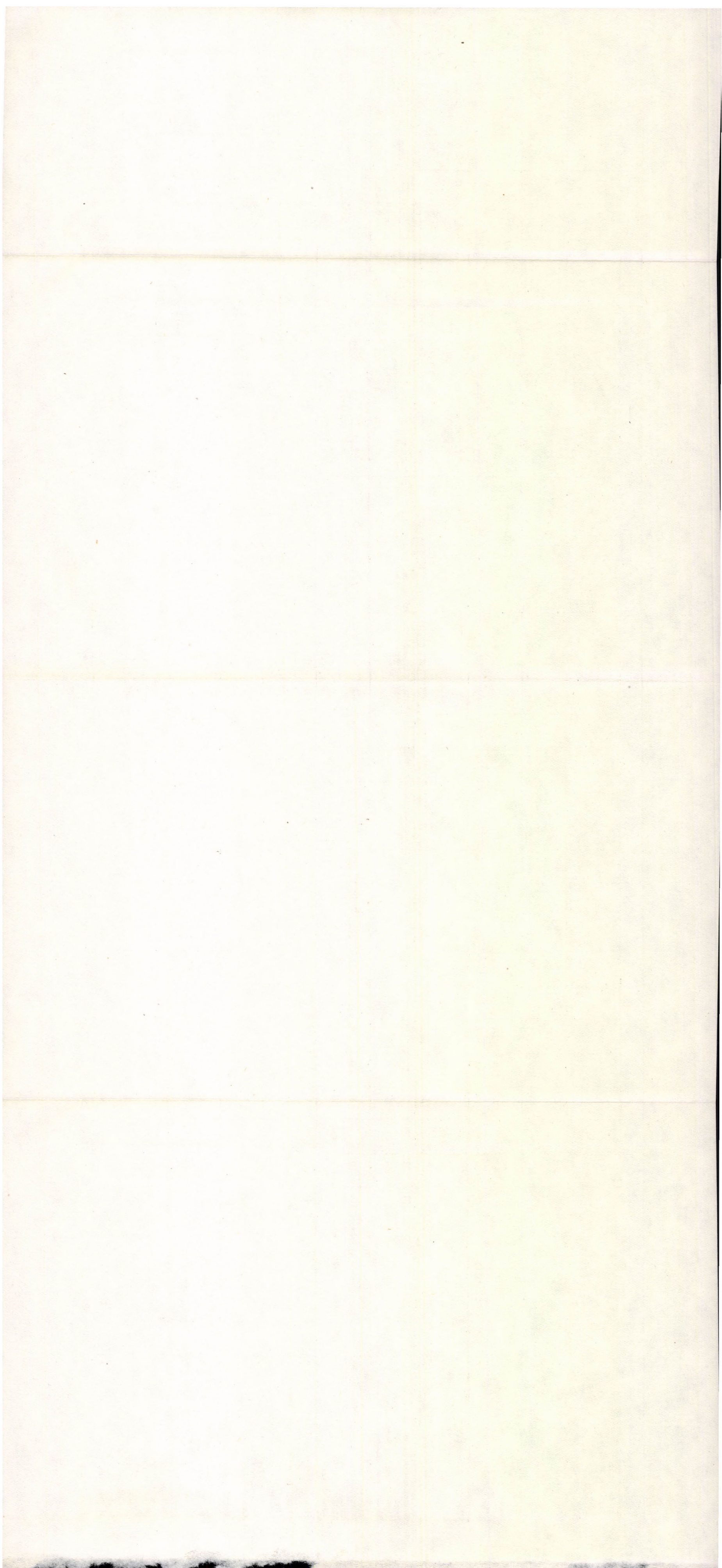
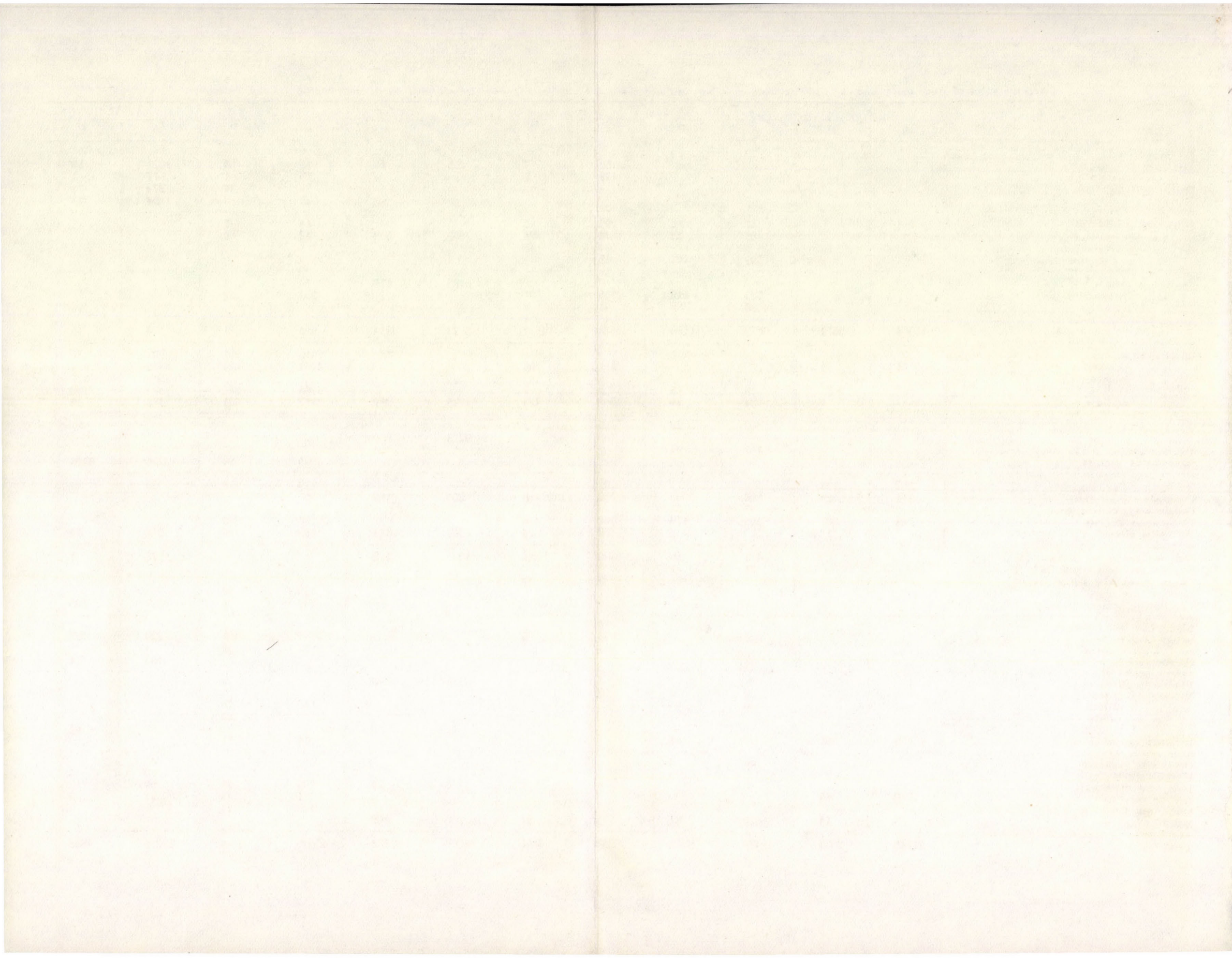


TABLE VIII.
Average value of Abundancy (ind/ha) and Production (g/ha) of Saltatoria found in types of SPG I—VI. established according to habitat types.

Species	I.		II.		III.		IV.		V.		VI.	
	A	P	A	P	A	P	A	P	A	P	A	P
<i>Acrida turrita</i>			19	10								
<i>Acrydium subulatum</i>					55	3	255	18	915	50	1021	58
" <i>bipunctatum</i>					129	7			16	1	17	1
<i>Parapleurus alliaceus</i>									37	13	274	73
<i>Chrysochraon dispar</i>									23	3	54	14
<i>Stenobothrus lineatus</i>			41	12	293	82			44	7		
" <i>crassipes</i>			486	32	2848	225	2859	222	43	3		
" <i>stigmaticus</i>					594	48						
" <i>nigromaculatus</i>			392	107	65	18						
<i>Omocestus rufipes</i>							5165	610	14	1		
" <i>haemorrhoidalis</i>			789	112	4758	391			250	23		
" <i>petraeus</i>			4586	290	30	3						
<i>Stauroderus biguttulus</i>					46	4						
" <i>bicolor-mollis</i>	19504	2072	9573	1193	15549	1792	30873	3861	668	81	88	15
<i>Chortippus dorsatus</i>									1916	291	698	84
" <i>parallelus</i>	141	14			411	66			4267	659	4655	551
" <i>longicornis</i>											2558	377
" <i>elegans</i>			19	3	55	9			4768	631	1488	192
" <i>declivus</i>			184	29	1561	193	1775	282	3317	431	105	22
<i>Gomphocerus maculatus</i>			522	23	35	2						
" <i>rufus</i>							9213	850				
<i>Dociostaurus cr. brevicollis</i>			147	24								
<i>Mecosthetus grossus</i>									945	296	10226	2326
<i>Aeolopus thalassinus</i>	352	108			91	11			773	156	266	86
<i>Oedipoda coerulescens</i>	216	120	806	302	554	188	255	142				
<i>Oedaleus nigrofasciatus</i>			77	35								
<i>Calliptamus italicus</i>	588	362	196	176	142	113			104	103		
<i>Pezotettix giornai</i>					322	26	3587	361	1969	180	314	30
<i>Stenobothrus s. lat. larva</i>			471	19	2425	204	1371	112			178	4
<i>Gomph. mac. seu Omoc. petr. l.</i>			21	1								
<i>Omoc. haem. seu rufip. larva</i>					385	39						
<i>Staurod. seu Omoc. larva</i>									180	22		
<i>Chortippus larva adeterm.</i>									742	74	4677	495
<i>Leptophyes albobittata</i>					30	5						
<i>Conocephalus fuscus</i>					26	5			1161	189	1326	217
" <i>dorsalis</i>									31	6		
<i>Homocoryphus nitidulus</i>											108	34
<i>Rhacocleis germanica</i>							2178	823				
<i>Metrioptera grisea</i>			20	14	58	37						
" <i>affinis</i>			140	94					116	75		
" <i>vittata</i>									146	36		
" <i>roesellii</i>											152	61
<i>Decticus verrucivorus</i>	60	104	20	51					14	35		
<i>Oecanthus pellucens</i>			52	3								
<i>Pteronemobius heydeni</i>											80	1
<i>Liogryllus campestris</i>					18	4	255	77	109	23	59	12
<i>Gryllus desertus</i>	239	45							321	46	27	5
<i>Liogr. seu Gryll. larva</i>									146	15		
<i>Mantis religiosa</i>	35	14	20	31	75	21	200	202				
Total	21145	2839	18489	2558	30552	3494	58000	7561	23036	3446	28375	4658



COMPARATIVE STUDY ON THE PHYSIOLOGY OF NATURAL POLYPLOIDS

I. The influence of various hydrogen ion concentrations upon the growth and productivity of *Puccinellia distans* $2n=42$, and *P. limosa* $2n=28$.

BY

LAJOS J. M. FELFÖLDY and M. MAGDA FELFÖLDY

From the Hungarian Biological Research Institute, Tihany, Lake Balaton

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INTRODUCTION

Results of cytogeographical research call our attention to contradictions between the physiological characteristics of natural and artificial polyploids. As opposed to the dynamic, resistant, large-sized, abundantly productive natural polyploids, adaptable to extremes in life conditions (see the literature cited ap. FELFÖLDY, 1948), the diminished vitality of the artificially induced polyploid, with its disturbed propagation and often smaller yield than the diploids, has been a great disappointment to the practical specialists working with colchicine (Cf. GYÖRFFY, 1941, NOGGLE, 1946). Research work was hence at first obliged to turn to the natural polyploids, to discover the secret of their better quality, so as to be able to use our experiences to induce artificial polyploids.

The following series of experiments was also conceived with this idea in mind. At the same time the solution of certain plant geography problems could be expected from it, which we wished to make use of for experimental ecology.

In Hungary three species of the genus *Puccinellia* are to be found (JÁVORKA, 1937:54), besides the endemic and rare *P. Peisonis* BECK, the *P. distans* (JACQ.) PARL. and *P. limosa* SCHUR. Some authors mention the latter as a ssp. of *P. distans*, called *P. distans* (JACQ.) PARL. ssp. *limosa* (SCHUR.) JÁV. On the basis of chromosome investigations and their morphological characteristics we can consider them separate species.

Three different chromosome races are given in the literature under the name of *Puccinellia distans*: $2n=14,42$ AVDULOV, 1931, and $2n=28$ STÄHLIN, 1929, TARNAVSCHI, 1939. PÓLYA (1947) mentions a $2n=28$ ssp. *limosa* in plants from the Hortobágy. We found $2n=42$ for *P. distans* at Tihany and for *P. limosa* $2n=28$ at Hortobágy among our experimental plants.

EXPERIMENTAL PROCEDURE

Among the plants examined *P. distans*, with $2n=42$ chromosomes, derived from the alkali-soil meadow of the Tihany Külső-tó. We planted it in our experimental garden in May, 1947. Mr. L. PÓLYA brought the *P. limosa* from the Hortobágy in June, 1947, and it was also plan-

ted in our garden. The plants produced a crop there and the seeds from it were planted out of doors in the autumn of 1947, and from there the plants were transferred on April 17th, 1948, to water-culture vessels. Their initial weight:

Puccinellia distans $2n=42:2.26\pm0.17$

P. limosa $2n=28:2.31\pm0.08$

We used 1 l glass jars as water-culture vessels, painted first with black, then with white Trinat enamel, and washed out with diluted hydrochloric acid and distilled water.

In pH experiments we may expect exact results only if we can assure constant hydrogen ion concentrations in the vessels for several weeks. This can be provided in water or sand cultures only by constantly flowing, always changing fluids (PIRSCHLE, 1939:584), which, however, we were obliged to disregard for technical reasons. But as the life processes of the roots of the plants change the pH of the nutrient solution, it was necessary to control it constantly and change it in case of need.

Composition of the initial solution:

0.2 g potassium dihydrophosphate,
0.1 g sodium chloride,
0.1 g magnesium sulphate cryst.
0.2 g potassium nitrate,
0.4 g sodium nitrate,
3 drops 5% ferric chloride,
1 ml A—Z solution according to HOAGLAND.

To obtain the desired pH values the following quantities of acids or alkalis were necessary:

To 1 liter solution:

n-HCl	pH 4: 6.09 ml
"	pH 5: 5.45 "
"	pH 6: 4.54 "
n-NaOH	pH 7: 1.00 "
"	pH 8: 3.59 "
"	pH 9: 6.00 "

The pH was established in each case to an exactude of ± 0.1 . The nutrient solutions were mixed from the initial solutions in an 11 liter bucket to assure homogeneity. The pH was measured electro-metrically by quinhydrone electrode with calomel cell, with a SZONNÁGH valve potentiometer. The solutions were controlled daily and if a difference of 0.5 was found in a vessel, the solutions in all of them were changed.

Dates:

Beginning:	April 16, 1948.
I. change	" 23
II. "	" 30
III. "	May 7
IV. "	" 12
V. "	" 15
VI. "	" 18
Flowering began	" 20
VII. change	" 21
Harvested	" 25

The experiment lasted for 40 days, during which the grasses, with the exception of those with pH 4 solutions, grew into stalks and blossomed. The tetraploid *P. limosa* began flowering a few days earlier, indeed at the end of the experiment it began to lose its anthers, which is a sign that blossoming is over.

There were 10 vessels in each series, each containing 2 plants, so the measurements and analyses were calculated from the average of 20 plants, except when some specimens died.

On harvesting them we measured the length of the shoot the fresh weight, then killed them in a drying chamber, one hour at 120° C, and dried them to constant weight at 90—10° C, to establish dry weight and dry content. The powdered samples were kept in paper bags in an exsiccator filled with CaCl₂ until analysed. The total nitrogen was determined by the KJELDAHL semi-micro method in a PARNASS-WAGNER apparatus. For calcium determination the dry matter was reduced to ash in a platinum crucible in an electric oven, the ash dissolved in hydrochloric acid and the Ca in it determined by MURER's (1937) method.

The measurements and analyses proved that the optimal pH-values for the plants could be determined only by taking several characteristics into consideration. The results of the measurements must also be evaluated statistically, so that the real optimum can be distinguished from the apparent. We made the statistical calculations with the following formulae:

$$M = \frac{\sum x}{n}, \text{ where}$$

M = the mean value, x = the members of the series observed or measured, n = the number of members.

$$\sigma = \sqrt{\frac{\sum (d^2)}{n-1}}, \text{ where}$$

σ = the standard deviation, d = the deviation of the different members from the mean value, without regard to plus or minus, n = number of members.

$$m = \frac{\sigma}{n}, \text{ of which } k, \text{ the significant difference:}$$

$$k = \frac{M_1 - M_2}{\sqrt{m_1^2 + m_2^2}}.$$

If $k > 2$ there is probably a statistical difference between the two mean values, if $k > 5$ then there is certainly a significant difference between them.

EXPERIMENTAL RESULTS

Length of shoot

The values in respect to length of shoot are summarized in Table I. Analysis of variance showed that the differences in lengths of the shoots are very significant in the case of the tetraploid *P. limosa*. The optimum at pH 9 is probable (the k values are: 8.58, 3.26, 5.00, 3.21, 3.96). In the case of pH 5—8 there is no difference statistically ($k =$

0.12—1.00). The hexaploid species is much more uniform; with 5—9 pH values there is no difference in the length of the shoot. *P. distans* ($2n=42$) was in all cases taller than *P. limosa* ($2n=28$). (Figure 1)

TABLE I.
Length of shoot (cm).

<i>Puccinellia limosa</i> 2n = 28				<i>Puccinellia distans</i> 2n = 42			
pH	cm	σ	m	pH	cm	σ	m
4	32.8	11.06	3.68	4	38.0	6.22	2.07
5	60.2	3.83	1.27	5	64.8	13.82	4.60
6	59.0	2.82	0.94	6	67.0	2.61	0.87
7	60.5	3.56	1.18	7	65.0	5.32	1.77
8	60.0	3.28	1.02	8	69.0	7.54	2.51
9	65.0	2.28	0.76	9	65.4	2.49	0.83

<i>P. limosa</i> 2n = 28 k					<i>P. distans</i> 2n = 42 k						
pH	5	6	7	8	9	pH	5	6	7	8	9
4	7.04	6.91	7.17	7.1	8.5	4	5.3	12.9	9.9	9.5	12.0
5	—	0.7	0.1	0.1	3.2	5	—	0.4	0.04	0.8	0.1
6	—	—	1.0	0.7	5.0	6	—	—	1.0	0.7	1.3
7	—	—	—	0.3	3.2	7	—	—	—	1.3	0.2
8	—	—	—	—	3.9	8	—	—	—	—	0.1

FRESH WEIGHT

The data in Table II show two optima for fresh weight in the tetraploid species (pH 5 and 9). The optimum at pH 5 cannot be confirmed statistically ($\sigma=1.82$, $k=0.43-0.95$) but the optimum at pH 9 is

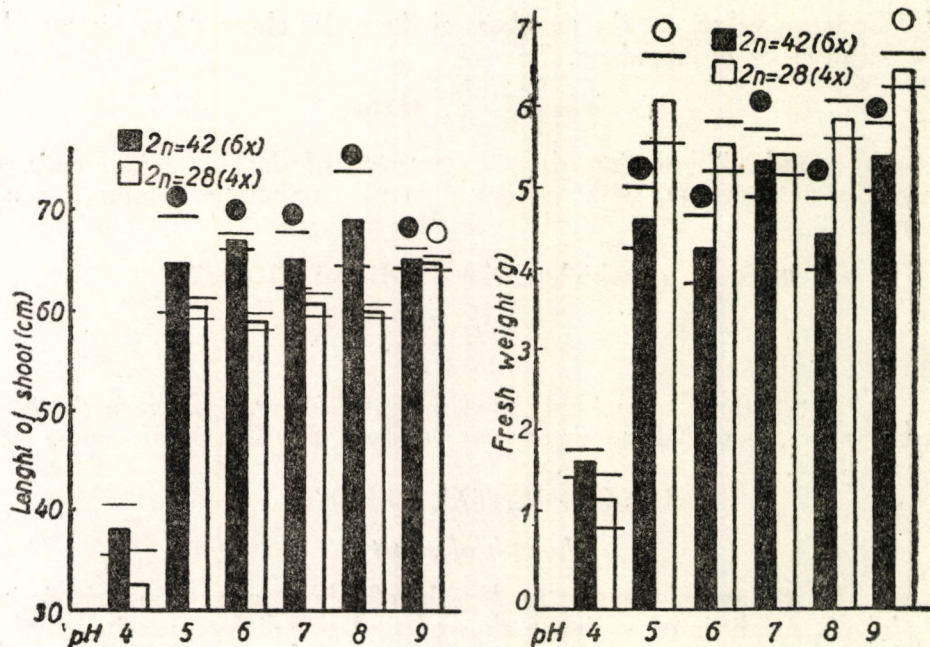


Fig. 1. Length of shoot and Fig. 2. fresh weight of the tetraploid and hexaploid plants cultivated in nutrient solutions with various (pH 4—9) hydrogen ion concentrations.

very probable ($\sigma=0.67$, $k=13.6$, 0.63 — as related to pH 5—2.61, 3.29, 2.19). In the hexaploid species we find cases, as in the length of shoot, where there is no significant difference ($k=0.21$ —1.37) between the values of plants raised in the pH 5—9 nutrient solutions. It is interesting that from the standpoint of fresh weight the tetraploid species surpasses the hexaploid, which can be explained by the greater bushiness of *P. limosa*.

TABLE II.
Fresh weight (g).

<i>Puccinellia limosa</i> 2n = 28					<i>Puccinellia distans</i> 2n = 42						
pH	g	σ	m		pH	g	σ	m			
4	1.16	1.03	0.34		4	1.62	0.51	0.17			
5	6.10	1.82	0.60		5	4.68	1.20	0.40			
6	5.51	1.03	0.34		6	4.24	1.40	0.46			
7	5.48	0.76	0.25		7	5.26	1.44	0.48			
8	5.82	0.76	0.25		8	4.44	1.44	0.48			
9	6.50	0.67	0.22		9	5.28	1.39	0.46			
k					k						
pH	5	6	7	8	9	pH	5	6	7	8	9
4	7.2	9.0	10.2	11.4	13.6	4	3.3	2.7	3.8	2.9	3.8
5	—	0.8	0.9	0.4	0.6	5	—	0.3	0.5	0.2	0.5
6	—	—	0.7	0.7	2.6	6	—	—	0.8	1.7	0.9
7	—	—	—	1.0	3.2	7	—	—	—	0.7	0.5
8	—	—	—	—	2.1	8	—	—	—	—	0.7

DRY WEIGHT AND DRY CONTENT IN %

The weight of dry matter is given in Table III and Figure 3 and the dry content of fresh weight (%) in Table IV and Figure 4. The values in dry weight change similarly in both species, for in both of them the optimum pH falls at 7—8—9. But the dry weight of the tetraploid species is considerably greater than that of the hexaploid. In *P. limosa* (2n = 28) an apparent optimum can also be observed at a pH 5 value (Figure 3).

TABLE III.
Weight of dry matter (g).

<i>Puccinellia limosa</i> 2n = 28				<i>Puccinellia distans</i> 2n = 42			
pH	g	σ	m	pH	g	σ	m
4	0.28	0.18	0.06	4	0.33	0.10	0.03
5	1.40	0.47	0.16	5	1.00	0.20	0.06
6	1.34	0.34	0.11	6	0.96	0.19	0.06
7	1.76	0.40	0.13	7	1.20	0.18	0.06
8	1.78	0.29	0.09	8	1.16	0.22	0.07
9	1.62	0.24	0.08	9	1.28	0.32	0.10

k						k					
pH	5	6	7	8	9	pH	5	6	7	8	9
4	6.5	5.5	10.5	15.0	13.4	4	10.0	9.4	12.9	10.9	9.1
5	—	0.3	1.8	2.1	1.2	5	—	0.4	2.3	1.7	2.4
6	—	—	2.4	3.1	2.1	6	—	—	2.8	2.1	2.7
7	—	—	—	0.1	0.9	7	—	—	—	0.4	0.6
8	—	—	—	—	1.3	8	—	—	—	—	0.9

In respect to dry matter content the species with 2n=28 chromosomes had a remarkably low value at pH 9, so that the optimum occurs

at pH 7 and 8. In *P. distans* we find the optimum at pH 8 and 9 (Figure 4).

TABLE IV.

Dry content as % of fresh weight.

<i>Puccinellia limosa</i> 2n = 28				<i>Puccinellia distans</i> 2n = 42			
pH	%	σ	m	pH	%	σ	m
4	15.2	3.63	1.21	4	19.4	5.58	1.86
5	23.4	4.43	1.47	5	21.8	2.18	0.72
6	26.1	2.60	0.86	6	23.5	3.05	1.01
7	30.0	3.16	1.05	7	21.9	0.95	0.31
8	29.5	4.64	1.55	8	25.7	2.08	0.69
9	25.3	3.54	1.18	9	24.5	2.26	0.75

<i>Puccinellia limosa</i> 2n = 28						<i>Puccinellia distans</i> 2n = 42							
		k						k					
pH		5	6	7	8	9	pH		5	6	7	8	9
4	4.3	6.1	9.2	7.2	6.0		4	1.2	1.9	1.5	3.1	2.5	
5	—	1.5	4.4	2.8	1.0		5	—	1.3	0.1	3.9	2.5	
6	—	—	2.8	1.9	0.5		6	—	—	1.5	1.8	0.8	
7	—	—	—	0.2	2.9		7	—	—	—	5.0	3.2	
8	—	—	—	—	2.1		8	—	—	—	—	—	1.1

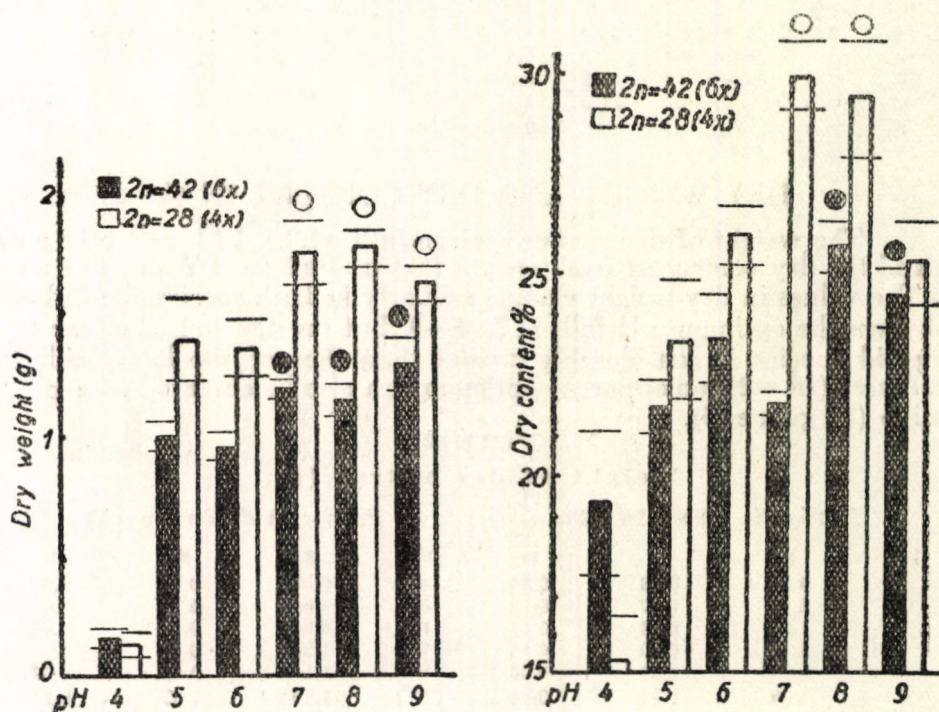


Fig. 3. Dry weight, Fig. 4. dry content and their standard deviations, in the tetraploid and hexaploid plants.

ASH CONTENT

The percentual ash content of the dry matter is summarized in Table V. In the tetraploid species an optimum can be seen (pH 9, the values of which, however, refer only to statistical probability: $k=2.20$, 4.12, 1.96, 2.30. In the other data there is no such difference ($k=0.46$ —

1.06). In the hexaploid species we found the optimum at the usual places (pH 7—8—9). (Figure 5)

TABLE V.

Ash content of dry matter (%).

<i>Puccinellia limosa</i> 2n = 28				<i>Puccinellia distans</i> 2n = 42			
pH	%	σ	m	pH	%	σ	m
5	8.07	1.22	0.43	5	9.27	1.15	0.47
6	8.35	0.65	0.23	6	8.65	0.44	0.22
7	7.60	0.55	0.20	7	6.86	0.86	0.32
8	7.59	0.42	0.14	8	7.49	0.83	0.37
9	6.99	0.61	0.25	9	7.51	1.06	0.35

k					k				
pH	6	7	8	9	pH	6	7	8	9
5	0.5	1.0	1.0	2.2	5	1.1	4.3	3.0	4.8
6	—	25.0	29.2	4.1	6	—	4.7	2.6	2.7
7	—	—	0.4	1.9	7	—	—	1.3	1.3
8	—	—	—	2.3	8	—	—	—	0.04

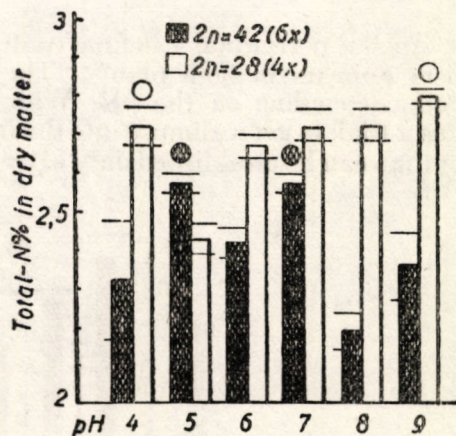
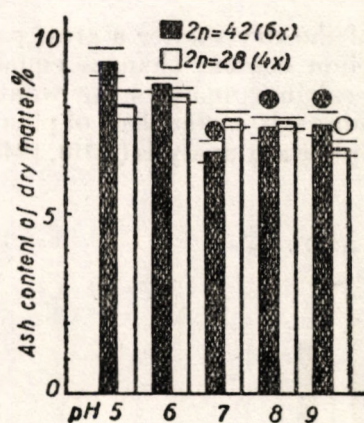


Fig. 5. Ash content of dry matter. Fig. 6. Total nitrogen content in % of dry matter.

TOTAL NITROGEN

The total nitrogen content of the dry matter of the two species is very interesting. In *P. limosa* we find the most nitrogen at values of pH 4 and pH 9, and in *P. distans* at pH 5 and 7. The low values of *P. distans* at pH 8 and 9 are very remarkable and may be connected with its ash content. Both in the case of ash and fresh weight pH 7 can be seen to be the apparent optimum (Figure 6).

TABLE VI.
Total nitrogen content of dry matter (%).

<i>Puccinellia limosa</i> 2n = 28				<i>Puccinellia distans</i> 2n = 42			
pH	%	σ	m	pH	%	σ	m
4	2.72	0.21	0.05	4	2.33	0.54	0.16
5	2.43	0.14	0.04	5	2.57	0.11	0.03
6	2.67	0.11	0.03	6	2.43	0.14	0.04
7	2.72	0.12	0.04	7	2.57	0.06	0.02
8	2.72	0.14	0.04	8	2.19	0.15	0.05
9	2.80	0.05	0.01	9	2.36	0.27	0.09

<i>Puccinellia limosa</i> 2n = 28						<i>Puccinellia distans</i> 2n = 42					
k						k					
pH	5	6	7	8	9	pH	5	6	7	8	9
4	4.1	0.7	0.0	0.0	1.4	4	15.0	0.5	15.0	8.2	0.1
5	—	4.4	5.3	4.6	7.8	5	—	2.5	0.0	7.0	2.2
6	—	—	0.9	0.9	3.6	6	—	—	2.9	3.8	7.0
7	—	—	—	0.0	2.2	7	—	—	—	7.9	2.3
8	—	—	—	—	1.7	8	—	—	—	—	17.0

CALCIUM

In the percentual calcium content of the dry matter a great parallelism appears in both plants. The calcium content changes equally in both, depending on the pH. With the calcium analyses we wanted only as a trial, to get a glimpse into the inorganic salt metabolism of plants; the optima can be established only after complete ash analysis (ILJIN, 1948),

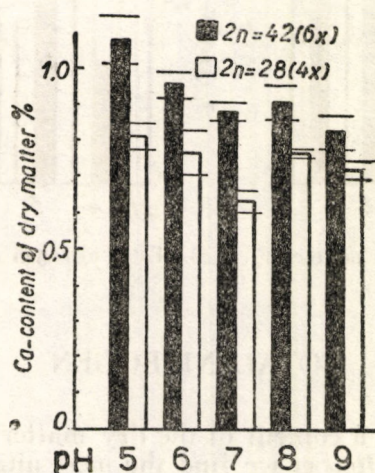


Fig. 7.

which we were obliged to omit because our material was used up. As we see in Figure 7, the hexaploid species exceeds the tetraploids in respect to Ca content.

TABLE VII.
Calcium content as % of dry matter.

<i>Puccinellia limosa</i> 2n = 28				<i>Puccinellia distans</i> 2n = 42			
pH	%	σ	m	pH	%	σ	m
5	0.81	0.12	0.04	5	1.07	0.18	0.07
6	0.76	0.25	0.08	6	0.96	0.08	0.04
7	0.64	0.09	0.03	7	0.89	0.07	0.03
8	0.77	0.04	0.01	8	0.91	0.11	0.05
9	0.72	0.05	0.02	9	0.83	0.14	0.05

DISCUSSION

If we want to establish the effect of the hydrogen ion concentration in the nutrient solution of the two species under investigation, we must sum up the optima of the characteristics observed. The simplest method for doing this can be seen in Figure 8. In Figures 1–6 we marked with small circles the statistically certain or probable optima. I transferred these circles to Figure 8: Black centers = *P. distans*, 2n=42; white centers = *P. limosa* 2n=28. From this drawing conclusions can be drawn:

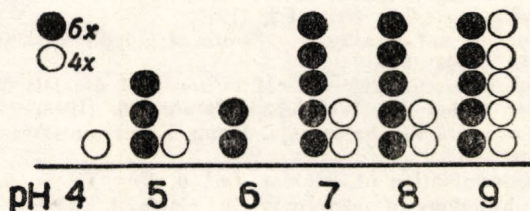


Fig. 8. The optima of the characteristics observed. (See text p. 131.)

The ecological amplitude of the hexaploid, i. e. higher polyploid *P. distans* is wider: it exists equally well at pH 7 to 9. Its optimum at the lower pH value is indistinct, it cannot be proved statistically. Conversely, the ecological amplitude of the tetraploid *P. limosa* is narrow. Its optimum at pH 9 is very definite. It is worthy of notice that its curve thus has two peaks; we do not find an optimum at pH 6. The two optima, very distant from one another (pH 4–5 and 9) have very likely some connection with the isoelectric point of the plasma (BUCHNIČEK, 1946).

It is very interesting that though *P. distans* is a taller plant, *P. limosa* produces more, whether in fresh weight, dry weight or dry content. The nitrogen and protein contents of the tetraploid are greater than that of the hexaploid, which, however, may be due to different stages of blossoming in the flowering specimens. *P. limosa* had already begun to lose its anthers by the end of the experiment, which is an indication of an advanced stage of flowering and of the seeds' being older.

There is no great difference in ash content between the different pH series, nor between the two species. Besides the length of shoot, its calcium content was a characteristic in which the hexaploid exceeded the tetraploid.

The ecological rôle of the two species is also comprehensible from their behaviour respect to pH. *P. limosa* is a plant typical in an alkali meadow of variable humidity (pH=9.30—8.25, UJVÁROSI, 1937:173). *P. distans* has a much more extensive dispersal, corresponding to its greater degree of polyploidy, forming associations on the muddy bottom of the ditches in the Tihany Külső-tó (pH 8.7) but it can be found in the same place in the *Agrostis alba-Juncus Gerardi* association (pH 6.8) in alkali strata, and even beside the artificial brook of the Nagyerdő park at Debrecen (Soó, 1948:49, FELFÖLDY, 1949:2).

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СРАВНИТЕЛЬНОЕ ИССЛЕДОВАНИЕ ФИЗИОЛОГИИ ЕСТЕСТВЕННЫХ ПОЛИПЛОИДОВ

Автор: ЛАЙОШ ФЕЛЬФЭЛДИ

РЕЗЮМЕ

Мы выращивали *Puccinellia limosa* Schur, $2n = 28$ и *P. distans* (Jacq.) Parl. $2n = 42$, растения равного возраста, в питательных растворах разного pH. (4—9). Сорок дней спустя, в течение которых мы 7 раз сменяли питательный раствор, чтобы получить постоянный pH, мы измеряли: длину стебля, свежий вес растений, сухой вес, содержание неорганического остатка, золы, общего содержания азота и кальция неорганического остатка. В результате этих опытов установлено:

1. При равных условиях гексаплоид *Puccinellia distans* выше роста, чем *P. limosa*.
2. Содержание кальция выше у гексаплоидного вида, чем у тетраплоидного вида.
3. С другой стороны тетраплоид *P. limosa* уступает по отношению свежего веса, сухого веса, сухого остатка и белка.
4. Имеющая 42 хромосомов *P. distans* располагает экологической амплитудой гораздо шире относительно pH питательного раствора, чем имеющая 28 хромосомов *P. limosa*. Это и можно было ожидать на основе цитогеографических данных.
5. Выяснив потребность в pH, становится понятным и экологическая роль этих видов.
6. На основе вышесказанного очевидно, что эти растения, различные с точек зрения морфологических и цитологических, различаются и физиологическими качествами. Таким образом их можно считать независимыми видами.

STUDIES ON THE SHORE VEGETATION OF LAKE* BELSŐ-TÓ AT TIHANY

BY

LAJOS J. M. FELFÖLDY

From the Hungarian Biological Research Institute, Tihany, Lake Balaton

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INTRODUCTION.

In the course of some work with Hungarian weed vegetation, my attention was drawn for the first time to the *Nanocyperion* type of low-growing weed societies. These communities are always found in silt or muddy places (FELFÖLDY, 1942:99—102, 1947:105—106, etc.). During my researches on vegetation on the Tihany peninsula I came upon societies of *Nanocyperetum* in the inundation area of Lake Belső-tó which recurred regularly each year, research into the environment, composition and occurrence of which led me to interesting results meriting publication.

The area surveyed was the S and SW shore of Lake Belső-tó in the Tihany peninsula. The whole southern shore is pasture, there are even wells there for herds, and consequently cattle, geese and rooting pigs exert a destructive effect upon the vegetation. The SW shore was planted with maize, owing to which the shore vegetation was protected from the land side, from the destructiveness of animals. Three zones are formed on this protected side up to October. There is a bare strip directly by the water without vegetation, where only little sprouting plants and young shoots can be found. These species are the most vigorous, the most resistant, the hardy species of the next vegetative zone. After this bare strip, a low-growing *Nanocyperion* type of plant community forms, which, from its dominant species, can be called *Pycreetum flavescens*. Beyond it, on the furthest borders of the inundation area grows the *Bidens tripartita* association, which is sharply distinguished from the *Pycreetum* by its high growth and characteristic floral composition (See Figure 1).

On the trampled grazed area, conditions are quite different. On the strip beside the water the animals have entirely destroyed the vegetation. But beyond it is a richly growing, fresh green, short turf almost entirely composed of *Pycreus flavescens* with a very few accidental species. The *Bidentetum* above the *Pycreetum* cannot develop because of the animals, in its stead the low-cropped *Pycreetum* grows, in which, however, many sorts of weeds have taken up habitation. The

* Through the „Belső-tó“ is called a lake (tó = lake), in the limnological sense it is a pond. (VARGA, 1937: 155 and 195; JACZÓ — MANN, 1940.).

tall, prickly stalks of the *Xanthium spinosum* are typical for this part (*Pycnietum Xanthiosum*). (Fig. 2).

The inundation area comes to an end, both in the pasture and the maize field, with a low, 20–60 cm shelf on which *Lolietum*, a permanent, characteristically dry-land plant society grows. The pasture itself is also composed of a *Lolium perenne*-*Poa angustifolia* association (See Figure 1–2).

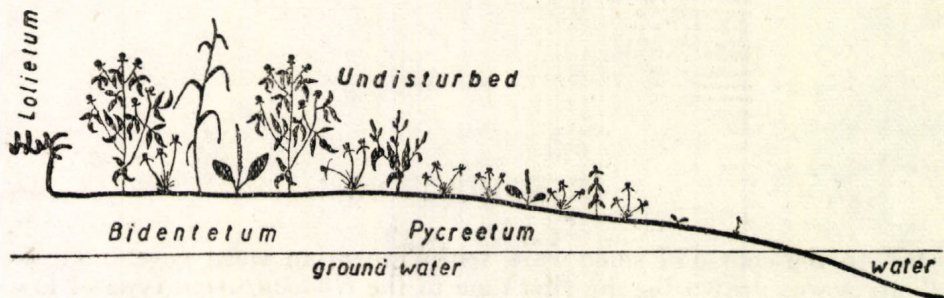


Fig. 1. Plant societies on the undisturbed parts of the shore investigated. (For explanation see the text, p. 135–136.)

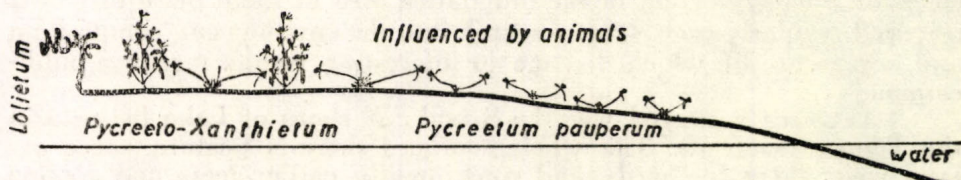


Fig. 2. Plant societies of the shore vegetation influenced by animals (see p. 136.).

METHODS.

For the plant ecological survey I used the BRAUN-BLANQUET quadrat method, ascertaining the abundance-dominance values (A–D) on a square of 2×2 m. I calculated the frequency from 10 or 20 surveys.

In every plant community I investigated the quantitative distribution of polyploid plants, using my own method (FELFÖLDY, 1948: 14 and 27).

The life forms were established on the basis of RAUNKIAER's Excursions flora, but I also kept in mind the mutability due to environment.

I employed the areal types as given in MÁTHÉ's work (1940, 1941). As to nomenclature, I followed the „Hung. Excursionsflora“ of JÁVORKA (1937).

I took samples of soils on September 10th, 1948, with a drill, from the root level and different depths. In every case I drilled till I reached ground water.

The moisture of the soils, collected on the spot in drying glasses with close-fitting covers, was determined by drying them at 105° C to constant weight.

I carried out the mechanical analysis of the sedimentation by pipette method and graphed it after PRESCOTT, TAYLOR and MARSHALL'S (1934) triangular diagram method (Figure 3).

As to the physical constants, I also determined the sticky point of the soils by the method of ARANY. The total soluble salt content was ascertained by determining the specific conductivity, which was measured by means of a WHEATSTONE bridge, after M. PLEISSNER, except that I used a cathode ray oscillograph instead of a telephone receiver. For measuring the specific conductivity I used the semi-fluid mass obtained in determining the sticky point according to ARANY, for which I took the total salt concentration from ENDRÉDY's empirical Table (BALLENEGGER-MADOS, 1944:139).

The total nitrogen was determined after KJELDAHL in a PARNASS-WAGNER apparatus by semi-micro method. The ammonia N was distilled from a 1% KCl extract after adding 3—4 g MgO. The nitrates were determined by PYNE's method, and following this I made the reduction with DEVARDA's alloy.

For the physiological Ca determination I used the aliquot part of the clay fraction in which I determined the calcium by MURRER'S (1937) method. I used the hydrochloric acid extract of 5 g soil for determining the total Ca, and measured the calcium oxalate precipitate as CaC_2O_4 in a G₄ glass-filter.

*

Abbreviations: P=polyploid, d=diploid, i=chromosome number unknown. (P)% and (d)%=polyploids and diploids exclusive of i. (Pm)%=polyploids, the small „m“ meaning that the values represent the mean value of the individuals of several associations, and the brackets that they relate to the sum of Pm+dm without i.

The life forms are: HH=hydro-helophytes, G=geophytes, H=hemikryptophytes, TH=hemitherophytes (biannuals), Th=therophytes. The areal types are: Eua=Eurasiatic, Eu=European, Em=Central European, Kont=Continental, M=Mediterranean, P=pontic, Cp=circumpolar, B=Balkan, end=endemic, Adv=Adventiv.

I. BIDENTETUM TRIPARTITAE

This community is living in the most favourable, fertile locality. It finds a place at the outside of the inundation area, under the ledge marking the actual shore. It is immediately distinguished from its environment by its tall growth. It was remarkable that its Thm% was low, 44.7%.

TABLE I.
Bidentetum tripartitae.

Q = 2 × 2 m.				1948. IX. 10.					A—D Fr%	
				1	2	3	4	5		
d	Eua	Th	Setaria viridis	—	—	1	1	1	1	3
P	K	Th	Echinochloa crus galli	2	1	1	1	2	1—2	5
P	Cp	H	Agrostis stolonifera	2	2	2	1	2	2	5
P	K	HH	Phragmites vulgaris	1	—	—	—	1	1	1
i	K	HH	Bolboschoenus maritimus	3	3	2	1	2	1—3	5
d	K	Th	Polygonum lapathifolium	2	1	1	2	2	2	5

Q = 2 × 2 m.

1948, IX, 10.

				1	2	3	4	5	A—D	Fr ₂₀
P	Cp	Th	<i>Chenopodium rubrum</i>	—	—	—	1	—	1	3
d	Cp	Th	<i>Atriplex hastatum</i>	—	1	1	1	—	1	3
d	Adv	Th	<i>Amaranthus retroflexus</i>	—	1	—	—	—	1	1
P	Adv	Th	<i>Medicago sativa</i>	—	—	1	—	1	1	1
P	Eua	H	<i>Lotus corniculatus</i>	—	1	1	1	—	1	3
d	Eua	H	<i>Trifolium fragiferum</i>	—	1	1	1	—	1	3
P	Eua	H	<i>T. repens</i>	1	1	1	1	1	1	5
d	Eua	H	<i>T. pratense</i>	—	—	—	1	1	1	1
d	K	H	<i>Verbena officinalis</i>	—	1	1	1	—	1	3
i	M	Th	<i>Stachys annua</i>	—	—	—	1	—	1	1
d	Eua	H	<i>Lycopus europaeus</i>	1	1	1	1	1	1	4
P	K	Th	<i>Solanum nigrum</i>	—	—	—	—	1	1	2
d	M	Th	<i>Kickxia spuria</i>	1	—	—	—	—	1	1
P	Cp	H	<i>Veronica anagallis-aquatica</i>	1	—	—	1	1	1	2
d	Eua	H	<i>Plantago major</i>	1	2	1	1	1	1	5
d	Adv	Th	<i>Erigeron canadense</i>	—	—	—	1	1	1	2
i	Adv	Th	<i>Xanthium spinosum</i>	1	—	—	1	1	1	2
P	Eu	Th	<i>X. strumarium</i>	—	1	—	1	1	1	3
P	Eua	Th	<i>Bidens tripartita</i>	2	2	3	3	2	2—3	5
d	Eu	Th	<i>Anthemis arvensis</i>	—	—	—	1	—	1	1
P	Eua	Th	<i>Arctium lappa</i>	1	—	—	—	—	1	1
d	Eu	Th	<i>Carduus acanthoides</i>	1	—	—	—	—	1	1
i	Em	H	<i>Centaurea pannonica</i>	—	—	—	—	1	1	1
d	Eua	H	<i>Taraxacum officinale</i>	—	—	—	1	1	1	2
P	Eua	G	<i>Sonchus arvensis</i>	—	—	—	—	1	1	1

Acc.: d—Eu—Th *Trifolium hybridum*, P—Eua—H *Mentha aquatica*.Cytological analysis: P = 42.4, d = 45.5, i = 12.1%; (P_m)% = 51.4, (d_m)% = 48.6%.

Areal types: Eua = 36.4, Eu = 12.1, Em = 3.0, K = 18.2, M = 6.1, Cp = 12.1,

Adv = 12.1%.

Spectrum of life forms: Th = 48.5, H = 39.4, HH = 6.1, TH = 3.0, G = 3.0;

Th_m % = 44.7, H_m % = 45.7, HH_m % = 7.5, TH_m % = 1.9, G_m % = 1.9.Frequency spectrum: Fr₅ = 21.2, Fr₄ = 3.0, Fr₃ = 21.2, Fr₂ = 15.1, Fr₁ = 39.5%.

II. PYCREETUM FLAVESCENTIS

After the *Bidentetum* comes a richly growing but short-turfed strip, like the *Nanocyperion*-type plant communities in general. The dwarfism of the plants living in it is striking, as in the neighbouring *Bidentetum* they are of normal size (*Echinochloa*, *Polygonum lapathifolium*, *Lycopus europaeus*, *Plantago major*, *Bidens tripartita*, etc.) (Cf. MOOR, 1936:114—115, PRISZTER, 1947:84, SÓÓ, 1948:53, etc.)

TABLE II.
Pycreetum flavescens.

Q = 2 × 2 m.

1948, IX, 10.

				1	2	3	4	5	A—D	Fr ₂₀
d	K	HH	<i>Typha latifolia</i> juv.	1	—	—	—	—	1	1
d	K	HH	<i>Alisma plantago aquatica</i>	1	—	—	1	—	1	3
P	K	Th	<i>Echinochloa crus galli</i>	—	—	—	—	1	1	1
P	K	G	<i>Cynodon dactylon</i>	—	—	—	—	1	1	1
P	K	HH	<i>Phragmites vulgaris</i>	1	—	1	1	—	1	3
P	K	Th	<i>Poa annua</i>	1	1	1	1	—	1	3
P	Kont	H	<i>Puccinellia distans</i>	—	—	—	1	2	1	1
d	Eua	H	<i>Lolium perenne</i>	—	1	—	—	—	1	1
d	K	Th	<i>Pycneus flavescens</i>	2	3	5	5	4	3—5	5
P	K	HH	<i>Schoenoplectus lacustris</i>	—	—	—	—	1	1	1
P	Eua	G	<i>Juncus Gerardii</i>	1	1	—	1	—	1	2

Q = 2 × 2 m.

1948, IX, 10.

				1	2	3	4	5	A—D	Fr ₂₀
P	Cp	H	<i>J. articulatus</i>	—	—	—	2	1	1	3
P	Eua	H	<i>Rumex crispus</i> p.p. juv.	1	1	1	1	1	1	5
P	K	H	<i>Polygonum amphibium</i>	—	—	1	1	1	1	2
d	K	Th	<i>P. lapathifolium</i>	—	—	1	1	—	1	3
P	K	Th	<i>P. persicaria</i>	—	—	1	—	1	1	1
P	K	Th	<i>P. aviculare</i>	1	1	1	1	1	1	4
P	Cp	Th	<i>Chenopodium rubrum</i>	1	—	1	1	1	1	4
d	Eua	Th	<i>C. glaucum</i>	1	1	—	—	1	1	3
P	K	Th	<i>C. album</i>	—	—	—	1	1	1	1
d	Eu	Th	<i>Ranunculus trichophyllus</i>	1	1	1	—	1	1	4
P	Cp	Th	<i>R. sceleratus</i>	2	1	1	1	—	1	3
P	Eua	Th	<i>Potentilla supina</i>	—	—	—	1	1	1	2
d	Eua	Th	<i>Medicago lupulina</i>	—	—	—	1	1	1	2
d	Eua	H	<i>Trifolium fragiferum</i>	—	—	—	1	1	1	2
P	Eua	H	<i>T. repens</i>	—	1	1	1	1	1	3
P	K	Th	<i>Lythrum hyssopifolium</i>	—	1—2	1	1	—	1	2
d	K	H	<i>Verbena officinalis</i>	—	1	1	1	1	1	2
d	Eua	H	<i>Lycopus europaeus</i>	—	1	1	1	1	1	3
i	B	H	<i>Veronica scardica</i>	—	—	—	1	—	1	1
P	Cp	H	<i>V. anagallis aquatica</i>	—	—	—	1	1	1	1
d	Eua	H	<i>Plantago major</i>	1	1	1	1	1	1	5
d	end	H	<i>Aster pannonicus</i>	—	—	—	1	—	1	1
d	Adv	Th	<i>Erigeron canadense</i>	—	—	—	—	1	1	1
P	Eua	Th	<i>Bidens tripartita</i>	—	1	1	1	1	1	2
P	Eua	Th	<i>Senecio vulgaris</i>	—	—	1	—	—	1	1
d	Eua	H	<i>Taraxacum officinale</i>	—	—	1	—	1	1	1

Cytological analysis: P = 56.8, d = 40.5, i = 2.7%; (P_m)% = 55.5, (d_m)% = 44.4%.

Areal types: Eua = 35.2, Eu = 2.7, Kont = 2.7, K = 40.5, Cp = 10.8, B = 2.7, end = 2.7, Adv = 2.7%.

Biological spectrum: HH = 10.8, Th = 46.0, G = 5.4, H = 37.8%; Th_m% = 51.4, HH_m% = 10.13, H_m% = 35.6, G_m% = 2.74%.Frequency spectrum: Fr₅ = 8.1, Fr₄ = 8.1, Fr₃ = 24.4, Fr₂ = 21.6, Fr₁ = 37.8%.

III. PYCREETUM FLAVESCENTIS XANTHIOSUM SPINOSAE

This occupies a place corresponding to the *Bidentetum* in the parts traversed by animals, trampled and grazed. The plants are low, but mutilated by the grazing and trampling. Nanism cannot be found among them. The usually dwarf *Pycnus flavescentis* also has long stalks but is flattened on the ground, its bunches trampled to pieces. There are very many foreign elements intermixed with the weed plants (Fr. 1: 45.6%).

TABLE III.

Pycnus flavescentis — Xanthium spinosum assn.

Q = 2 × 2 m.

1948, IX, 10.

				1	2	3	4	5	A—D	Fr ₁₀
P	K	Th	<i>Digitaria sanguinalis</i>	—	1	—	—	—	1	1
P	K	Th	<i>Echinochloa crus galli</i>	1	1	1	1	1—2	1	5
d	Eua	Th	<i>Setaria viridis</i>	1	1	—	1	1	1	4
P	Cp	H	<i>Agrostis stolonifera</i>	—	—	1	1	1	1	2
P	K	G	<i>Cynodon dactylon</i>	—	1	—	1	—	1	2
P	K	Th	<i>Poa annua</i>	1	1—2	1	1	1	1	5
d	Eua	H	<i>Lolium perenne</i>	1	1	—	1	1	1	4
d	K	Th	<i>Pycnus flavescentis</i>	2	2	2	2	1	2	5
P	Eu	H	<i>Carex distans</i>	—	1	1	—	—	1	2
P	Cp	H	<i>Juncus articulatus</i>	1	—	—	—	—	1	1
P	Eua	G	<i>J. Gerardii</i>	—	—	1	—	1	1	1

Q = 2 × 2 m.

					1948. IX. 10.					A—D Fris	
					1	2	3	4	5		
d	K	Th	Polygonum lapathifolium		1	1	—	1	1	1	3
P	K	Th	P. aviculare		1	1	1	1	1	1	5
d	Eua	Th	Chenopodium glaucum		1	—	—	—	—	1	1
d	Cp	Th	Atriplex hastatum		—	1	—	—	—	1	1
P	Eu	H	Rubus caesius		—	—	—	1	—	1	1
P	Eua	Th	Potentilla supina		—	1	1	—	—	1	1
d	Eua	Th	Medicago lupulina		1	1	1	1	1	1	5
d	Eua	H	Trifolium fragiferum		—	1	—	1	1	1	3
P	Eua	H	T. repens		—	1	1	—	—	1	2
P	Eua	H	Lotus corniculatus		1	1	—	1	1	1	3
d	Eu	Th	Geranium pusillum		1	—	—	—	1	1	2
P	K	Th	Erodium cicutarium		1	1	1	1	—	1	3
P	Eua	Th	Malva pusilla		—	—	—	—	1	1	2
P	K	Th	Lythrum hyssopifolia		1	—	—	—	—	1	1
P	K	Th	Anagallis arvensis	1—2	1—2	1	1	—	—	1	3
d	K	H	Verbena officinalis		1	1	1	1	1	1	5
P	Eua	H	Marrubium vulgare		1	—	—	1	—	1	1
d	Eua	H	Lycopus europaeus		—	1	—	—	—	1	1
d	M	Th	Kickxia spuria		—	1	—	—	—	1	1
P	M	Th	K. elatine		—	—	—	—	1	1	1
P	Cp	H	Veronica anagallis-aquatica		1	—	1	—	—	1	1
i	B	H	V. scardica		—	—	—	1	—	1	1
d	Eua	H	Plantago lanceolata		—	1	—	—	—	1	2
d	Eua	H	P. major		2	2	1	1	1—2	1—2	5
d	end	H	Aster pannonicus		—	—	—	—	1	1	1
d	Adv	Th	Erigeron canadensis	1—2	1	1	1	1	1	1(—2)	5
i	Adv	Th	Xanthium spinosum		2	1—2	2	2	2	2	5
P	Eua	Th	Bidens tripartita		—	1	—	—	—	1	1
P	Eua	Th	Senecio vulgare		—	1	—	—	—	1	1
d	Eu	TH	Carduus acanthoides		1	—	1	1	—	1	3
d	Eua	G	Cirsium arvense		1	—	1	1	—	1	3
d	Eua	H	Taraxacum officinale		1	1	—	—	1	1	2

Acc.: P—Eua—H Potentilla reptans, P—Eu—Th Xanthium strumarium.

Cytological analysis: P = 52.2, d = 43.5, i = 4.3%; (P_m)% = 47.1, (d_m)% = 52.83%.

Areal types: Eua = 43.5, Eu = 10.9, K = 23.9, Cp = 8.7, M = 4.3, B = 2.2, end = 2.2,

Adv = 4.3%.

Biological spectrum: H = 41.3, G = 6.5, Th = 50.0, TH = 2.2%; H_m% = 34.9,G_m% = 6.7, Th_m% = 56.4, TH_m% = 1.3%.

Frequency spectrum: Fr5 = 19.6, Fr4 = 2.2, Fr3 = 15.2, Fr2 = 17.4, Fr1 = 45.6%.

IV. PYCREETUM FLAVESCENTIS PAUPERUM

Inhabits the most unfavourable strip. The trampling and grubbing of the animals near the water is of very great extent here, as can be seen from the poverty of its composition.

TABLE IV.

Pycreus flavescens assn. (pauperum).

Q = 2 × 2 m.

					10th Sept. 1948.					A—D Fris	
					1	2	3	4	5		
P	K	Th	Echinochloa crus galli		1	1	1	—	1	1	5
P	Cp	H	Agrostis stolonifera		—	—	—	—	1	1	1
P	K	HH	Phragmites vulgaris		—	1	—	—	—	1	1
P	K	Th	Poa annua		—	—	1	1	1	1	3
P	Kont	H	Puccinellia distans		—	1	—	—	—	1	2
d	K	Th	Pycreus flavescens		5	3	3	3	3	3—5	5
P	Eu	H	Carex distans		1	1	—	1	1	1	4
P	Cp	H	Juncus articulatus		—	—	1	1	1	1	1

Q = 2 × 2 m.

				1948, IX, 10.						
				1	2	3	4	5	A—D	Fr10
P	Eua	H	Rumex crispus (pp. juv.)	—	—	1	—	—	1	1
d	K	Th	Polygonum lapathifolium	1	1	—	—	1	1	3
P	K	Th	P. aviculare	—	1	1	1	—	1	3
P	Cp	Th	Chenopodium rubrum	1	1	—	—	1	1	3
d	Eua	Th	C. glaucum	—	—	1	1	—	1	2
P	Eua	H	Lotus corniculatus	—	—	1	—	—	1	2
P	K	Th	Anagallis arvensis	—	—	—	1	—	1	1
d	K	Th	Verbena officinalis	—	—	1	1	1	1	3
d	Eua	H	Lycopus europaeus	1	1	1	1	1	1	5
P	K	Th	Solanum nigrum	—	1	1	—	1	1	2
P	Cp	H	Veronica anagallis-aquatica	—	1	—	1	1	1	4
i	B	H	V. scardica	—	—	1	—	—	1	1
d	Eua	H	Plantago major	1	1	1	1	1	1	5
d	end	H	Aster pannonicus	—	—	—	—	1	1	1
i	Adv	Th	Xanthium spinosum	1	—	1	—	—	1	2
P	Eua	Th	Bidens tripartita	1	1	1	—	1	1	3

Acc.: P—Eu—Th Xanthium strumarium.

Cytological analysis: P = 64.0, d = 28.0, i = 8.0%; (P_m)% = 61.6, (d_m)% = 38.3%.

Areal types: Eua = 24, Eu = 8, Konf = 4, K = 36, Cp = 16, B = 4, end = 4, Adv = 4%.

Biological spectrum: HH = 4, H = 48, Th = 48%; HH_m% = 1.4, H_m% = 46.8, Th_m% = 51.6%.

Frequency spectrum: Fr5 = 16, Fr4 = 8, Fr3 = 24, Fr2 = 20, Fr1 = 32%.

SOIL INVESTIGATION

According to the literature on plant geography, the societies of dwarf species of *Cyperaceae* and *Juncaceae* are of edaphic origin, as they are considered to be related to the largest silt content of the soil (Soó, 1940:31, UBRIZSY, 1948:13, etc.). A good occasion thus offered itself for investigating this, for not only had three types of the same *Pycnus flavescentis* association evolved under the same conditions on a small area, but one of them was a *Bidentetum* differing essentially from them in many respects. I made comparative investigations on the soils of four plant societies.

There was no difference in the moisture of the soil on September 10th, 1948, in the four biotopes, as can be seen in Table V.

TABLE V.

Moisture of soils of different biotopes.

	0—10	10—20	20—30	30—40 cm.
<i>Bidentetum</i>	23.9	33.1	33.7	44.2%
<i>Pycnetum</i> typ.	27.9	31.2	41.6	ground water
<i>Pycneto-Xanth.</i>	22.6	30.0	45.0	43.8%
<i>Pycnetum</i> paup.	20.5	29.8	42.0	ground water

Mechanical analysis of the sedimentable parts (<2 mm) of the soils shows that the soils of the different plant communities resemble each other. Figure 3 shows that all the soil, whether taken from the upper or the lower level, can be considered loam. No significant difference can be found in silt content between the *Bidentetum* and the *Pycnetum*.

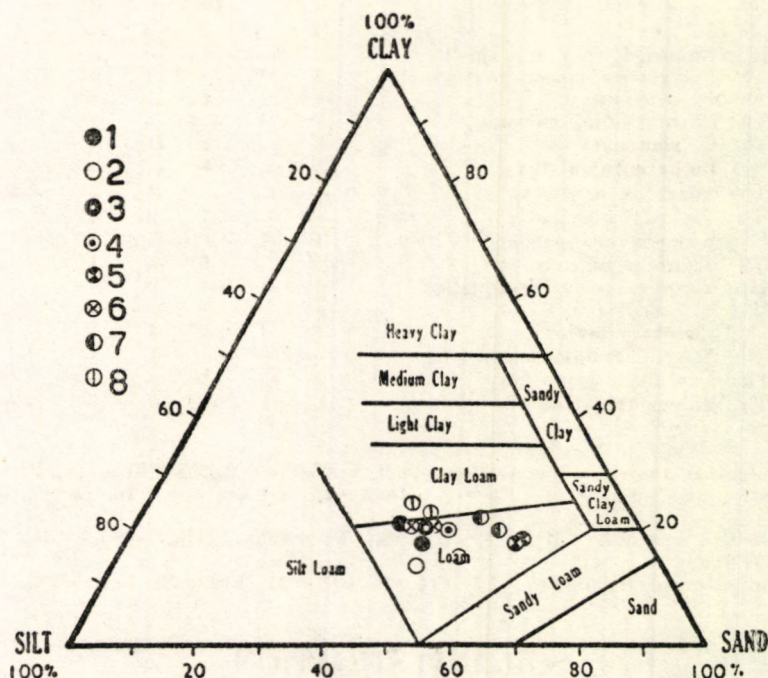


Fig. 3. Triangular diagram showing the various textures of soils investigated.
 1. Bidentetum 0 cm; 2. Bidentetum 30 cm; 3. Pycreeetum typ. 0 cm; 4. Pycreeet. typ. 30 cm; 5. Pycreeet.-Xanth. 0 cm; 6. Pycreeet.-Xanth. 30 cm; 7. Pycreeet. paup. 0 cm; 8. Pycreeet. paup. 30 cm.

TABLE VI.

Results of the mechanical analysis of the sedimentable parts of soils and the sticky point according to ARANY. (S. P.)

		Sand 2-0.02 mm	Silt 0.02-0.002	Clay 0.002 mm	S. P.
Bidentetum	0-10 cm	47.7	36.0	16.3	47.4
		42.5	38.2	19.3	45.2
	30 cm	54.4	31.7	13.9	51.9
		48.5	38.9	12.6	50.4
Pycreeetum typ.	0-10 cm	46.1	33.7	20.2	50.8
		49.5	31.3	19.2	47.6
	0-10 cm	61.8	21.4	16.8	43.8
		61.7	20.8	17.5	44.4
Pycreeetum Xanthiosum		46.3	34.3	19.4	57.0
	30 cm	43.6	37.1	19.3	57.6
	0-10 cm	58.8	23.0	18.2	41.4
		54.6	25.6	19.8	43.5
Pycreeetum pauperum	30 cm	46.8	33.1	20.1	59.7
		41.6	35.2	23.2	57.4

The pH values and the buffer capacity of the soils investigated are as follows:

TABLE VII.
pH values and buffer capacity of the soils.

	cm	pH _{H₂O}	pH _{HCl}	0.1n HCl				0.1n KOH			
				25	10	4	2cm ³	1	4	10	25cm ³
Bidentetum	0	8.01	7.54	7.1	7.2	7.5	7.9	8.2	8.8	9.4	11.2
	30	7.84	7.40	6.0	7.3	7.4	7.6	8.0	9.0	9.6	11.0
Pycreetum typ.	0	8.11	7.61	7.2	7.3	7.6	7.8	8.4	8.6	9.9	11.0
	30	7.95	7.60	7.1	7.5	7.6	7.7	8.1	9.0	10.3	11.2
Pycreetum-Xanth.	0	8.04	7.90	7.2	7.6	7.7	7.8	8.5	9.1	9.6	10.3
	30	7.99	7.61	7.1	7.3	7.7	7.8	8.2	8.7	9.6	11.3
Pycreetum paup.	0	7.93	7.71	7.1	7.5	7.7	7.7	8.3	8.8	9.5	11.3
	30	7.99	7.53	7.1	7.5	7.6	7.7	8.1	8.6	9.3	11.2

Table VIII. shows the results of the chemical analysis of the soils, with special reference to N and Ca content.

TABLE VIII.
Results of chemical analysis of soils.

	cm	Total-N %	NH ₃ -N	NO ₃ -N	Ca < 2μ %	Ca %	Total soluble salts %
			mg/100 g soil				
Bidentetum	0	0.15	8.1	10.7	2.84	2.03	0.09
	30	0.16	8.1	7.4	2.20	4.69	0.07
Pycreetum typ.	0	0.15	6.2	9.1	2.76	8.20	0.07
	30	0.05	2.5	18.6	18.12	51.55	0.06
Pycreetum-Xanth.	0	0.14	1.2	18.0	4.85	15.04	0.08
	30	0.08	9.3	16.2	15.64	38.35	0.08
Pycreetum paup.	0	0.12	3.6	5.2	4.08	13.45	0.08
	30	0.08	2.5	14.0	15.64	40.84	0.10

DISCUSSION

All observations and the results of our measurements show that edaphic factors do not play a decisive role in the four biotopes, which differ essentially as to habitat and floristic composition, as was hitherto believed of the *Nanocyperion* type of plant societies („vegetation of silty soils“). (MOOR, 1936:17).

We must take other factors into consideration instead. In the case of *Pycreetum Xanthiosum* and *Pycreetum pauperum*, the grazing, trampling and seed-dispersing activities of animals pastured there, undoubtedly play an important part. This explains the mixed nature of the weedy *Pycreetum*, made up of many species. But we do not get satisfactory results in the dwarf societies formed near the water, which can be found both on trampled and undisturbed surfaces, and aside from their composition, the low stature of the plants growing in them, their nanism, is the most remarkable. The silt content of the soil is not the determining factor for this because we find no difference in it (Table

VI), neither is there any difference in the moisture of the soil (Table V). The close proximity of the body of the lake however, reminds us that these strips become dry late, usually in the middle of July, so that the life of the vegetation can only begin then for them. A definite difference thereby also develops between the *Bidentetum*, which begins in April and the tardier *Pycreeetums* from the photo-periodic standpoint. This observation is also supported by the literary data. Societies of the *Nanocyperetum* type always form on the sites of dried-out puddles or on sections of the shore which become dry in the middle of the vegetative season (MOOR, 1936:115). The investigations of TIMÁR (1947) on a bank of the Tisza at Szócnok show that *Dichostylieto-Gnaphalietum* can also live on sandy soil (p. 5) but the *Bidentetums* grow only on the upper crest of the bank islet which is above water by June (p. 3). The *Nanocypereta* can be found on places which have become dry during August. According to the graphs of UBRIZSY (1948:6) the *Nanocyperion* species (*Schoenoplectus supinus*, *Heleocharis acicularis*, *Elatine hungarica*) flower at the end of August or beginning of September, whereas the higher growing rice and *Echinochloa crus galli* reach their maximum in July.

The range of the polyploids can be brought into relationship with photo-periodicity and on all four biotopes. From this standpoint the order of the plant communities is: *Pycreeetum pauperum*, *Pycreeetum typ.*, *Bidentetum*, *Pycreeetum Xanthiosum*. The mixed composition of the weedy *Pycreeetum* explains the low (Pm)% value which, however, is very similar to the 41.5% value of the dry *Xanthietums* FELFÖLDY, (1948:15). GUSTAFFSON'S (1948 1—2) explanations do not hold good here, for the polyploid-abundancy is parallel with the increase in the number of therophytes, as the following Table proves:

TABLE IX.
(Pm)% and Thm % values of plant societies examined.

	Thm %	σ^*	m*	(Pm)%	σ	m
Bidentetum	44.7	6.37	2.12	51.4	8.81	2.93
Pycreeetum-typ.	51.4	5.8	1.9	55.5	5.3	1.7
Pycreeetum paup.	51.6	7.5	2.5	61.6	6.8	2.2
Pycreeetum-Xanth.	56.4	7.2	2.4	47.1	6.2	2.0

TABLE X.
k* values for (Pm)% and Thm %

$^k\text{Thm}\%$	typ.	paup.	Xanth.	$(^k\text{Pm})\%$	typ.	paup.	Xanth.
	Pycr.	Pycr.	Pycr.-Xanth.		Pycr.	Pycr.	Pycr.-Xanth.
Bidentetum	2.4	2.1	3.8		1.2	2.8	1.2
Pycreeetum typ.	—	0.06	1.6		—	2.2	3.2
Pycreeetum paup.	—	—	1.4		—	—	5.0

$$^*) \sigma = \pm \sqrt{\frac{\sum (\bar{x})^2}{n-1}}, \quad m = \frac{\sigma}{\sqrt{n}}, \quad k = \frac{M_1 - M_2}{\sqrt{m_1^2 + m_2^2}}.$$

If $k > 2$, there is a significant difference between the two mean values. (These values are given in fat type).

That the shore floras display a derived chromosome status (ROHWEDER, 1937, SOÓ, 1947:108, FELFÖLDY, 1948:8 and 26) can be explained by the great capacities for adaptation and dispersal of the polyploids (ROHWEDER, TISCHLER) by the exuberance in the vegetative system which polyploidy causes, permitting a dispersal by rhizomes, stolons and runners (GUSTAFSSON, 1948:3), to which we may add the fact observed especially in respect to artificially produced polyploids, that the low osmotic pressure of their cells attaches them to localities favourable as to water supply. But, as not of least importance, we must take into consideration the observation of LÖVE-LÖVE (1943:158) concerning the *Nanocypertums* which live in direct proximity to the water, that there are many factors of long day or neutral reactivity to the photo-period among the polyploids as compared with the diploids.

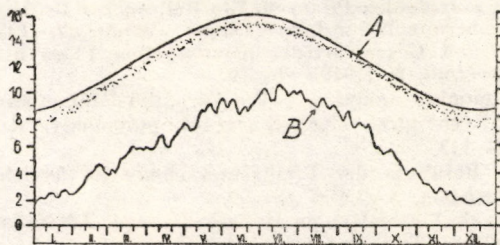


Fig. 4. 'Abscissa: Months of the year; ordinate: hours. A = astronomically possible sunlight: length of days. B = Mean values of the empirical intervals of sunlight for 50 years. Dots = Maximal sunlight registered over 50 years (TAKÁCS, 1949:4).

If we examine Figure 4 we can see the yearly change in the sun's rays and it is evident from the curves that the empirical maximum (beginning of July) does not fall together with the maximum obtained astronomically (June 21st). This can be attributed to meteorological causes and can be explained by the cloudier, more hazy state of the sky in the spring and at the beginning of summer, as opposed to the drier, clearer weather in July, August and September. As we know, besides the primarily significant periodicity (the length of the days) especially in the life of germinating plants, the amount of light obtained and its force are also important, and according to the empirical maximum undoubtedly fall into the three summer months. Neither can we leave out of consideration the qualitative composition of the light, which is also a consequence of the vapour content of the atmosphere.

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ИССЛЕДОВАНИЯ ВЕГЕТАЦИИ ПОБЕРЕЖЬЯ ОЗЕРА „БЕЛЬШЕ-ТО“ ВБЛИЗИ ТИХАНЬ

Автор: ЛАЙОШ ФЕЛЬФЕЛЬДИ

РЕЗЮМЕ

1. В области наводнения озера „Бельше-то“, соответственно экологическим условиям, развиваются 4 сообщества растений: I. *Bidentetum tripartitae*. II. *Pycneetum flavescens*. III. *Pycneetum flavescens-Xanthiosum spinosae*. IV. *Pycneetum flavescens pauperum*. 2. Не говоря о ботаническом составе (Таблицы I—IV) имеются бросающиеся в глаза различия во внешнем виде между этими четырьмя сообществами: *Pycneetum* живут непосредственно около воды. Это короткие травы, всегда низкого роста (нанизм). Дерн *Pycneetum Xanthiosum* также короток, вследствие вытаптывания пастущимся там скотом, т. е. мы имеем дело с механическим повреждением. *Bidentetum* состоит из нормальных растений высокого роста.

3. Имеется очевидная связь между внешним видом, средой и экологическими отношениями сообществ растений. *Bidentetum* живет в спокойной, самой выгодной полосе, свободной от воды приблизительно с начала апреля. Беспокоящее влияние скота отмечается в случае *Pycneetum Xanthiosum* в таком же расстоянии от края озера. Характерный для проживающих по близости воды *Pycneetum*-ов нанизм, их богатство полиплоидами и условия среды говорят за то, что в их развитии фото-периодические факторы играют большую роль, чем эдафические факторы.

4. Это подтверждается и исследованием почвы (влажность, механический анализ, точка осаждения росы, общая концентрация солей, содержание натрия, кальция, pH, буферная сила и т. д.), которые указывают на то, что с точки зрения науки о почве, нет существенных различий между четырьмя биотопами.

5. Самым ценным результатом моей работы является рабочий гипотез, на основе которого следует выяснение вопроса путем физиологических опытов, с применением фото-периодических исследований над преобладающими здесь растениями.

HEREDITARY TUMOUR FORMATION IN AMICRONUCLEATE KAHLIA

BY

JÁNOS HORVÁTH

From the Hungarian Biological Research Institute, Tihany, Lake Balaton

With 8 microphotographs on Plates I—II

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In earlier publications we discussed how it is possible to remove the micronucleus from *Kahlia simplex* HORVÁTH (1949 a) and how the animal behaves, when deprived of its micronucleus, during vegetative and germinative propagation (1947 and 1948 b). As appears from these papers, the amiconucleate animals show no significant difference in their vegetative life activities compared with those with normal nuclei. Then the question naturally arose, whether any hereditary changes could in general be produced in the amiconucleate animals. It is well known that the micronuclei are the nuclei which carry the chromosomes of the animal, so that if they are removed it is to be supposed that the system becomes rigid, and no hereditary change can occur, at least this should be so on the basis of the chromosome theory. But after lengthy experimentation it was found possible to produce a hereditary change in amiconucleate *Kahlia*, in the way described below.

As we have already set forth in an earlier publication (1948 a), we likewise exposed animals with complete nuclear equipment to the effect of ultra-violet irradiation, but, at the same distance at which we produced the amiconucleate animals, we irradiated our animals not 6 but up to 12 minutes, which led to results. Before the irradiation we thoroughly examined the animals, to make sure they did not deviate from the normal in any morphological characteristic. Twelve hours after the irradiation we isolated numerous, apparently healthy animals, to breed clons.

On investigating the different clon cultures it appeared that, though they propagated, there were very many chimeras among them. On investigating the nuclear state of these clons we also found that the micronucleus was missing. It was destroyed by the irradiation. We had previously established (see HORVÁTH, 1948 a) that owing to the larger doses of ultra-violet irradiation, the transformation of the micronuclei to macronuclei does not occur, but the membrane of the micronucleus simply splits open and the injured micronucleus, as a foreign body, disperses in the food vacuole and is digested. In the present case also only this could have occurred.

From detailed investigation of the individuals in the clons containing the chimeras the following was established: We found in them individuals which resembled the normal, and double forms, i. e. twins. It is typical of these twins that they grow together at the back, other-

wise each twin-half has all its own organelli (motile and feeding organs, contractile vacuoles, macronuclei). There were furthermore many members of the clon which exceeded several times the normal size, with numerous macronuclei. Finally, we also found monsters which had several mouths and irregular, abnormal motile organs. There were many side protrusions from their bodies, each corresponding to an animal. The dimensions of these monsters were abnormally large. I measured some which were 10—12 times the size of the normal animal.

In the following we illustrate in detail the different irregular types within the clon: In microphotograph No. 1, which is taken of living animals, we see that, besides the normal-sized twins which are grown together at the back, there are monsters of deformed shape several times bigger than the normal. Again in microphotograph No. 2 we see a monster of this sort (from a fixated preparation) but at the same time we also see that the twins grown together at the back are separating from the monster. In microphotograph No. 3, we see besides the large deformity a smaller one, but also with an irregular form. Microphotograph No. 4 shows a deformed shape from which extend apparently normal individuals. Microphotographs Nos. 5—8 show the number and condition of the micronuclei of such deformed shapes, dyed with carminic acid. This photograph proves that 5—10 animals remain together in such deformed shapes.

We took under thorough investigation the possibility of eliminating changes in shape, by forming clons of those individuals which had normal shapes and cultivating them further, the result of which was the creation of a progeny part of which were apparently normal, some being twins and some the most diversely shaped monsters.

Another characteristic of these clons is that they are capable of breeding only between relatively small temperature ranges, at a temperature of 16—18 C°, though at this temperature we also found that those among the animals which had exceedingly many macronuclei and were at the same time of large dimensions, died successively. With a rise or drop in temperature, the mortality extended to the simpler forms as well, indeed total mortality occurred with a relatively slight rise in temperature. Investigating the activity of the contractile vacuoles, I observed that with a rise in temperature the pulsation tempo did not change essentially; on the other hand, the body of the animal becomes full of holes filled with water, then these unite, the animal becomes spherical at the same time and death ensues. At lower temperatures the contrary occurs: the activity of the contractile vacuoles is gradually arrested and then, here too, the body becomes round and the animal dies.

The percentual relations of the different types in one culture cannot be established, in view of the causes mentioned above, for they change constantly in the culture.

After revealing the condition of amiconucleate clons treated by ultra-violet irradiation, changes of form and detail, the question of the significance of the variations in form still remains open. In view of their characteristics, it seems natural to state that we have to do with tumours. We also saw that this tumefaction extended to all the progeny; even among the progeny of the apparently simple shapes, there always occurred the irregular ones described above. Our statement, that we

are dealing with a tumour, is confirmed by an experiment carried out by MOTTRAM (1940) on *Paramaecium* with the carcinogenic 3:4 benz pyrene. MOTTRAM added 3:4 benz pyrene to a *Paramaecium* culture and after a long time found abnormal specimens which he afterwards isolated and cultivated and found among the progeny the varied forms which appeared in our results. He also established that among the apparently normal progeny there always were twins and varied monstrosities which differ from them. The same emerges from our experiments as from those of MOTTARM, i. e. that the tumour is hereditary: our experimental observations extended over 400 generations, but the tumour always occurred in the above described way.

DISCUSSION

In evaluating the results, we must emphasise that we produced in *Kahlia* hereditary tumours in the absence of the chromosome nucleus. The objection might be raised that just the lack of the micronucleus would cause this hereditary tumour, or that by its removal the division of the animal became labile. In reply to this we can only remark that the removal of the micronucleus by the method described in other cases led just to an increase in vitality (see HORVÁTH, 1949) and in numerous amiconucleate experiments of ours we found no tumefaction. Though it is true that we are at any time able to produce twin animals by ultra-violet radiation, among them both amiconucleate and those with complete nuclear equipment, these divide for a certain time regularly, then successively take on the normal shapes again, i. e., the twins separate. The irregular division artificially produced is therefore not always inherited; it can be a modification only, which the animal eliminates after the slightest shock, such as changes in salt concentration or pH variation, effect of bacterial metabolism, etc., and it again reproduces itself normally by vegetative multiplication. But in the experiments described above, it is not a question of this, as, in complete uniformity with the experiments of MOTTRAM, we are confronted here by hereditary tumour, as we see proved through 400 generations.

The absence of the extirpated chromosome nucleus, the micronucleus, at the same time excludes the possibility that this hereditary tumour might be connected with the chromosome from a hereditary standpoint. But the somatic nucleus, the macronucleus, is left behind which, though it does not produce chromosomes, can, as a supposed enzyme-activating center, also be held potentially responsible for the hereditary tumour. Let us also investigate this possibility. The macronucleus in the vegetative life and in the quiescent state is a double body. These two bodies without chromosomes are of very large dimensions, compared to the micronucleus. If, in the interest of solving the question raised, we take into consideration the following, then we also get the question answered: when by micro-operation, we cut off part of the animal, so that only a part of one macronucleus remains, the macronucleus regenerates with the cytoplasm and we get a progeny of complete value (the regenerated animal is of smaller dimensions, naturally, than the average normal animal). From this it follows that the macronucleus has a polyploid value. For this reason we cannot believe that we have been able to influence all the macronuclei by irradiation, but much rather that we have inter-

ferred with the enzyme-system of the protoplasm with an irreversible effect, and so it has become hereditary. Further explanations can be of only completely hypothetical value, such as whether it is possible, that such extensive transformation of the protoplasm can act on the macronucleus considered as physiological center. We have not dealt with this or with other such possibilities, because our animals proved to be so sensitive to changes in temperature and in salt concentration that we could not carry out crossing experiments with them (compare SONNEBORN, 1947).

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EXPLANATION OF FIGURES ON PLATES I—II.

Figure 1. Photograph of a group of living tumorous amiconucleate *Kahlin*. The double, twin forms can well be distinguished, as well as the large-sized monsters. Magnification: 60 x. Figure 2. A group of twin and monster forms in a division of large dimensions, fixed in formol-osmium. The quantity of macronuclei can well be seen in the different animals. Magn.: 136 x. Figure 3. Microphotograph of fixation in formal osmium of a small and a large-sized monster. In the larger ones the simple animal wanting to separate is well apparent. Magn.: 137 x. Figure 4. Monster fixed in formol-osmium in one extension of which a twin form can be seen, and in the other a simple shape. Magn.: 140 x. Figures 5, 6, 7 and 8. Tumorous amiconucleate animals of different sizes with numerous macronuclei. Carminic acid stain. Magn.: 210 x.

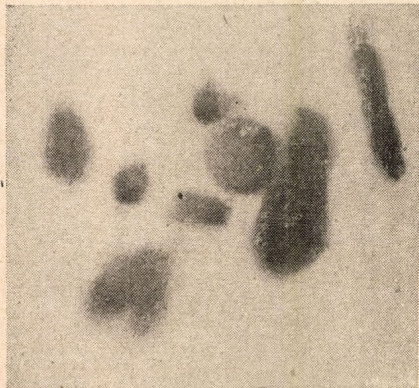
ОБРАЗОВАНИЕ НАСЛЕДСТВЕННОЙ ОПУХОЛИ В АМИКРОЯДЕРНЫХ КАХЛИА

Автор: ЯНОШ ГОРВАТ

РЕЗЮМЕ

1. Посредством ультрафиолет-ионизирующей и ультрафиолетовой иррадиацией мы производили амикроядерных *Kahlia*, которые показали наследственные опухоли в вегетативном размножении.
2. Наследственная опухоль проявлялась в клонных разведениях; потомство выявилось в самых разнообразных уродливых формах, среди которых однако всегда встречались и нормальные на вид образы.
3. Если мы разделили в клоны этих на вид нормальных амикроядерных животных, тогда их потомство вело себя так, как члены исходного клона.
4. Нами установлено, что в том случае наследственность тесно связана с протоплазмой.

Plate I.



1



2



3

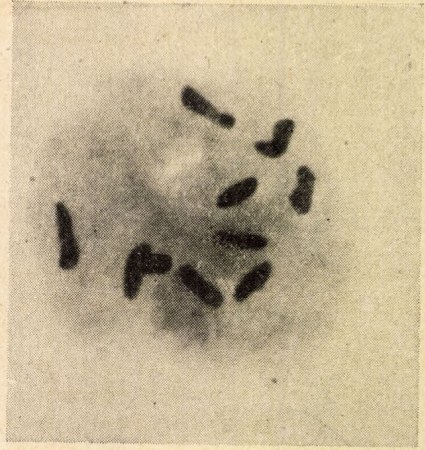


4

Plate II.



5



6



7



8

CONTRIBUTIONS TO STUDIES ON SOIL PROTOZOA OF THE CILIATA GROUP, WITH SPECIAL REGARD TO THEIR ADAPTATION TO SOIL CONDITIONS.

BY

JÁNOS HORVÁTH

From the Hungarian Biological Research Institute, Tihany, Lake Balaton.

During investigation of ciliate soil protozoa the question arose whether these animals, which have relatively large bodies in comparison with the other protozoa, are occasional visitors in the soil, or whether, in spite of its varying water content, they could be considered permanent inhabitants. The question became of still greater interest from the surprising discovery that most of the ciliate species observed in the soil were originally described as inhabitants of puddles, moss and running water, that is to say, from areas where there is much more water than in the soil. If I had based my investigations on this alone, then the reply to the question would already have been that the ciliate protozoa in the soil are only occasional visitors in areas with little sub-soil water — capillary and adhering water as well as seepage. But other points of view had also to be taken into consideration, on the basis of which the soil-dwelling propensities of a certain group of ciliates could not easily be denied. The question had to be approached from a different angle, for instance, because identical species of Ciliata could be found in soils of different consistencies, provided they had the same hydrogen ion concentration. If it had been a question merely of the protozoa brought to the soil by the wind, the species found here would have had to be of very heterogeneous character. But the truth was that the dimensions, shape, movement, food, as well as, in many cases, the propagation also seemed to conform in accommodating themselves to the small water volume of the soil.

In what follows, therefore, I wish to record to what extent ciliates were found in my investigations to be constant inhabitants of the soil.

QUESTIONS OF METHOD

In the literature no good method for demonstrating the ciliate protozoa which interest us is given. The methods used in investigating free-water creatures are available first of all. But, though the ciliates live in the soil as aquatic animals, they cannot be studied by these methods, for the water in the soil is never so abundant that the ciliates in it can be drawn up with a pipette and studied under a microscope. It seemed indicated to use a process whereby water was poured on the soil (tap or rain

water), and to try to take up the ciliates from this solution with a pipette. This method was not satisfactory, however, for in most of the soils the part suspended was so great that the field of vision under the microscope was no longer transparent. It is true, of course, that after a day or two the water on the soil becomes clearer, but in the meantime many animals could emerge from their cysts (which they would not have done in soil with little water volume) thus including the inhabitants of cysts brought by the wind as well.

In preliminary investigations I used the following method (DEMEETER, 1936) to some extent: Small clods of the soil under investigation are put on the object glass, with a glass cover, then water is rapidly released from a pipette on to the bits of soil. The water streams in under the cover glass and carries part of the soil protozoa with it. We thus get an idea of the ciliates present in the soil in an active state. But as this method was not sufficient for closer identification, we remedied the defect by comparing the animals thus found with those found after a day or two with the soil diluted with well water to twice its volume (when the water on the soil was already fairly clear), taking into consideration among the latter only those which could also be seen under the cover glass.

This method has several defects, however: In the case of muddier soil, grains of earth also get under the glass on flooding it with water and often impede the view. Conversely, we cannot be sure that the more adherent animals will get in under the glass. It follows that this method is only partly suitable for qualitative determinations, and not at all for quantitative.

For both qualitative and quantitative investigations I employed a new method, which was, briefly, that I attached the two poles of an electric torch battery to two opposite sides of a Boveri cup. I put 1 g of the soil under investigation into this cup, previously emulsified with 10 ml filtered and sterilized, 20-times diluted soil solution. Attracted by the electric current, the animals assemble at one pole. I gathered them up with a pipette, then, using the same electric method, washed them several times in a 20-times diluted soil solution and thus got them into good condition for examination. The animals so prepared were then investigated by the microtechnical method of the Gelei school (V. Recapitulation, GELEI J. and J. HORVÁTH, 1934, 1937, 1940). For rapid staining Breslau opal-blue was used.

During the investigation it became necessary to cultivate clons of the different species of ciliates, to determine exactly which seemed labile. For this purpose I prepared a soil extract of the soil from which I had isolated the animals in question, diluting it suitably to make an environment favourable to them (a dilution of from ten to twenty times always served the purpose). I dissolved a little gelatine in this nutrient solution and adjusted it to the original pH value with HCL or NaOH. The ciliates preferring bacterial diet were fed on soil bacteria cultivated on gelatine and agar; the carnivorous ones were given suitable ciliates.

SOILS INVESTIGATED

Two essentially contrasting kinds of soil were chosen for these investigations. The one was garden earth, the other sandy soil which had never been subjected to agricultural cultivation. Investigation of garden earth was also made upon two areas. One of them was the flower garden of a university building in Ady Square, the other farm garden belonging to the Szeged Teachers' Seminary. The sandy soil derived from the flood area of the Tisza beach at Szeged, an area inundated by the Tisza floods at most once a year. I wanted to ascertain from study of the latter area whether the proximity of the Tisza, or the yearly inundations influenced the occurrence of active protozoa in the soil.

The chief constituent in the two garden soils was marshy loess; the sandy soil contained ordinary loess as well as sand. There was a great difference in humus content in these soils. That from the Ady Square garden had the richest humus content, about 9%, that of the farm garden of the Teachers' Seminary had 2%, and the average humus value of the Tisza flood area was 1%. The high CaCO_3 content assured approximately uniform pH values to all three soils.

From now on, for simplicity, the Ady Square soil will be called Area No. I, the farm garden II, and the flood area soil III.)

SPECIES FOUND ON THE AREAS INVESTIGATED, AND THEIR ADAPTATION TO THE SOIL

Systematic research on Area I was begun in November 1938, when the humidity of the soil leapt up to 17% as effect of rainfall. From the soil samples then taken all the species given in Table A were found. From the middle of December of that year until the middle of March no active ciliates were found in the soil samples. From then till June 1939 the same species were again found, then from the first days in June till October no Ciliata in an active state were to be demonstrated. In these spring and autumn months, with about 13% greater soil moisture, ciliates in an active state could still be demonstrated, though they appeared in largest quantity at 17–18% or even greater humidity.

In Table A are summarized the characteristics typical of the animals found in area I, data on their size, movements, possible body changes, nutriment, as well as the places so far known from the literature to be their habitats.

We see that of the 22 species found the length of 13 was $50\ \mu$ or less, but none was less than $25\ \mu$. There is only 1 species between 50 and $100\ \mu$, whereas between 100 and 150 there are 8, yet none exceeding $150\ \mu$. It is true that, according to the literature, the *Gastostyla steini* can attain to $350\ \mu$, though I never isolated any of such dimensions from the soil.

From the standpoint of locomotion, among these species only *Halteria decemsulcata* requires great water volume, though according to my observations this species thanks to its small size ($25\ \mu$) is also capable of living in areas with less, such as the capillary, adherent and seepage water of the soil. It is remarkable that in 18 of the 22 species

we find a sliding or walking movement, which adduces a great degree of adaptation to the small water volume, or to the detours occasioned by the particles of earth. Four species are not thus provided for (2 *Cyclidium*, 1 *Halteria* and 1 *Vorticella* species) but one of these (*Vorticella*) was sessile and two (the *Cyclidium*) were inclined to be. Furthermore all these four species were of very small proportions compared with the others.

A still more interesting connection between the size of the body and the animal's flexibility was discovered: The animals longer than $100\ \mu$ were all flexible. They had adapted themselves in this way to the small water areas in the soil. Only two of the species smaller than $100\ \mu$ were flexible, the others having the regular body form. Their small size apparently allowed them ease of locomotion in the small water areas, so that pliancy of body was superfluous.

In the matter of nutriment it is interesting that the animals with large bodies were generally carnivorous, 6 in number, whereas the smaller ones fed on bacteria, fungi, detritus and algae. In some groups in the animal world the larger-sized of a species are herbivorous and the smaller carnivorous. This also applies to the ciliates living in free-water areas. Neither is it a case in our biotopes of the carnivorous growing to be larger than the herbivorous, for — with a few exceptions — these species are of the same sizes as the average specimens present in free water areas. Here we can merely state that the herbivorous animals living in the soil are smaller than the carnivorous. Apparently the environment does not suit the larger-sized herbivorous animals. I also see characteristic adaptation in the fact that bacteria and fungi form the principal food of the herbivorous, i. e., the nutriment in the soil corresponds to their needs.

The literary data on the habitats of these animals are assembled in a separate column in Table A. Kahl's (1935) summarizing work has been the principal source for this. According to his showing there are only 4 species which are expressly earth and mud dwellers. Seven species are recorded in mosses. Five are shown to be from water containing putrifying plant material, and research so far has produced 6 of our animals in fresh water. A great many of the moss-dwellers, however, were demonstrated by pouring water on collected moss, letting the „raw“ culture thus produced stand for a while and then describing the animals present in the culture as moss-dwellers. But with this method it is not in the least certain that these Ciliata really live in the moss, for there is no question but that, in collecting earth mosses, for example, bits of earth also get into the culture and with them the cysts of soil-dwelling ciliates. Let us suppose, however, that ciliates also live in an active state in water adhering to moss. The question of how they got there still remains. It seems beyond doubt, from the soil. This naturally applies only to earth mosses. The species described as inhabiting water were also shown from moss infusions and, as we see in the Table from notes on their distribution, they are not frequent in these environments — whereas, as I have already mentioned, I always found them, given the necessary soil humidity. We can therefore confidently state that the soil is the original habitat of the moss-dwellers.

TABLE A
Ciliata Protozoa found in Area I

(Explanation of signs: R=regular (=having constant shape); F=flexible; B=Bacteria; Fu=fungus; A=algae; C=predaceous; S=swimmer; Sl=slider; W=walker; Cr=creeper).

N a m e	Length, shape	Food	Loco- motion	Habitat, distribution, food
1. Holophrya simplex	32 μ F	A C	S Sl	Frequent in fresh water. Oahu island. Feeds on: Bodo, Monas and small Ciliates.
2. Platyophrya lata	105 μ F	C	S Sl	From moss infusions; Wide-spread; feeds on: Algae, Ciliates.
3. Prorodon terres	120 μ F	A C	S Sl	In earth and saline pools; feeds on: diatoms, Rhodobacteria, Ciliates.
4. Prorodon (Holophrya) discolor	60-80 μ F	A C	S Sl	Frequents inland waters; feeds on: Algae, Ciliates.
5. Sphidium amphoriforme	120 μ F	BAC	S Sl	In Mitterwald and Zittertal, among mosses.
6. Chilodonella algivora	50-70 μ R	B A	S Cr	Among grasses and algae; very wide-spread.
7. Colpoda maupasi	35-70 μ R	B Fu	S Sl	From straw infusions.
8. Colpoda steini	25-30 μ R	B Fu	S Sl	In decaying water plants.
9. Colpoda fastigata	55-60 μ R	B Fu	S Sl	Fresh water; frequent.
10. Colpoda inflata?	30-40 μ R	B Fu	S Sl	From moss infusions.
11. Colpoda Aspera	30-50 μ R	B Fu	S Sl	In mud.
12. Glaucoma myriophylli	100 μ F	A B	S Sl	In Myriophyllum.
13. Cyclidium terricola	30-40 μ R	B	S	In earth-moss at Hamburg, in Alpine mosses; rare.
14. Cyclidium glaucoma	25-30 μ R	B	S	Among decaying plants.
15. Halteria decemsulcata	25 μ R	B Fu	S	From soil.
16. Kahlia simplex	120 μ F	B Fu	S W	From soil.
17. Amphisiella milneki	100 μ F	A Fu	S W	From sand, at Kiel. Eats: diatoms, Ciliates.
18. Gastrostyla steini	150-350 μ F	B Fu C	S W	Frequent in fresh water.
19. Opistrotricha similis	100 μ F	B Fu	S W	Frequent in fresh water.
20. Gonostomum affine	50 μ F	A B Fu	S W	Detritus feeder. In moss.
21. Euplotes muscicola	40-70 μ R	B Fu	S W	In European and American mosses; European soil.
22. Vorticella microstoma	35 μ R	B	Sessile	In water containing decaying plants.

TABLE B
Ciliata Protozoa found in Area II
(For abbreviations see Table A)

Name	Length, shape, locomotion	Food	In active state in the samples, 1939 May—November						
			V	VI	VII	VIII	IX	X	XI
1. <i>Holophrya simplex</i>	34 μ F S Sl	A C			+	+	+	+	+
2. <i>Platyophrya lata</i>	105 μ F S Sl	Cu			+	+	+	+	+
3. <i>Prorodon terres</i>	120 μ F S Sl	A C			+	+	+	+	+
4. <i>Prorodon</i> (<i>Holophrya</i> <i>discolor</i>)	60-80 μ F S Sl	A C			+	+	+	+	+
5. <i>Enchelys agricola</i> nov. sp.	60-70 μ F S Cr	C			+	+	+	+	+
6. <i>Spathidium spatula</i>	150-160 μ F S Cr	B C		+	+	+	+	+	+
7. <i>Spathidium</i> sp.	100-120 μ F S Cr	A B C	+	+			+	+	+
8. <i>Nassula</i> sp.	65-70 μ R S	A B		+			+	+	+
9. <i>Chilodonella algivora</i>	50-70 μ R S Cr	B A	+				+	+	
10. <i>Colpoda aspera</i>	30-50 μ R S Cr	B Fu	+	+	+	+	+	+	+
11. <i>Colpoda maupasi</i>	35-70 μ R A Cr	B Fu	+	+	+	+	+	+	+
12. <i>Colpoda steini</i>	25-30 μ R S Cr	B Fu	+	+	+	+	+	+	+
13. <i>Colpoda fatigata</i>	55-60 μ R S Cr	B Fu	+	+	+	+	+	+	+
14. <i>Colpoda inflata?</i>	30-40 μ R S	B Fu	+	+	+	+	+	+	+
15. <i>Glaucoma myriophylli</i>	100 μ F S S	A B	+	+	+	+	+	+	+
16. <i>Glaucoma scintillans</i>	40-75 μ R S Sl	B Fu	+	+					
17. <i>Halteria decemsulcata</i>	25 μ R S	B Fu	+	+	+	+	+	+	+
18. <i>Kahlia simplex</i>	120 μ F S W	B Fu						+	+
19. <i>Gastrostyla steini</i>	150-350 μ F S W	B Fu C	+	+				+	+
20. <i>Opistotricha similis</i>	100 μ F S W	B Fu			+		+	+	+
21. <i>Opistotricha terrestris</i> nov. sp.	80 μ F S W	B Fu	+	+	+	+	+	+	+
22. <i>Gonostomum affina</i>	50 μ F S W	A B Fu	+	+	+	+	+	+	+
23. <i>Euplotes muscicola</i>	40-70 μ R S W	B Fu	+	+	+		+	+	+

In No. I soil I found five species which the literature recognizes as being from „putrifying water“, or from water which contains decaying plant material. It is known, however, that in damp soil, under partially anaerobic conditions, there is a certain degree of putrefaction. Here in the soil we also find the bacterial food which experience has shown to satisfy the optimum requirements of the ciliates preferring such putrifying water. Indeed the soil is really the primary biotope of bacteria which effect mineralization in this way. If we classify the five species in question as soil-dwellers on the basis of what has been said, this does not in the least imply that every ciliate preferring „putrifying water“ is at the same time a soil-dweller, for many such species are limited by the small area offered by the soil and by their size, shape and state of movement, favourable or unfavourable to it. *Paramecium caudatum* can be cited as an example of this. This species was found at Szeged at all seasons in the section of the city's sewers which empties into the Tisza, and J. Gelei (verbal communication) found *Paramecium* in a very vigorous form and in great quantities in the septic tank of the Tihany Biological Institute. In this environment, therefore, the actively rotting anaerobic bacteria flourish, as well as in moist soil. Conversely, *Paramecium caudatum* was never found in the soil, as its size, movement and shape prohibit its living in such a habitat. Indeed its complicated and prolonged way of encysting and excysting would have prevented it. (The encystment is known only experimentally; *Paramecium* cysts have never yet been seen free in nature.)

In Table A, finally, we find 6 species which are known in the literature as being fresh water inhabitants. It has been demonstrated of three of these that they are unquestionably ubiquitous and hence can also be regular inhabitants of the soil, given the other necessary morphological conditions. The other three species, on the other hand, as we have seen in the foregoing, are capable of adapting themselves to the environment provided by the soil.

The ciliate protozoa on experimental area No. II. were studied for what was essentially a different purpose (see Horváth, 1943), but during the investigations I naturally kept in mind the considerations stated at the beginning of this paper. This garden was constantly watered, so that it had about 16% moisture from June till October 1939, and during the rest of the period of investigation — in October and November — this percentage was at times greater, due to rainfall, at times slightly less.

The results of this experiment are summarized in Table B. It appears first of all from this that in habitats thus artificially assured Ciliata in an active state were also found during the summer months. During the six months of the experiment (from May to December) I collected altogether 23 species of Ciliata from this area. If this list of ciliates is compared with those in Table A, we see that, with the exception of six species, they are the same on areas I and II. But two of the six occurred in such small numbers that — as can be seen — we could not identify them more exactly. (They are: *Spathidium* sp. and *Nassula* sp.) Two new species were also found: *Enchelys agricola* and *Opisthotricha terrestris*, *Spathidium spatula* and *Glaucoma scintillans*

are also new species not found in area No. I. How do these four species adapt themselves to the environment offered by the soil? *Enchelys agricola* nov. sp. is a carnivorous species, 60–70 μ in size. Because of its small dimensions we might think it adapted to the small water water areas in the soil, and even more so because of its very pliant shape, which can really be said to be contractile. This characteristic makes it capable of slipping through the small clods of earth and thus always capable of getting about and finding its food, the ciliata required by its carnivorous nature.

The other new species, *Opisthotricha terrestris*, is a small-sized Hypotrichus (80 μ in length): its shape differs nowise from the other local representatives of its order. Thus on the whole it adapts itself well to the environment offered by the soil in question.

Spathidium spatula is a 160–170 μ , very flexible, carnivorous Hymenostomata protozoön. Besides being carnivorous it was also, according to my observations, capable of feeding on bacteria and fungi. These qualities enable it to live in the water volume provided by the soil.

Glaucoma scintillans, with a length of 40–60 μ , is characterised chiefly by its huge mouth, which enables it to whirl masses of bacteria into its gullet. According to previous literary data, it occurs in large numbers chiefly where there are bits of rotting plant material in the water, a thing obviously related to its preference for bacterial diet. These requirements are to be found in garden soil also.

Though these four latter species seem regular soil dwellers, they could not be found in soil No. I. I can give no other reason for it than that the pH of investigative area II, though it rose to 8 during my investigations, was also round about 6, whereas soil No. I more regularly gave about an 8 pH value. The differences in humus content mentioned above may also have had an influence on the differences in the occurrence of this fauna in the two areas, which can be said in any case to be insignificant.

In Table B the monthly occurrence of the different species is noted separately. On scrutinizing this it is apparent that all the species are chiefly in an active state in the autumn. Touching on this problem, I reported in another work (see Horváth, 1943) that the herbivorous ciliates are the first to appear in the soil in an active state, the carnivorous only later. But it is possible that there is some other cause for the differing presence of the species: In connection with research area No. I we have said that in autumn and spring all the species in Table A were always found there, whereas on area No. II this was the situation only in autumn. The amount of soil humidity, examined each month, could not be the cause of the difference, for we get nearly the same percentage throughout the whole investigation. It seems likely that the effect of the temperature ought to be taken into consideration as acting on this phenomenon, or as one of the factors bringing it about. Varga (1936), for example, found in connection with the protozoa in forest soil that they generally occur in an active state in cold weather, and showed that forest-soil protozoa are cold-stenothermous forms. From the data in Table B this could not be said to be generally true of garden

TABLE C
Ciliata Protozoa found in Area III
(For explanation of signs see Table A)

N a m e	Length, shape	Food	Locomotion	Habitat, distribution, food*
1. <i>Rhopalophrya elevans</i> nov. sp.	16-20 μ R	A B	S	
2. <i>Platyophrya lata</i>	105 μ F	C	S SI	
3. <i>Cyclogramma sorex</i>	55 μ R	B	S SI	In fresh water, Geneva, Berchtesgaden, Werra dis- trict, California, Feeds on: large bacteria.
4. <i>Chilodonella labiata</i>	35 μ R	A B	S Cr	Among Utricularia.
5. <i>Colpoda steini</i>	25-30 μ R	B Fu	S SI	
6. <i>Colpoda fastigata</i>	55-60 μ R	B Fu	S SI	
7. <i>Colpoda aspera</i>	30-50 μ R	B Fu	S SI	
8. <i>Glaucoma reniformis</i>	50 μ F	A B	S	Fresh water, near Sid- ney.
9. <i>Colpidium campillum</i>	50-15 μ R	B Fu	S SI	Among decaying water plants.
10. <i>Cinetochilum margari- taceum</i>	15-45 μ R	B Fu	S SI	Fresh water, moss-infu- sion.
11. <i>Cyclidium glaucoma</i>	25-30 μ R	B	S	
12. <i>Pseudocristigera hymen- ofera</i> nov. gen. nov. sp.	30-35 μ R	B Fu	S Cr W	
13. <i>Halterioforma caudata</i> nov. gen. nov. sp.	15-20 μ R	B Fu	S	
14. <i>Halteria decemsulcata</i>	25 μ R	B Fu	S	
15. <i>Kahlia simplex</i>	120 μ F	B Fu	S W	
16. <i>Gastrostyla steini</i>	150-350 μ F	B Fu C	S W	
17. <i>Paruroleptus lacteus</i>	110-120 μ F	A B	S W	Fresh water, Botanical Garden, Hamburg.
18. <i>Tachysoma pelionella</i>	95-85 μ R	B Fu	S W	In fresh water, frequent; feeds on: bacteria.
19. <i>Oxytricha hymenostomata</i>	80-100 μ F	A B	S W	Among Lemna.
20. <i>Urosoma macrostya</i>	120-150 μ F	A B	S W	Among Lemna.
21. <i>Histrio complanatus</i>	80 μ R	A B	S W	In puddles, in spring- time.
22. <i>Histrio muscorum</i>	100-150 μ F	AB Fu	S W	In moss infusions, E. Germany, California.
23. <i>Aspidisca costata</i>	25-40 μ R	B	S W	In decaying water plants, very wide-spread.
24. <i>Astylozoa pyriforme</i>	50 μ R	B Fu	Sessile	In New Zealand, in hol- lows in forests.
25. <i>Vorticella microstoma</i>	35 μ R	B	"	

* Notes only on species not in previous Tables.

soil. As we see, there are species which are present both at warm and cold temperatures. They can therefore bear changeable temperatures, i. e., are eurythermous, e. g., the *Colpoda* species, *Opisthotricha terrestris* and *Gonostomum affine*. As the other species in the soil live an active life in cool weather, they can be classified as cold-stenothermous. Other of my observations, however, do not altogether confirm so simple a classification of the phenomenon. For example, I found *Kahlia* in an active condition on area No. II. in October and November. It might therefore be concluded that this species was a cold-stenothermous creature. The truth is, on the contrary, that it thrives best at 25–30° C room temperature. Furthermore, I found *Glaucoma scintillans* in an active state in May and June, but not during the dog days nor in the colder autumn, yet VARGA (1935) found them in the winter fauna of forest soil. From these examples it is evident that the presence of active ciliates in the soil here is not due merely to the temperature. It is to be supposed that many other factors are involved in the phenomena (such as the water-content of the soil) which, however, my observations failed to elucidate.

Area No. III was the high sandy beach of the Tisza flood regions near Szeged. As I have already mentioned, this area was inundated on an average of once a year, usually during the early spring floods. Systematic investigations were carried out on this area from April to December of 1939, and from March to June 1940. Material for investigation was collected every two weeks and always from places where the sand was still wet. Active protozoa were generally found where the soil had a 16% water content, hence chiefly only in the spring and autumn months. The pH value of the soil at such times was 7.8 in the damp soils, i. e., slightly alkaline, and the drier soils containing no active protozoa had a 6.6 value.

In Table C are given the 25 species of ciliates which I succeeded in identifying on the third area investigated. Seven of these 25 also live in the two garden soils of territories I and II, and two, *Vorticella microstoma* and *Cyclidium glaucoma*, only in No. I. If now we take into consideration that the soil of area III was loose, sandy and permeable, and therefore in severe contrast with the soils of areas I and II (only in the pH reaction was there no sharp difference between them), then we must conclude that these seven species — by name *Platyophrya lata*, *Colpoda steini*, *C. fastigata*, *C. aspera*, *Halteria decemsulcata*, *Kahlia simplex*, *Gastrostyla steini* — are soil-ubiquist creatures. Of the other 17 species, the Table shows eight to be of 50 μ or less we find five between 50–100 μ , and three between 100 and 150 μ . Most of the species found here belong, therefore, to the small-sized ciliates. Here too the rule is valid that the animals with larger bodies are flexible, whereas the smaller ones have regular bodies and thus both accommodate themselves to their environment in the tortuous little water fields. In general it can be said that on experimental area No. III there were no open-water forms at all. Previous researchers had found 8 of these species in fresh water, two in moss or moss infusions, three in water containing constituents of rotting plants, while I myself isolated three new species from the soil. This habitat seems in interesting contrast to

areas I and II, in that there only two carnivores among the ciliates found here, the others feeding on bacteria, fungi and algae.

This territory is particularly worthy of interest as contrasted with the two previous, because here there is the possibility for water ciliates to change into soil ciliates. How does this occur? In the beginning my idea of it was that after the withdrawal of the floods, the ciliate fauna characteristic of this soil develop in the remaining little puddles and afterwards simply get into the soil with the water seeping through. I investigated numerous small puddles containing little water. I found only 1—2 pelagic protozoa, and not one of the species given in Table C. It is therefore evident that in this soil it is not a question of a simple, seasonal faunal emigration. Hence the only remaining possibility is that the majority of the species remain attached to the soil even during floods. Whether they are encysted or in an active form I was unable to establish, as I could not avoid getting free water along with the sand taken from under water. We can therefore get an answer to the question only from general biological knowledge. It is known, for instance, that where any ciliate species lives an active life, there we should usually also find their cysts. (It is only in the laboratory that we can produce conditions under which the animals always live an active life). It is therefore probable that this soil-fauna develops from cysts remaining in the inundated soil after the water has withdrawn. That is to say, it is evident that the ciliates living an active life in the soil during floods drift into the upper regions of the water and that the flood carries them along. This applies only to the flood-area soil, lying high and evenly, for in excavations and deep flood areas we should in all probability find an entirely different state of affairs.

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ИССЛЕДОВАНИЯ ПРОТОЗОА, ПОЧВЫ ГРУППЫ РЕСНИЧНЫХ И В ОСОБЕННОСТИ ВОПРОСОВ ИХ ПРИСПОСОБЛЕНИЯ К УСЛОВИЯМ ПОЧВЫ

Автор: ЯНОШ ГОРВАТ

РЕЗЮМЕ

Мы исследовали фауну ресничных инфузориев в окрестности города Сегед (Венгрия) с точки зрения приспособления этих простейших к жизненным условиям различных видов почвы.

Мы исследовали: 1. Почву сада, орошенного главным образом только дождем. 2. Почву сада, постоянно орошаемого. 3. Затопленную водой почву.

Наши результаты нижеследующие:

1. Приблизительно нейтральная почва должна содержать в среднем 16% подпочвенной воды, для того чтобы ресничные могли развить в ней активное существование.

2. Ресничные приспосабливающиеся к условиям недостаточного увлажнения почвы двоякого вида: а) ресничные постоянных форм и небольших размеров. б) более крупных размеров, но имеющих гибкое тело и также способных изменять свою форму.

3. Чаще всего длина видов, встречающихся в почве, не достигает 100 м.

4. Движение ресничных, проживающих в почве, происходит главным образом путем скольжения хождения и ползания в почве. Среди ресничных, исследованных в наших почвах, обнаружены, хотя и редко, оседлые или полу-оседлые типы, но никогда не встречались формы, проживающие в открытой воде.

5. Большая часть видов, проживающих в описанных выше почвах 1 и 2 встречается, по мнению прежних авторов, в настоях мха, или в воде содержащей гниющие растения. Более мелкие экземпляры, по мнению этих авторов, происходят из открытой воды.

Жизненные условия в средах, упомянутых выше, тождественны с условиями, имеющимися в почвах 1 и 2 потому, что и там можно определить периодическое гниение в почве. (навоз.)

В почве 3 мы встречали также и формы, характерные для свежей воды, в соответствии с характером почвы в области затопления, являющейся переходной стадией от жизненных условий сухой почвы до воды.

6. Большая часть ресничных, найденных в почве садов, является эвритермическими существами.) Это установление еще нельзя обобщать, так как имеются противоречащие наблюдения.)

7. Сравнивая результаты исследования всех трех видов почвы, мы нашли виды ресничных, встречающиеся в равной степени во всех трех видах почвы. Так как два из этих видов почвы существенно отличаются друг от друга — почва садовая и песчаная — мы назвали ресничных, встречающихся в обоих видах почвы: „везде сущими почвы“. На основе наших исследований можно установить, что в почве имеется постоянная, приспособленная к почве фауна ресничных.

ÜBER MIKROBIOLOGISCHE UMGESTALTUNG VON STERINEN

II. Oxydation von Cholesterin durch *Proactinomyces roseus*

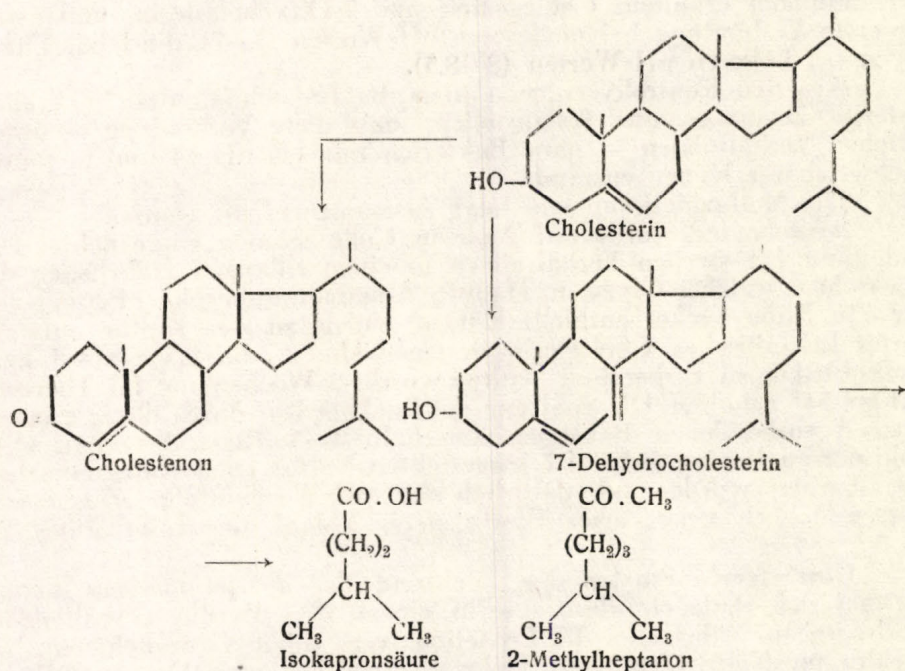
Von

JÁNOS HORVÁTH und ANDRÁS KRÁMLI

Aus dem Ung. Biol. Forschungsinstitut, Tihany am Balaton-See

(Eingegangen am 30 Mai, 1948)

In unserer ersten Abhandlung (1) haben wir die auf Cholesterin ausgeübte oxydative Wirkung eines von uns isolierten Azo to bacters besprochen, den wir *Azotobacter oxydans* n. sp. benannt hatten. Es ergab sich, dass *Azotobacter oxydans* das Cholesterinmolekül aus drei Richtungen angreift, und zwar es oxydiert am 3. Kohlenstoff-Atom wodurch Cholestenon entsteht; dehydriert zwischen dem 7. und 8. Kohlenstoff-Atom, was durch das Erscheinen des 7-Dehydrocholesterins im Oxydationsprodukt zum Ausdruck kommt; endlich trennt sich die Seitenkette ab, was durch die Entstehung von Isokaproensäure und 2-Methylheptanon bestätigt wird:



Die Ergebnisse unserer Versuche wurden, besonders in Bezug auf die Entstehung von Cholestenon und auf die Abtrennung der Sei-

tenkette, durch eine in der letzten Zeit erschienene Abhandlung von TURFITT (2.) bestätigt, indem die Abtrennung der Seitenkette auf die Wirkung von *Proactinomyces erythropolis* ebenfalls eintrifft und die zwei genannten Verbindungen in erwähnten Oxydationsprodukt gleichfalls erscheinen.

Wir haben die erwähnten Versuche mit wenigen Ausnahmen mittels Durchlüftung der Kulturen durchgeführt. Bei der Durchlüftung war aber die Gefahr vorhanden, dass die Kulturen durch andere Bakterien infiziert werden, welcher Umstand deshalb gefährlich ist, weil unser *Azotobacter* auf die Stoffwechselprodukte anderer Bakterien ausserordentlich empfindlich reagiert und rasch zugrunde geht. Wir haben uns deshalb bemüht, unsere Versuche mit einer solchen cholesterinoxydierenden Bakterienart durchzuführen, die gleichzeitig auch selektiv gezüchtet werden kann. So verwendeten wir dazu die Gruppe der *Proactinomyces*, deren eine Art: *Proactinomyces roseus* Pyridin zu zersetzen und sich in solchen Nährböden zu vermehren vermag, in welchen Pyridin die einzige Kohlen- und Stickstoffquelle ist.

Von diesem Bakterium wurde durch frühere Versuche nachgewiesen (3.), dass bei seiner Züchtung während der Zersetzung des Pyridins überschüssiger Stickstoff auftritt. Diese Umstände wirkten sich bei unserem mit *Proactinomyces roseus* durchgeführten Versuche sehr vorteilhaft aus: gegen die bei der Durchlüftung erfolgte Infektion wurde die Kultur durch die Anwesenheit des Pyridins geschützt, der Mangel an Kohlenstoff dagegen wurde durch den Cholesterins ersetzt.

Bei diesen Versuchen haben wir als Oxydationsprodukte zwei Verbindungen erhalten: Cholestenon und 7-Oxycholesterin, und zwar die erste Verbindung bei niedrigeren pH-Werten (5—7), die letztere dagegen bei höheren pH-Werten (8—8.5).

Aus den Kontrollversuchen über die Entstehung des 7-Oxycholesterins gelang es uns festzustellen, dass diese Verbindung — unter gleichen Verhältnissen — ohne Bakterien nur bei pH 11 und in kaum nachweisbarer Menge entstand.

Die Methodik kann wie folgt zusammengefasst werden:

Azotobacter wurde auf Agar in Colle-Schalen vorgezüchtet (4.) und dann bei sterilen Verhältnissen in einen flüssigen Nährboden eingewaschen, welcher Glyzerin, Mannit, Ammoniumphosphat, Pepton, sowie 5% Rübenzucker enthielt. Darauf wurde zu der Kultur pulverisiertes kristallisches Cholesterin in einer Menge von 0.5% steril beigemischt. Die so vorbereitete Kultur wurde 2 Wochenlang im Thermostat bei 34° gehalten. Die Spaltung des Zuckers war durch die in grossen Mengen vorhandenen Bakterien innerhalb 4—5 Tagen beendet. Obwohl der zu Beginn auf pH 7 eingestellten Kultur auch Kalziumkarbonat zugefügt wurde, sank natürlich der pH-Wert infolge Zersetzung grosser Mengen organischer Stoffe nach Ablauf der Inkubationszeit bis 5.

Unser Verfahren bei der Züchtung des *Proactinomyces* kennzeichnet sich dadurch, dass wir in einem 2‰ Pyridin enthaltenden synthetischen Nährboden die *Proactinomyces* solange vorzüchteten, bis Pyridin im Nährboden nicht mehr nachweisbar war. Dann mischten wir einem ebenfalls 2‰ Pyridin enthaltenden synthetischen Nährboden 0.5% pulverisiertes kristallisches Cholesterin bei, stellten den pH-Wert der Kultur entsprechend ein (siehe oben) und wuschen die

vorgezüchtete *Proactinomyces*-Kultur dazu. Diese Kulturen wurden hernach im Thermostat mit, oder ohne Durchlüftung 2 Wochen lang bei 34 C° gehalten.

Die Oxydationsprodukte wurden aus der Kultur extrahiert. Mit Rücksicht darauf, dass die untersuchten Bakterien das Cholesterin durch ihre Ektoenzyme oxydieren, braucht man die Kultur vor der Extraktion nicht gesondert aufzuschlissen. Aus dem meist mittel Petroläther erhaltenen Extrakt haben wir zwecks Identifizierung, die einzelnen Produkte mit der üblichen Methode durch fraktionierte Kristallisation, durch Ausscheiden mit Semikarbazid und bei Uviolbelichtung an Al_2O_3 ablaufende chromatographische Adsorption getrennt.

Endlich haben wir mit *Proactinomyces roseus* auch Kontrollversuche durchgeführt und es gelang uns nachzuweisen, dass dieser Sterine in nachweisbarer Menge nicht produziert.

Unsere Resultate zusammenfassend können wir folgendes feststellen:

Die mikrobiologische Umgestaltung des Cholesterins hängt von der Oxydationsfähigkeit der Arten ab und sie ändert sich je nach den Arten mit den Umständen der Züchtung.

Betreffs der Reaktionstypus, sind nach unseren bisherigen Ergebnissen an Cholesterin mit Mikroorganismen die folgenden Oxydationsreaktionen nachgewiesen:

1. Oxydation von sekundären Alkoholgruppen zu Keton.
2. Die Entstehung ungesättigter Bindung im hydrierten Ring.
3. Oxydation der Methylengruppe zu sekundärem Alkohol.
4. Desoxydation der gesättigten Kohlenwasserstoff-Kette.

Zum Schluss möchten wir noch diejenigen Versuche erwähnen, die wir jetzt zur Entscheidung der Frage durchführen, ob etwa aus Sterinen durch Wirkung der Bakterien karzinogene Stoffe entstehen können. Diese Annahme fusst nämlich eben auf der Entstehung der ungesättigten Bindung. Bezüglich dieser Frage besitzen wir aber noch keine endgültigen Ergebnisse.

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II. ОКИСЛЕНИЕ ХОЛЕСТЕРИНА ПОСРЕДСТВОМ PROACTINOMYCES ROSEUS

(Из Венгерского Биологического Исслед. Института)

Автор: ЯНОШ ГОРВАТ и АНДРАШ КРАМЛИ

РЕЗЮМЕ

Мы исследовали окислительное действие „*Azobacter oxydans*“-а и расщепляющее действие пиридина на холестерин.

Разводка бактерий производилась в синтетической среде, к которой холестерин прибавился в форме pulverизированных кристаллов. Культуры проветривались во время инкубации, при чем „*Azobacter oxydans*“ в стерильных условиях а у „*Proactinomyces roseus*“-а при наличии пиридина, который препятствует размножению других, вредных для культур бактерий.

Из окислительного продукта, полученного путем „*Azobacter oxydans*“ мы изолировали холестеном, 7-дегидрохолестерин, а также 2-метилгептанон, образовавшийся отщеплением по боковой линии, и изокапроновую кислоту.

Действием *Proactinomyces roseus* образовались при pH 5—7 Холестеном и при pH 8—8,5 . 7 оксихолестерин.

По нашим опытам микробиологическое окисление холестерина зависит от видов способных производить окисление, и кроме этого оно подвергается изменению и обстоятельствами разведения.

Наконец производятся опыты для решения вопроса, не могут-ли образоваться карциногенные вещества из стерина действием микроорганизмов. Однако эти исследования пока положительных результатов не дали.

EXPERIMENTS IN THE PREPARATION OF PENICILLIN FROM LOCAL RAW MATERIALS

BY

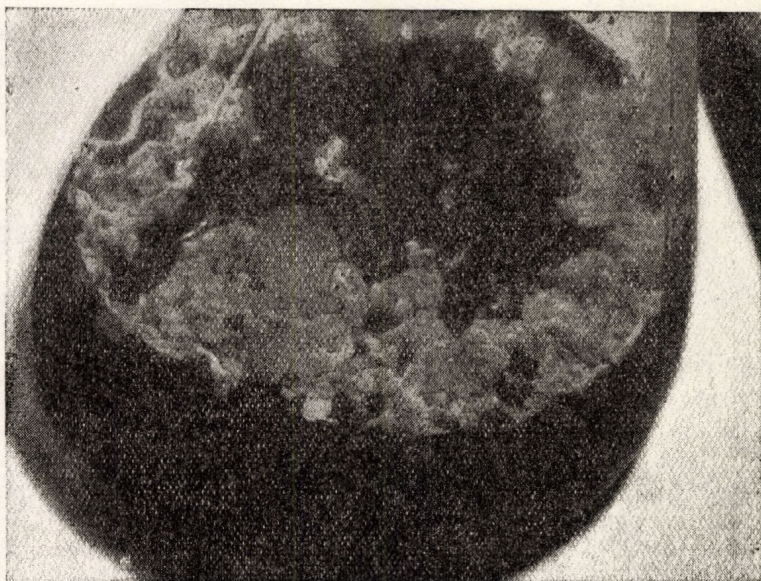
JÁNOS HORVÁTH and ANDRÁS KRÁMLI

From the Hungarian Biological Research Institute, Tihany, Lake Balaton

With 1 photograph in the text

(Received for publication 30th May, 1949.)

The purpose of these experiments was to make use of cheap local raw materials for cultivating *Penicillium*, and producing penicillin. It was our idea to seek first of all a complex organic material which, besides



Penicillium culture.

being a source of nitrogen, possessed substances which stimulate growth. The most expedient for this purpose seemed to be sertamin, which is manufactured in this country for cheap alimentation and which is in reality nothing but a strain of beer yeast further cultivated with a top ferment, characterised by its high vitamin and protein content. To prepare it, the yeast suspension heated to 90°C , is dried on a vapour rotary dryer. Aside from the standpoints given above, we turned to this material especially, because we wanted a liquid culture, for which sertamin is particularly suitable, as it is a substance which suspends well. To assure a source of carbon we employed buckwheat as chief mass in

the culture medium. To liquify the medium we fermented the milled buckwheat with 5% malt in the presence of a few drops of HCl at 80° C.

The composition of the culture medium was as follows: To a water solution of 0.5% NaNO_3 , 0.2% KH_2PO_4 , 0.05% KCl, and 0.05% $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$, which also contained traces of FeSO_4 , we added 10% buckwheat flour which had previously been fermented with 2% malt. 2% sertamin was finally suspended in the solution thus prepared. The medium was then fixed at pH 7 with NaOH and decanted into 1-liter slope culture retorts. The amount of culture medium was 500 ml. We sterilized the medium at 1.5 Atm. and inoculated it with *Penicillium* from a solid medium prepared for spore formation. In the first phase of our experiments we kept in evidence to what extent the *Penicillium* strain breeds without aeration in the medium described. The accompanying photograph (Fig. 1) shows the increase of the *Penicillium* cultivated for 10 days. Its colour was a homogeneous apple-green. The filtrate contained 25 Oxford U/ml penicillin. Further experiments are in progress.

EXPERIMENTELLE BESTIMMUNG DES THROMBININAKTIVIERUNGSPROZESSES

Von

M. GERENDÁS

Ung. Biol. Forschungsinstitut, Tihany, am Balaton-See

Mit 7 Abbildungen und 3 Tabellen im Text

(Eingegangen am 31. Mai 1949.)

Es kann experimentell festgestellt werden, dass ein dem Blute oder dem Serum zugesetztes aktives Thrombinpräparat binnen kurzem sein Gerinnungsvermögen einbüsst. Da das das Thrombin zum Verschwinden bringende System des Blutes sehr stark ist und auf seine Wirkung hin nicht allein das dem Blute zugefügtem, sondern gleicherweise auch das in ihm entstehende Thrombin rasch verschwindet, ist es unzweifelhaft, dass *dieser Erscheinung auch vom Gesichtspunkte der Blutgerinnung aus eine wichtige Rolle zukommt.*

Im Laufe unserer Versuche (1, 2) haben wir nachgewiesen, dass das Verschwinden des Thrombins im Blute sich aus 2 Prozessen zusammensetzt: 1. aus einer raschen *Adsorption*, mit der wir uns diesmal nicht eingehender befassen und 2. aus einer auf Wirkung eines Inaktivierungssystems hin mit der Zeit ständig fortschreitenden *Inaktivierung*. Nach Feststellung der Gesetzmässigkeiten von Adsorption und Fermentwirkung gelang es uns beide Faktoren auf chemischem Wege auszuschalten. Als Ergebnis davon lassen sich aus 1 ccm Blut etwa 300 *E* Thrombin herstellen. (Unter 1 Thrombineinheit verstehen wir die Thrombinmenge, die 1 ccm Oxalatplasma binnen 1 minute bei Zimmertemperatur zur Gerinnung bringt.)

Da im Blute im Laufe der normalen Gerinnung nur 3–6 *E* Thrombin pro ccm nachweisbar sind, so ist es möglich festzustellen, dass 98–99% des entstehenden Thrombins bereits während des Gerinnungsprozesses inaktiviert werden. Das Blut verfügt demnach über *eine wesentlich grössere Thrombinreserve als allgemein bekannt ist, doch verschwindet ein bedeutender Teil derselben im Blute selbst, noch bevor sie ihre Gerinnungswirkung auszuüben vermag.* Diese Feststellung schafft einen völlig neuen Gesichtspunkt für die Beurteilung der Blutgerinnungsanomalien.

Der bei der Blutgerinnung zustandekommende Thrombinspiegel, also eigentlich das Blutgerinnungsvermögen, wird von 2 Prozessen, den Geschwindigkeiten von Thrombientstehung und — verschwinden, gemeinsam bestimmt. Da die Thrombininaktivierung nach obenerwähntem einen sehr starken Einfluss auf das entstehende Thrombin ausübt, ist leicht einzusehen, dass unter den Blutgerinnungsstörungen die Störungen der Thrombininaktivierung (gesteigerte oder verminderte Inaktivierung) ebensowohl eine Rolle spielen können, wie die Thrombientstehungsstörungen. Diese Annahme wird auch durch unsere klinischen Beobachtungen bekräftigt. Im Falle herabgeminderter Inaktivierung

wird der Gerinnungszustand des Blutes in Richtung einer gesteigerten Gerinnbarkeit, bei gesteigerter Inaktivierung jedoch in Richtung einer reduzierten Gerinnbarkeit verschoben.

Auf die klinische Bedeutung des Thrombinabbaues bei postoperativen Thrombosen hat zuerst LENGGENHAGER (3) die Aufmerksamkeit wachgerufen. Er arbeitete auch ein Untersuchungsverfahren für den Thrombinabbau aus. Nach seiner Methode erfolgt indessen die Inaktivierungsuntersuchung mit dem im Blute des zu untersuchenden Individuums entstehenden Thrombin, deshalb spielt im Versuche auch das Thrombinerzeugungsvermögen des untersuchten Blutes eine Rolle. Das so erhaltene Ergebnis ist das einer zusammengesetzten Wirkung, weshalb denn diese Untersuchung kein vollständiges Bild der Thrombininaktivierung selbst liefert. Soll demgegenüber ein Einblick in den Mechanismus der Blutgerinnungsstörungen gewonnen werden, so müssen gerade die diese hervorrufenden Prozesse voneinander abgesondert werden.

Da bereits Standard-Thrombinpräparate entsprechender Aktivität zur Verfügung stehen, so besteht die Möglichkeit einer einfachen und raschen Untersuchung, die in eindeutiger Weise über die Thrombininaktivierung Aufschluss erteilt.

Mit einem solchen Standard-Thrombinpräparate arbeiten z. B. ASTRUP u. DARLING (4) bei der Untersuchung der einzelnen Glieder des Thrombininaktivierungssystems. Diese Verfasser bestimmen aber die Menge des verschwindenden Thrombins, wogegen nach unserer Auffassung für die oben erwähnte Erscheinung nicht die Menge des zum Verschwinden gebrachten Thrombins, sondern die Geschwindigkeit des Prozesses charakteristisch ist.

Wir haben in unseren Versuchen nachgewiesen, dass die zufolge Einwirkung des Inaktivierungssystems erfolgende Thrombininaktivierung kinetisch gemäss einem Reaktionstypus I. Ordnung verläuft. Demzufolge ist der Prozess durch den Reaktionsgeschwindigkeitsfaktor k gut charakterisierbar. Beim gesunden Menschen befindet sich der Reaktionsgeschwindigkeitsfaktor um 0,5, in pathologischen Fällen lassen sich indessen sehr starke Abweichungen in beiden Richtungen beobachten. So ist z. B. bei Sclerosis multiplex (5) $k=0,22$, bei Hämophilie (6) $k=2,2$. Ausserdem zeigt der Wert des Reaktionsgeschwindigkeitsfaktors auch bei unterschiedlichen Versuchsbedingungen sehr charakteristische Veränderungen und seine Untersuchung bietet gute Möglichkeiten, einen Einblick in den Mechanismus der Blutgerinnungsanomalien zu gewinnen.

In letzter Zeit sind zahlreiche Publikationen erschienen, die sich auf unsere Thrombininaktivierungsuntersuchungen beziehen und unsere Methode hat bereits in weiten Kreisen Interesse erregt, teils in Verbindung mit pathologischen und klinischen Fällen (5, 6, 7, 8, 9, 10), teils in solcher mit Tierversuchen (11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23). So erschien es als erwünscht, unser Verfahren auch in einer methodischen Mitteilung zusammenzufassen.

EXPERIMENTELLER TEIL

Das Prinzip der experimentellen Bestimmung der Thrombinaktivierung nach meiner Methode besteht darin, dass dem Serum des abgenommenen Blutes eine Thrombinlösung bekannter Aktivität zugesetzt und deren Aktivitätsverminderung in von der Zugabe gerechneten Intervallen von 1—2 Minuten auf Grund des Gerinnungsvermögens bestimmt wird. Zur Feststellung des Gerinnungsvermögens der Proben, wird Oxalatplasma oder eine Fibrinogenlösung verwendet.

Vorwegnehmend sei bemerkt, dass die Thrombinaktivierungsbestimmung — hauptsächlich bei klinischen Untersuchungen — im allgemeinen auch mittels Oxalatplasma gut durchführbar ist. Es ist indessen richtiger, dafür eine Fibrinogenlösung zu verwenden. Für exaktere Bestimmungen empfehle ich entschieden die Verwendung einer reinen Fibrinogenlösung, was umso leichter möglich ist, als eine entsprechende Fibrinogenlösung im allgemeinen bereits fertig zu haben ist, beziehungsweise ihre Selbstherstellung auf keine besondere Schwierigkeit stösst. Nachfolgend bespreche ich beide Methoden und teile die Bereitungsweise des Fibrinogens mit.

Zu den Inaktivierungsversuchen werden folgende Lösungen vorbereitet:

1. *Bereitung der Thrombin-Standardlösung.* Hierfür ist jedes im Handel befindliche Thrombinpulver verwendbar. (Wir selbst haben teils ein selbstbereitetes Thrombinpräparat, teils Thrombin pulvis von HOFFMANN LA ROCHE verwendet.) Mit dem verfügbaren Pulver wird mit dest. Wasser zweckmässig soviel Lösung bereitet wie sie zu Versuchen für einen Tag ausreichend ist. Die reine, wässrige Thrombinlösung zerfällt nämlich ohne Konservierungsmittel verhältnismässig rasch, ist also nicht längere Zeit haltbar. Der Zusatz von Konservierungsmitteln ist hingegen nicht empfehlenswert, weil sie einen starken Einfluss auf die Inaktivierung ausüben. So reduziert z. B. Trikresol die Inaktivierungsgeschwindigkeit sehr stark.

Da die Aktivitäten der erhältlichen Thrombinpulver sehr verschieden sind, stellt man die Konzentration der Lösung auf Grund der Gerinnungszeit ein. Zwecks Bestimmung des Gerinnungsvermögens werden der bereiteten Standardlösung 0,2 ccm entnommen und mit 0,2 ccm dest. Wasser auf das Doppelte verdünnt. (Diese Verdünnung des Thrombins ist deshalb erforderlich, damit es die Konzentration erreiche, auf die es sich späterhin im noch zu besprechenden Inkubationsgemisch verdünnen wird). Diesem verdünnten Thrombin werden sodann 0,1 ccm entnommen und dessen Gerinnungswirkung in folgenden Zusammenstellungen untersucht:

0,1 ccm Oxalatplasma oder	0,1 ccm Fibrinogen,
0,1 ccm dest. Wasser	0,1 ccm dest. Wasser,
0,1 ccm verdünntes Thrombin	0,1 ccm veruntes Thrombin.

Natürlich wird für die Thrombinlösungseinstellung diejenige dieser beiden Zusammenstellungen gewählt, die auch bei den späteren Untersuchungen benützt werden soll. Die für die Bestimmung der Gerinnungszeit dienenden Gemische, d. h. Wasser und Plasma, bzw. Wasser und Fibrinogenlösung, werden zweckmässig vorher in die Vertiefungen einer Farbenplatte pipettiert. Beim Hinzufügen der Thrombinlösung wird die Stoppuhr in Gang gesetzt und die Gerinnungszeit mit Hilfe des Glashakens festgestellt. Die Stoppuhr wird abgestellt, sobald mit dem Haken der erste massive Gerinnelsknoten herausgehoben wird.

Zur Bereitung der Standardlösung wird soviel Thrombin angewendet, als zur Gerinnung der Proben obiger Zusammensetzung binnen 10 Sek. erforderlich ist. Die so erhaltene Gerinnungszeit dient als Ausgangswert und sie ist eigentlich die der Thrombinaktivität vor Inaktivierung entsprechende Gerinnungszeit. Die zum Hervorbringen der Gerinnungszeit von 10 Sek. erforderliche Thrombinkonzentration lässt sich durch Verdünnung oder Thrombinzusatz nach einigem Versuchen leicht einstellen.

2. *Bereitung von Oxalatplasma.* Auf 1 Teil 2 %iger Na-Oxalatlösung werden 9 Teile Blut genommen. Das Blut kann einem gesunden Menschen entnommen werden, im

Fälle des Gebrauchs grösserer Mengen hingegen — wenn z. B. mehrere Versuchsreihen zur Durchführung gelangen — ist es zweckmässig z. B. Kaninchenblut, bzw. im Schlachthofe genommenes Rinder — oder Schweineblut zu benützen. Die Blutzellen werden sodann abzentrifugiert und das oben befindliche Plasma abgesaugt. Das auf diese Weise gewonnene Plasma, ist im Eisschranke gehalten etwa 1 Woche benützlich. Zur Untersuchung der Thrombinaktivität kann dieses Plasma unmittelbar verwendet oder — falls man in obigem Sinne mit Fibrinogen zu arbeiten wünscht — auch zur Bereitung der Fibrinogenlösung benützt werden.

3. *Bereitung der Fibrinogenlösung.* Bereitet die Beschaffung der fertigen Fibrinogenlösung Schwierigkeiten, so ist es zweckmässig, sie aus dem vorhergehenden Punkte gemäss hergestellten Rinder — oder Schweineoxalatplasma selbst zu erzeugen. Methoden für die Herstellung einer Lösung kristallisierten Fibrinogens sind von LAKI (24, 25) mitgeteilt worden.

Auf Grund dieses Verfahrens zubereitete Fibrinogenlösung enthält ungefähr 12 mg/ccm Fibrinogen. Wir benützen diese Lösung mit einer im Verhältnis 1 : 3 verdünnten physiologischen Kochsalzlösung.

DER INAKTIVIERUNGSVERSUCH

Von der zu untersuchenden Person werden aus der Vena cubitalis 2—3 ccm Blut durch die Nadel hindurch rinnend in einem Zentrifugierröhrchen gesammelt. Bei Versuchstieren wird das Blut aus der Ohrvene oder dem Schwanz tropfen gelassen bzw. eventuell durch Herzpunktion gewonnen. Das abgenommene Blut wird 20 Min. bei Zimmertemperatur stehen gelassen, das entstandene Gerinnsel wird sodann mittels Glasstab von der Röhrchenwand abgelöst und 5—7 Min. bei etwa 2000 Umdrehungen pro Minute zentrifugiert. Vom Gerinnsel wird das Serum mittels Pasteur-Pipette abgesaugt und davon 0.4 ccm in die zum Inkubieren benutzte Embriumschale oder in eine Wassermannröhre pipettiert.

Die Untersuchung ist genau in der 30. Min. nach Blutentnahme zu beginnen. In dieser Zeit ist nämlich das eigene Thrombin des Blutes aus dem Serum bereits verschwunden, zumindest aber in einem Masse inaktiviert, dass die noch vorhandene Menge neben der hinzugegebenen Thrombinlösung von 10 sek. Gerinnungsvermögen vernachlässigt werden kann. In der 30-sten Min. werden 0.4 ccm der auf beschriebene Weise bestimmten Thrombinlösung von 10 Sek. Gerinnungsvermögen zu dem vorbereiteten Serum hinzu pipettiert. Die Zusammensetzung des *Inkubationsgemisches* wird somit die folgende sein:

0,4 ccm zu untersuchendes Serum,
0,4 „ Thrombin-Standardlösung.

Hier sei noch bemerkt, dass in Fällen, in denen der Thrombininaktivierungsprozess im in-vitro-Versuche durch einen Wirkungsstoff beeinflusst wird, dem Kontrollgemische auch 0,1 ccm dest. Wasser zugesetzt wird, Versuchsgemisch aber wird anstatt des Wassers die Lösung des fraglichen Stoffes hinzugefügt. So wird z. B. bei Untersuchung der Heparinwirkung die Zusammenstellung der *Inkubationsgemische* folgende sein:

0,4 ccm zu untersuchendes Serum
0,1 „ dest. Wasser,
0,4 „ Thrombin-Standardlösung bzw.

- 0,4 ccm zu untersuchendes Serum,
 0,1 „ Heparinlösung,
 0,4 „ Thrombin-Standardlösung.

Zweckmässig ist die Benützung von *zwei Stoppuhren* beim Versuche. Im Momente des Hinzufügens des Thrombins wird *die die Inkubationszeit messende Stoppuhr* in Gang gesetzt und das Gemisch kräftig durchgerührt.

Nach Verlauf von 1 Min. wird dem Gemische eine Probe von 0,1 ccm entnommen und der bereitgestellten Fibrinogenlösung oder dem Oxalatplasma zugesetzt *die die Gerinnungszeit messende Stoppuhr in Bewegung gebracht* und die Gerinnungszeit auf oben beschriebene Weise bestimmt. Die Zusammensetzung des *Gerinnungsgemisches* ist also folgende:

- | | | |
|---------------------------|------|---------------------------|
| 0,1 ccm Oxalatplasma | oder | 0,1 ccm Fibrinogenlösung |
| 0,1 „ dest. Wasser, | | 0,1 „ dest. Wasser, |
| 0,1 „ Inkubationsgemisch. | | 0,1 „ Inkubationsgemisch. |

Dem Inkubationsgemisch wird sodann auch in der 2., 3. bzw. 5. Minute je eine Probe entnommen und notiert in welcher Zeit *diese* das Probegemisch zur Gerinnung bringen. Die so gewonnenen Gerinnungszeiten werden immer länger, ein Zeichen dafür, dass *das im Inkubationsgemisch befindliche, zu untersuchende Serum die Thrombinaktivität von Minute zu Minute vermindert. Diese Aktivitätsverminderung ist gleichbedeutend mit der Thrombininaktivierung.*

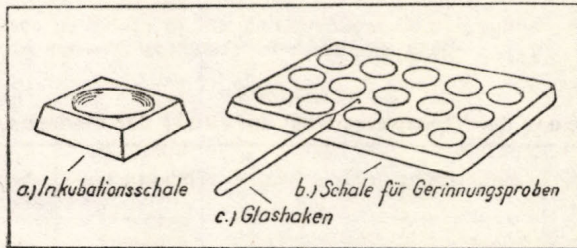


Abb. 1. Für der Versuch erforderliche Geräte.

FÜR DIE DURCHFÜHRUNG DES VERSUCHS ERFORDERLICHE GERÄTE

1. Zur Bereitung des Inkubationsgemisches lässt sich die sog. Embriumschale (Abb. 1. a) gut verwenden, weil das Pipettieren aus dieser bequem und rasch vonstatten geht. Natürlich entsprechen auch Reagenzgläser oder andere Glasgefässchen.

2. Für die Bestimmung der Gerinnungszeiten hat sich die Tüpfelplatte Jena Nr. 5250 bewährt. Gut brauchbar ist indessen auch die Porzellanschale laut Abb. 1. b. Das *der Bestimmung der Gerinnungszeiten dienende Gemisch* wird in die Vertiefungen dieser Geräte pipettiert.

3. Für die Feststellung des Momentes der Gerinnungsbildung wird ein kleiner Glashaken mit 8–10 cm langem Stiel verwendet. Dieser lässt sich aus einem Glasstabe leicht anfertigen (Abb. 1. c).

4. Für die Zusammenstellung und Vermengung der Gemische werden eingeteilte Pipetten gebraucht. Es empfiehlt sich für dest. Wasser, Fibrinogenlösung, zu untersuchendes Serum und Thrombinlösung je eine 1,0-ccm-Pipette mit 0,1-ccm-Einteilung zu verwenden, für das Inkubationsgemisch aber eine 0,1-ccm-Pipette.

5. Es ist am bequemsten, — und Irrtümer werden am sichersten vermieden —, wenn zum Messen der Inkubations- und der Gerinnungszeiten je eine besondere Stoppuhr gebraucht wird, Mangels solcher tut es aber auch eine Uhr mit Sekundenzeiger.

WERTUNG DER VERSUCHSDATEN

Die erhaltenen Gerinnungszeiten können zu Charakterisierung des Thrombinaktivierungsprozesses auf folgende Arten benützt werden:

a) *Tabellarische Zusammenstellung.* In dieser werden die Inkubationszeiten, die dazugehörigen Gerinnungszeiten sowie die den einzelnen Gerinnungszeiten entsprechenden Thrombinaktivitäten dargestellt (Tab. II). Letztere werden wie folgt bestimmt:

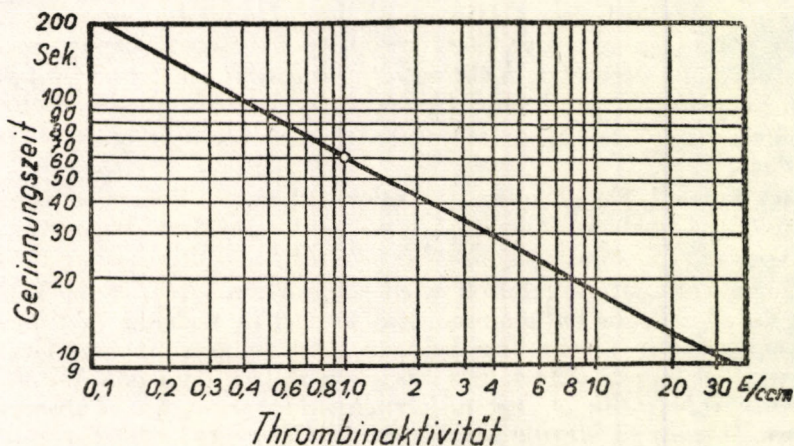


Abb. 2. Zusammenhang zwischen Gerinnungszeit und Thrombinaktivität.

Bei der Umrechnung der Gerinnungszeiten auf in Einheiten ausgedrückte Thrombinaktivität gehen wir von einem empirisch festgestellten Zusammenhang aus (Abb. 2).

TABELLE I
Berechnung der Thrombinaktivität auf Grund der Gerinnungszeit

Sek.	Einheit/ccm	Sek.	Einheit/ccm	Sek.	Einheit/ccm	Sek.	Einheit/ccm
9	35	32	3,4	55	1,22	96	0,435
10	29	33	3,2	56	1,20	98	0,42
11	24	34	3,0	57	1,14	100	0,40
12	20	35	2,8	58	1,10	105	0,38
13	17,8	36	2,7	59	1,06	110	0,35
14	15,5	37	2,6	60	1,00	115	0,32
15	13,5	38	2,4	62	0,97	120	0,29
16	12,0	39	2,3	64	0,94	125	0,27
17	11,0	40	2,2	66	0,90	130	0,25
18	10,0	41	2,1	68	0,85	135	0,23
19	8,8	42	2,0	70	0,80	140	0,21
20	8,0	43	1,9	72	0,76	145	0,20
21	7,4	44	1,85	74	0,72	150	0,19
22	6,6	45	1,8	76	0,69	155	0,175
23	6,2	46	1,7	78	0,66	160	0,17
24	5,6	47	1,65	80	0,63	165	0,16
25	5,2	48	1,6	82	0,60	170	0,15
26	4,8	49	1,5	84	0,56	175	0,14
27	4,5	50	1,45	86	0,54	180	0,135
28	4,3	51	1,4	88	0,51	185	0,125
29	4,0	52	1,35	90	0,49	190	0,12
30	3,8	53	1,3	92	0,47	195	0,115
31	3,6	54	1,25	94	0,45	200	0,110

Bei diesem wählten wir die in 60 Sek. zur Gerinnung bringende Thrombinlösung als 1 E/ccm, die übrigen Werte aber bestimmten wir einerseits durch Verdünnung der Lösung, andererseits durch Steigerung der Thrombinkonzentration. Die erzielten Punkte ergeben in dem angewandten logarithmischen Masstabe eine gute Annäherung an die auf der Abbildung dargestellte Gerade, mit deren Hilfe innerhalb des dargestellten Interwalls die der Gerinnungszeit entsprechende Aktivität werden kann. Des leichteren Verständnisses halber, haben wir die auf Grund von Abb. 2 gewonnenen Daten auch tabellarisch zusammengestellt (Tab. I). Hier haben wir neben den Gerinnungszeiten die Thrombinaktivitäten in E/ccm angeführt. Auf dieser Grundlage stellten wir auch bei den Beispielen der Tab. II die Thrombinaktivitäten fest.

TABELLE II

Die Veränderung der Thrombinaktivität bei normaler gesteigerter, bzw. verminderter Inaktivierung

Inkubationszeit in Minuten		1'	2'	3'	5'
Normales Kaninchenblut	Gerinnungszeit in Sek.	21"	25"	30"	44"
	Thrombinaktivität (E/ccm)	7,4	5,2	3,8	1,85
Gesteigerte Inaktivierung (Heparin 0,005 mg/ccm)	Gerinnungszeit in Sek.	25"	35"	49"	94"
	Thrombinaktivität (E/ccm)	5,2	2,8	1,5	0,45
Verminderte Inaktivierung (Toluidinblau 0,05 mg/ccm)	Gerinnungszeit in Sek.	18"	20"	22"	26"
	Thrombinaktivität (E/ccm)	10	8,0	6,6	4,9

Auf Tab II führen wir als Beispiel die Inaktivierung eines normalen Kaninchenserums vor, weiters die durch Heparin gesteigerte bzw. durch Toluidinblau herabgesetzte Inaktivität des gleichen Serums.

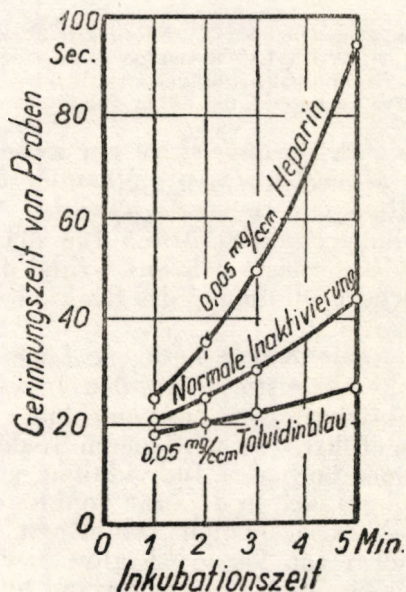


Abb. 3. Darstellung der Inaktivierungskurven (Gerinnungszeitkurven).

b) *Graphische Darstellung.* Über die Inaktivierung kann ein übersichtliches Bild auf Grund der Inaktivierungskurven gewonnen werden. Die Daten lassen sich auf drei Arten aufzeichnen:

1. *Die Gerinnungszeiten werden auf Millimeterpapier dargestellt* (Abb. 3). Auf diese Weise erhalten wir steigende Kurven. Je steiler diese sind, umso stärker ist die Inaktivierung. Bei dieser Darstellung läuft die mit Heparin erzielte Kurve zu oberst (stärkste Inaktivierung), die mit Toluidinblau erhaltene zu unterst (schwächste Inaktivierung).

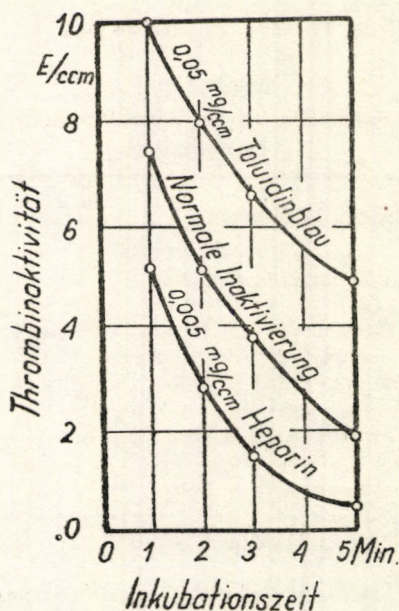


Abb. 4. Darstellung der Thrombinaktivitätsverminderung.

2. *Die in Einheiten ausgedrückten Thrombinaktivitäten werden auf Millimeterpapier übertragen.* (Abb. 4). Wir erhalten von oben nach unten laufende Kurven, die die Herabminderung der Thrombinaktivität gut zum Ausdruck bringen. Hier läuft die mit Heparin erhaltene Kurve zu unterst, die durch Toluidinblau erzeugte zu oberst.

3. Nach unserer Erfahrung ist es am zweckmässigsten, die *Gerinnungszeitwerte in logarithmischem Masstabe darzustellen* (Abb. 5). In diesem Falle erhalten wir steigende Geraden, bei denen der *Neigungswinkel* der Geraden charakteristisch für die Inaktivierungsstärke ist. Die so erhaltene Gerade lässt sich auf Grund der späteren Beschreibung für die graphische Bestimmung des Reaktionsgeschwindigkeitsfaktors *trefflich* verwerten.

Die auf die normale Kurve bezogene Lage der Kurven ist im allgemeinen bereits charakteristisch für den Inaktivierungszustand des Blutes. Wird die Inaktivierung in Zusammenhang mit einer Blutgerinnungsanomalie durchgeführt, so wird deren Inaktivierung gewöhnlich mit der des Blutes eines normalen Individuums verglichen, wird dagegen ein Versuch durchgeführt, in dem die Inaktivierung — wie im vorliegenden Beispiele — experimentell beeinflusst wird, so betrachtet man die Inaktivierungen vor Versuchsbeginn bzw. vor Zusetzen der fraglichen Stoffe zum Serum als Grundzustand und vergleicht mit diesem die im Laufe des Versuchs späterhin gewonnenen Inaktivierungs-

werte. Auf Grund dieser Werte lässt sich feststellen, ob die Kurve in einem gegebenen Falle einem Blute gesteigerter, oder verminderter Inaktivität angehört.

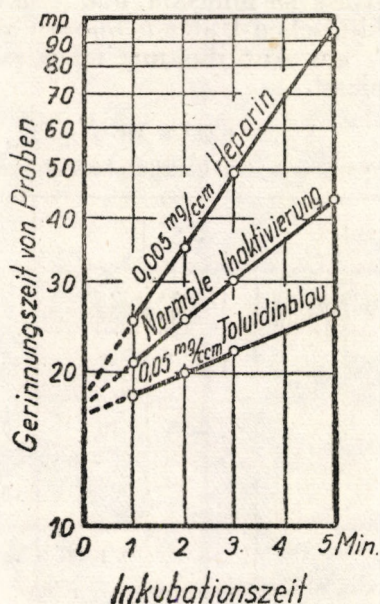


Abb. 5. Darstellung der Inaktivierungskurven (Gerinnungskurven) in logarithmischen Masstabe.

Trotzdem erweist es sich in zahlreichen Fällen als erforderlich, die Inaktivierungsstärke auch zahlenmässig auszudrücken. Dies lässt sich nach der Methode von PÁLOS (8) bewerkstelligen, nach der die mit dem Kontrolltier gewonnenen Gerinnungszeiten durch die entsprechenden Zahlenwerte des Versuchstieres dividiert werden, und der Mittelwert der so erhaltenen Daten der Koagulationsfaktor (Cf) ist.

Prinzipiell ist es indessen am richtigsten, wenn aus den beim Versuche gewonnenen Daten der Reaktionsgeschwindigkeitsfaktor berechnet wird. Dies ist ein wohldefinierter Wert und mit seiner Hilfe lassen sich auch mehrere wichtige Daten des Inaktivierungsprozesses (Veränderung der Reaktionsgeschwindigkeit durch die Temperatur, Aktivierungsenergie usw.) berechnen. Da die Inaktivierung kinetisch gemäss einer Reaktion I. Ordnung verläuft, dient zur Berechnung des Geschwindigkeitsfaktors die Gleichung:

$$k = \frac{1}{t} \cdot 2,7 \cdot \log \frac{a}{a-x}$$

Darin sind k = Reaktionsgeschwindigkeitsfaktor der Reaktion I. Ordnung, t = Intervall der Probeentnahmen, a = Anfangskonzentration, x = Konzentrationsveränderung während des Intervalls t . Die Berechnung der Reaktionsgeschwindigkeitskonstante bringe ich auf Grund der Daten von Tab. II. (normale Inaktivierung) in Tab. III. Der k -Wert ist auf Grund der Berechnung gleich 0,34. Wegen der Einzelfheiten

der Berechnung verweise ich auf ein meiner älteren Mitteilungen, (2) sowie auf die zusammenfassende Arbeit von E. EICHWALD (26).

Unstreitbar ist die Berechnung der Reaktionsgeschwindigkeitskonstante auf diese Weise so mühsam und langwierig, dass das Verfahren besonders bei klinischen Untersuchungen völlig unbrauchbar erscheint. Dies hat mich zur Ausarbeitung einer raschen und sehr einfachen Methode veranlasst.

TABELLE III
Die berechnung des Reaktionsgeschwindigkeitsfaktors

Inkubationszeit in Minuten	0'	1'	2'	3'	5'
Gerinnungszeit von Proben (Sek)	17,5''**	21''	25''	30''	44''
Thrombinaktivität E/ccm*	10,5	7,4	5,2	3,8	1,85
a	—	10,4	7,4	5,2	3,8
a — x	—	7,4	5,2	3,8	1,85
$\frac{a}{a - x}$	—	1,42	1,42	1,37	2,06
$\log \frac{a}{a - x}$	—	0,152	0,152	0,138	0,315
$2,3 \cdot \log \frac{a}{a - x}$	—	0,35	0,35	0,32	0,73
t Zeitintervall (Minuten)	—	1	1	1	2
$\frac{1}{t}$	—	1	1	1	0,5
$k = \frac{1}{t} \cdot 2,3 \cdot \log \frac{a}{a - x}$	—	0,35	0,35	0,32	0,36
Reaktionsgeschwindigkeitsfaktor (Mittelwert)	k = 0,34				

* Auf Grund von Abb. 2, berechnete Werte.

** Extrapolierte Date.

d. *Graphische Bestimmung des Reaktionsgeschwindigkeitsfaktors.* Wenn für die graphische Darstellung laut Abb. 5. Papier mit einer Einteilung benützt wird, in der die logarithmische Einheitslänge der einen Achse 100 mm beträgt, die andere Achse aber eine einfache Millimetereinteilung hat¹, so lässt sich der Wert des Geschwindigkeitsfaktors durch einen einfachen Kniff, ohne jede Berechnung unmittelbar ablesen (Abb. 6). Unser Verfahren besteht darin, dass wir die über die Punkte gelegte Gerade bis zur Ordinate extrapolieren (gestrichelte Linie), sodann an den 45. mm der Abszisse eine Senkrechte legen und an

¹ Solchermassen eingeteilte Papiere sind z. B. Schleicher u. Schüll Nr. 365 oder Aerni-Leuch (Bern) Nr. 535.

dieser die Länge des zum Öffnungswinkel Alpha gehörenden Liniestückes messen. Wird die gemessene Länge in Dezimeter ausgedrückt, so ist deren Zahlenwert gleich dem *Reaktionsgeschwindigkeitsfaktor*. In unserem Falle beträgt die Länge des Liniestückes 0,34 dm, danach ist also $k=0,34$, was identisch ist mit dem Ergebnis der in T a b. III mitgeteilten langwierigen Berechnung. Das Gesagte wird von den Daten der A b b. 6 noch besser beleuchtet. Ich bemerke, dass einzelne Forscher, die meine Methode übernommen haben, leichter Ausdrückbarkeit halber den k -Wert öfters durch die abgelesene mm-Zahl ausdrücken

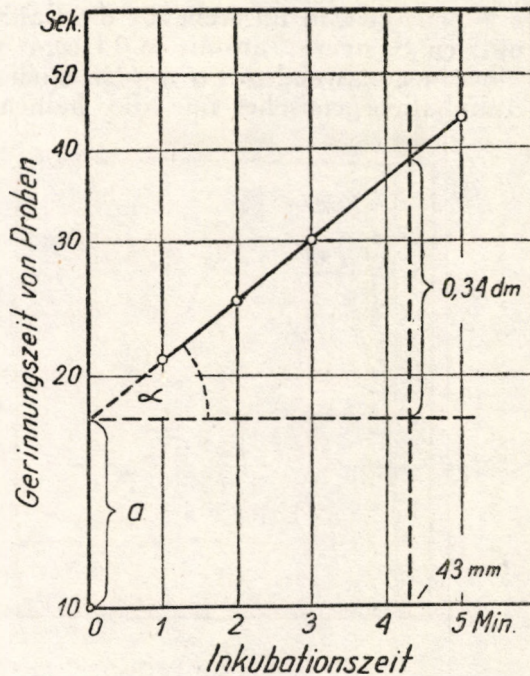


Abb. 6. Graphische Bestimmung des Reaktionsgeschwindigkeitsfaktors (k).

(k_{mm}) also im Falle unseres Beispiels $k_{mm}=34$ schreiben. Durch Dividierung dieses Wertes mit 100 erhält man den wirklichen Wert des Reaktionsgeschwindigkeitsfaktors.

Erwähnt sei noch, dass der extrapolierte Anfangspunkt der erhaltenen Geraden bei obiger Darstellung des Inaktivierungsprozesses im allgemeinen eine längere Gerinnungszeit aufweist, als wir solche zu Beginn unseres Versuches auf die Anfangsaktivität des Thrombins bekamen, d. h. dass die Gerade meistens von höher als 10 Sek. ausgeht. Die Differenz zwischen den beiden Werten (Liniestück a) wird durch Adsorption eines Teils des Thrombins an das Serum im Augenblicke des Vermischens verursacht (2). Es empfiehlt sich bei den Versuchen auch deren Grösse zu beachten, denn in manchen krankhaften Fällen ist auch die Adsorptionsstärke charakteristisch.

Andrerseits beobachteten wir auch, dass bei einzelnen Sera die in der 3., 5. Min. erhaltenen Gerinnungszeitwerte sich nicht auf der Geraden befinden, sondern etwas nach oben, in anderen Fällen nach unten

zu liegen kommen, dass also eine konvexe oder konkave Kurve erzielt wird. Wir haben festgestellt, dass diese Erscheinung eine Eigenheit des Blutes einzelner Tierarten ist: so biegt z. B. Inaktivierungskurve des Rattenblutserums stark nach unten. Auf die Erklärung dieser Erscheinung will ich jetzt nicht eingehen. In solchen Fällen ist die Linie streng über die erhaltenen Punkte zu legen und der k -Wert zu dieser Kurve graphisch zu berechnen.

Als praktische Modifikation sei erwähnt, dass die angewandte Blutmenge nötigenfalls noch weiter reduziert werden kann. Bei der Blutuntersuchung von Säuglingen, von Individuen mit schlechten Venen, besteht die Möglichkeit, in unserem für die Bestimmung der Gerinnungszeit benützten Systeme anstatt je 0,1 ccm nur je 0,05 ccm Plasma bzw. Fibrinogen anzuwenden. So werden auch bei der Zusammenstellung des Inkubationsgemisches nur die halben Mengen ge-

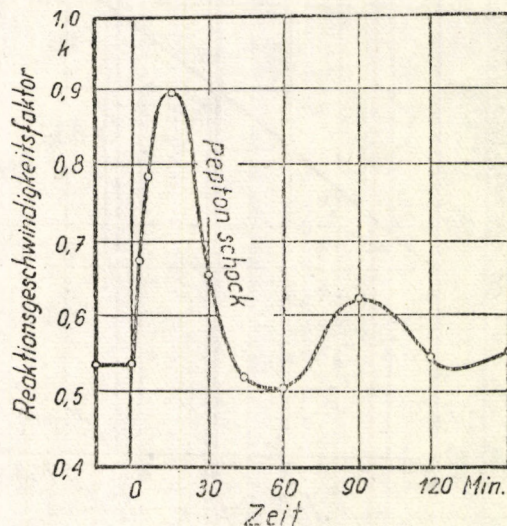


Abb. 7. Veränderung der k -Werte bei experimentellem Peptonschock.

braucht, und kann die Inaktivierung auch mit einigen Blutstropfen bestimmt werden, also sogar auch mit aus der Fingerspitze genommenem Blute gearbeitet werden. Dann hat der Versuch auch den Vorteil, selbst 10 minutenweise wiederholbar zu sein, wodurch die Zustandsveränderungen des Blutes gut verfolgbar sind. Dies ist besonders dann von Wert, wenn das Inaktivierungsvermögen des Blutes bei in-vivo oder in-vitro-Versuchen durch Wirkstoffe beeinflusst wird und der Wirkungsverlauf beobachtet werden soll.

Im Laufe unserer Untersuchungen benutzten wir früher die auf A b b. 3 angegebene Art der Charakterisierung der Thrombininaktivierung. Seit Ausarbeitung der graphischen Berechnungsweise des k -Wertes zeichnen wir indessen die Gerinnungszeiten ausschliesslich in A b b. 5. entsprechender Art auf und bestimmen gleichzeitig die zu den Geraden gehörenden k -Werte. Auf diese Weise ist es möglich, bereits in 1–2 Min. nach Beendigung des Versuches den genauen und wohl definierten Reaktionsgeschwindigkeitsfaktor in der Hand zu haben.

Schliesslich sei erwähnt, dass in Fällen, in denen im Laufe eines Versuches die Veränderung der Thrombininaktivierung fortlaufend verfolgt werden, die zeitliche Veränderung der k -Werte mittels der in unseren Abbildungen figurierenden Werte festgestellt werden können. Ein solches Beispiel führen wir in Abb. 7 vor, wo wir auf Grund eines älteren Versuches (20) die Veränderungen des Reaktionsgeschwindigkeitsfaktors auf Wirkung intravenösen Peptons hin darstellten. Diese Darstellungsart ist sehr geeignet, den zeitlichen Verlauf der im Blute vor sich gehenden Prozesse zu veranschaulichen.

Auf Grund unserer bisherigen Erfahrungen hoffen wir, dass unsere oben beschriebene Methode bei der Untersuchung der Anomalien der Blutgerinnung und bei der Aufklärung der Detailfragen ihres Mechanismus gute Dienste leisten wird.

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ЭКСПЕРИМЕНТАЛЬНОЕ ОПРЕДЕЛЕНИЕ ПРОЦЕССА ИНАКТИВАЦИИ ТРОМБИНА

Автор: М. ГЕРЕНДАШ

РЕЗЮМЕ

Инактивация тромбина в крови следует кинетично реакцией первого порядка. Описывается очень простой метод, при помощи которого делается возможным наблюдать инактивацию и определить ее скорость.

Приводятся некоторые примеры для зарисовки кривых инактиваций и их оценки и сообщается скорый графический метод для определения фактора скорости реакции.

GLEICHGEWICHTSBEDINGUNGEN DES THROMBININAKTIVIERUNGSVERMÖGENS DES BLUTES

VON

M. GERENDÁS und I. CSEFKO

Vom Ung. Biol. Forschungsinstitut, Tihany, und von Institut f. Allgemeine Pathologie
der Universität, Budapest

Mit 3 Abbildungen im Text

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Bekanntlich verschwindet in frisch genommenem Blute entstehendes Thrombin alsbald aus dem Serum, desgleichen bösst auch Blut, Plasma oder Serum zugesetztes fertiges Thrombin binnen kurzem seine Wirkung ein. Wir haben nachgewiesen, dass diese mit der Zeit progressiv vor sich gehende Inaktivierung des Thrombins wie eine Reaktion I. Ordnung verläuft (1, 2). Die Grösse des nach der Gleichung $k = 1/t \cdot \log. nat. c_0/c$ berechneten Reaktionsgeschwindigkeitsfaktors (3.) fällt im allgemeinen zwischen 0,1 und 1,5, sein Wert ist jedoch auch je nach Herkunft des Blutes sehr verschieden. Bei Tauben beträgt er — wie wir beobachteten — 0,1—0,2, bei Ratten 0,3, beim Rinde 0,2—0,4 beim Kaninchen 0,4—0,6, beim Schwein 0,8—0,7, beim Meerschweinchen 0,8—1,5. Im allgemeinen konnte auch festgestellt werden, dass die Gerinnung umso rascher erfolgt, je geringer die Inaktivierung ist. Der Thrombininaktivierungsfaktor k des Blutes gesunder Menschen bewegt sich um 0,5 in pathologischen Fällen sind indessen sehr erhebliche Abweichungen zu beobachten, so beträgt er z. B. bei Sclerosis multiplex 0,22, (4.) bei Hämophilie 2,2 (5.) Dabei lag die Blutgerinnungszeit der Sclerosis-multiplex-Fälle um etwa 1 Min. herum, die der Hämophiliefälle bei ungefähr 20 Min.

Im Laufe unserer Versuche stellten wir auch fest, dass Heparin die Reaktionsgeschwindigkeit dieses Prozesses erhöht (6.), wogegen die Steigerungswirkung des Heparins und die Thrombininaktivierung durch Kinase überhaupt verhindert werden kann (7.).

Demzufolge führt das Erscheinen von Heparin im Blute zur Steigerung der Inaktivierung und somit zur Verminderung des Gerinnungsvermögens, das Auftreten von Kinase dagegen zur Reduktion der Inaktivierung und dadurch zur Erhöhung des Gerinnungsvermögens.

Da wir unsere bisherigen Versuche lediglich im Zeitpunkte des Zusetzens von Heparin bzw. Kinase durchführten, untersuchten wir in vorliegender Arbeit, auf welche Weise der Entwicklung von in vivo gegebenem Heparin ausgelöste Prozess sich im Laufe der Zeit abspielt, bzw. inwieweit dieser Prozess durch Untersuchung der Inaktivierung verfolgbar ist. Unsere Versuche vervollständigten wir des Vergleiches halber durch eine Untersuchung der Wirkung des dem Serum in vitro zugefügten Heparins bzw. von Kinase.

EXPERIMENTELLER TEIL

Das zu den Versuchen verwendete Heparin war ein Erzeugnis der Firma VITRUM (Stockholm), das Thrombin stammte das HOFFMANN-I. A ROCHE (Basel), als Kinase benützten wir von uns selbst hergestelltes, durch Aceton getrocknetes Kaninchenhirnpulver. Zu den Versuchen gebrauchten wir 1 Tag altes Kaninchenserum, zu den Gerinnungsproben nach dem Verfahren von LAKI (8, 9) hergestellte Fibrinogenlösung. Hinsichtlich der Versuchsmethode verweisen wir auf unsere bereits angeführten Veröffentlichungen (2., 3.).

I. IN-VITRO-VERSUCHE

a. Zunächst stellten wir fest, in welcher Weise das Inaktivierungsvermögen des Kaninchenserums der in-vitro-Untersuchung von der Konzentration des zugesetzten Heparins abhängt. Wir fanden dass der Grundwert der Inaktivierung (heparinloser Wert) $k=0,4$ beträgt. Der Wert des Reaktionsgeschwindigkeitsfaktors nimmt nach Zusatz von Heparin und Steigerung der Heparinkonzentration innerhalb des untersuchten Intervalles exponentiell zu (A b b. 1.).

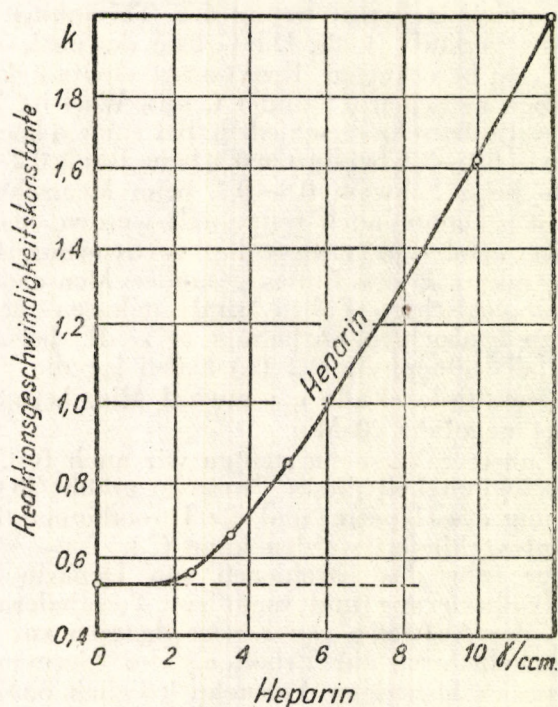


Fig. 1. Die Wirkung von Heparin auf die Reaktionsgeschwindigkeitskonstante der Thrombininaktivierung. In vitro Versuch.

b. Sodann untersuchen wir, wie die inaktivierungssteigernde Wirkung des dem Serum in vitro zugesetzten Heparins sich im Verlaufe der Zeit verändert, d. h. wir bestimmten die Inaktivierung im Momente

der Vermengung von Heparin und Serum, sodann auch nach einer von da ab gerechneten Inkubationszeit von 5, 10, 20, 30 Min. und 1, 2, 4, 8 Stunden.

Aus den in A b b. 2 dargestellten Versuchsergebnissen geht hervor, dass die Inaktivierungsgeschwindigkeit im Augenblicke des Heparinzusatzes plötzlich emporschnellt, um dann anfänglich rascher, späterhin in nur allmählicher Senkung gegen den Ursprungswert hin zurückzukehren (Heparinkurve in A b b. 2.). Eine je grössere Heparinkonzentration wir anwandten, einen desto grösseren Sprung nach oben machte der Wert des Inaktivierungsfaktors, doch kehrte er auch desto rascher gegen den Ausgangswert hin zurück wobei jedoch, die Rückkehr auf den Ursprungswert erst nach Stunden erfolgte.

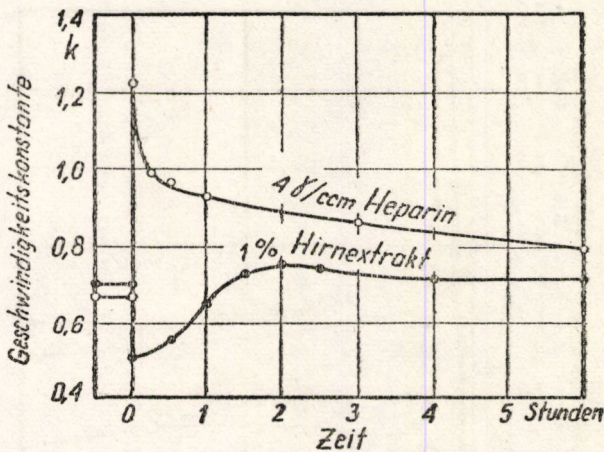


Fig. 2. Die zeitliche Veränderung der Wirkung von Heparin, bzw. Kinase. In vitro Versuch.

Es sei erwähnt dass die auf Heparinwirkung hin erhöhte Inaktivierung — wenn das Serum auch Blutzellen enthielt — rascher, ohne Blutzellen hingegen (reines Serum) langsamer auf den Originalwert zurückkehrte. Daraus kann gefolgert werden, dass die Blutzellen den die Heparinkompensation hervorbringenden Stoff in grösserer Menge enthalten.

c. Den zeitlichen Verlauf des Kinaseeffektes untersuchten wir auf die Weise, dass wir Kaninchenhirnpulver in dest. Wasser suspendierten und es dem Serum zusetzten. Nach dem Hinzufügen der Suspension verminderte sich sofort die Thrombininaktivierungsgeschwindigkeit, um dann allmählich wieder zuzunehmen (A b b. 2.). Der k -Faktor erreichte nach 1 Stunde bereits den Ausgangswert und weiter steigend nach etwa 2 Stunden sein Maximum. Von da ab fiel er wieder allmählich auf den Grundwert zurück.

II. IN-VIVO-VERSUCHE

Bei den in-vivo-Versuchen spritzten wir das Heparin in die Ohrvene der Kaninchen, entnahmen nachher Proben aus dem anderen Ohr und untersuchten deren Thrombininaktivierung. Beim Einspritzen lösten

wir soviel Heparin in 2 ccm dest. Wasser, dass es auf die annähernd berechnete Menge des kreisenden Blutes (1/12 des Körpergewichts) verteilt die gewünschte Konzentration ergab. An den erzielten Ergebnissen (Abb. 3.) lässt sich erkennen, dass die Inaktivierungsgeschwindigkeit — während sie in den in-vitro-Versuchen bei Heparinzusatz sofort hochgeht — bei in-vivo-Gabe erst in etwa 10 Min. ihr Maximum erreicht und dann sofort sehr stark zurückfällt. Bei der geringeren Konzentration (10 γ Heparin/ccm Blut) (Kurve a) sinkt die Inaktivierungsgeschwindigkeit sogar unter die Anfangskonzentration, selbst bei der Konzentration 20 γ /ccm (Kurve b) fällt sie auf den Ausgangswert. Sodann sieht man bei beiden Kurven eine neuere Steigung. Bei der höheren Heparinkon-

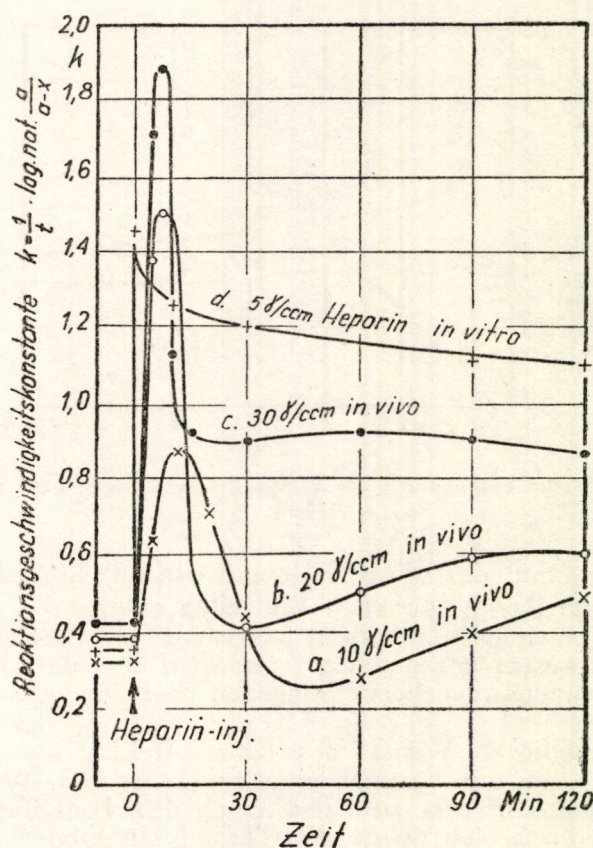


Fig. 3. Die zeitliche Veränderung der Wirkung von Heparin, In vivo Versuch.

zentration (30 γ /ccm) (Kurve c) ist der Spitzenwert Inaktivierung $k=1.9$. Nach dem Sinken kehrt die Inaktivierungskurve nicht bis zum Grundwerte zurück, sondern bleibt verhältnismässig hoch bei $k=0.9$ stehen und beginnt nach einer geringen Erhöhung sich aufs neue dem Ausgangswerte zu nähern.

Bei mehrmaligem Wiederholen der Versuche erhielten wir ähnliche Ergebnisse.

BESPRECHUNG DER VERSUCHSERGEBNISSE

I. In-vitro-Versuche

Auf Grund der im Vorhergehenden besprochenen Versuche lässt sich feststellen, dass die durch Heparin *gesteigerte* Inaktivierung in den in-vitro-Versuchen im Laufe der Vermengung von Heparin und Serum fortgehend *abnimmt*, also gegen die *tieferen Gleichgewichtslage* hin verläuft. Infolgedessen ist es möglich festzustellen, dass der auf die Kompensation des Heparins gerichtete Prozess — wenn auch nur in geringem Masse — bereits im abgenommenen Blute selbst in Erscheinung tritt.

Zugleich beweisen unsere mit Kinase durchgeführten in-vitro-Versuche, dass die auf Kinasewirkung hin *verminderte* Inaktivierung nach einer gewissen Zeit fortlaufend *zuzunehmen* beginnt. Also rückt die Inaktivierung aus dem reduzierten Zustande der Gleichgewichtslage, in diesem Falle einem *höheren* Inaktivierungswert zu. Beachtenswerterweise erfolgt dies auch in vitro, also bereits bei der Untersuchung des vom Organismus separierten Blutes.

II. In-vivo-Versuche

Werden die in den in-vivo-Versuchen erhaltenen Inaktivierungswerte mit den in-vitro-Werten verglichen, so lässt sich in erster Linie feststellen, dass es in den in-vivo-Versuchen zur Erzielung des gleichen Inaktivierungsfaktors einer wesentlich stärkeren Heparinkonzentration bedarf als im in-vitro-Versuche. So kann im in-vitro-Versuche z. B. bei 5 γ /ccm Heparin die gleiche Inaktivierungssteigerung beobachtet werden, wie bei in vivo gegebenen 20 γ /ccm. Daraus lässt sich der schluss ziehen, dass der Organismus das in ihm auftretende Heparin auf irgendeine Weise stärker kompensiert und dass infolgedessen Wirkung nicht in vollem Masse zur Geltung zu kommen vermag.

Ein Ergebnis dieses Kompensationseffektes ist es auch, dass die Inaktivierungsstärke in den in-vivo-Versuchen plötzlich zurückstürzt, in gewissen Fällen sogar unter den Ausgangswert fällt. Dies bedeutet, dass das Blut gerinnbarer wird als es ursprünglich war, d. h. es kommt eine Überkompensation zustande. Dies kann sich im Tierversuche darin äussern, dass die Gerinnbarkeit des Blutes im Falle einer geringen Heparin-gabe — obgleich sie vorübergehend abnimmt — nach einer gewissen Zeit so sehr zunimmt, dass z. B. die eingebundenen Kanülen miteinkoagulieren. Dies ist eine sehr häufige Erscheinung und sie pflegt sich in der Regel 1/2—1 Stunde nach der Heparin-gabe zu melden, also zu dem Zeitpunkte, in dem die Überkompensationsphase an der Inaktivierungskurve wahrgenommen wird. Nunmehr kann die Erscheinung auf Grund der Kurve gut erklärt werden und aus dem erzielten Ergebnis kann die Nutzenanwendung gezogen werden, dass wenn die Heparinwirkung noch über 1/2—1 Stunde hinaus aufrecht erhalten werden soll, eine Heparinkonzentration anzuwenden ist, die die Inaktivierung auch nach erfolgter Kompensation auf einem Niveau erhält, das die Blutgerinnung noch zu verhindern vermag. Des weitern unterstreicht das erhaltene Ergebnis auch klar den Vorteil der Heparininfusion bei der Prophylaxe der Thrombose.

Im Laufe unserer älteren Versuche sahen wir einen ähnlichen, doch gegensätzlichen Kompensationseffekt auf die Wirkung intravenös gegebenem Thrombins hin (10.). Das allmählich eingespritzte Thrombin verursachte anstatt der erwarteten Gerinnungssteigerung oder intravasalen Gerinnungswirkung eine Erhöhung der Thrombininaktivierung und so eine Streckung der Gerinnungszeit. Somit kam auch hier eigentlich eine Überkompensation zustande, nach der die Inaktivierungsgeschwindigkeit sich schliesslich auf dem Ausgangsniveau retablierte. (Natürlich beobachten wir parallel mit dieser Erscheinung-ähnlich JÜRGENS u. STUDER (11.) — auch eine Verminderung des Blutfibrinogengehaltes).

Es kann also festgestellt werden, dass *der Organismus die Gerinnbarkeit des Blutes regelt*. Diese Regelung erfolgt durch die Inaktivierung, die eine Gleichgewichtszustand hervorruft den der Organismus mittels Kompensationsprozesse aufrechterhält. Natürlich bleibt das Blut durch überstarkes Heparin in ungeronnenem Zustande. Durch überstarkes Thrombin aber entsteht intravenöse Gerinnung und das Tier verendet. Wird dagegen nicht extrem hohe (also aphysiologische) Konzentrationen angewendet und die Blutgerinnung durch intravenöses Heparin verhindert oder soll dieselbe durch intravenöses Thrombin gesteigert werden, so ist in beiden Fällen eine Kompensation zu beobachten. Dies ist das Ergebnis der im Organismus vor sich gehenden, das Gleichgewicht aufrecht erhaltenden Abwehrprozesse, in deren Verlauf auch eine sehr erhebliche Überkompensation zustandezukommen vermag.

Es kann noch festgestellt werden, dass *das Gleichgewicht, also das Streben nach Zustandebringen eines normalen Inaktivierungsspiegels sich im Blute sowohl in vivo wie in vitro gleicherweise äussert. Dass Thrombininaktivierungsvermögen des Blutes stellt sich in jedem einzelnen Falle auf normales Niveau ein, gleichviel ob es im Laufe der Versuche in Richtung der gesteigerten oder verminderten Inaktivierung verschoben wird.*

Erwähnt sei noch, dass wir unsere Versuche auch an Tieren durchführten, die einen extrem geringen (Taube $k=0,15$) oder extrem hohen (Meerschweinchen $k=1,2$) Inaktivierungswert aufweisen. Auch in diesen Fällen kehrte die durch Heparin gesteigerte bzw., Kinase verminderte Inaktivierung stets auf das für die betreffende Tiergattung charakteristische Niveau zurück. Für diese Tiere bedeutet also dieser niedrige, bzw. hohe k -Wert das Gleichgewichtsniveau und ihr Organismus ist bestrebt, durch Kompensationsprozesse das für sie physiologische Niveau aufrecht zu erhalten, gleichviel ob dasselbe tief oder hoch liegt.

Demgegenüber bezweifeln wir auf Grund unserer Versuche nicht, dass beim Menschen in pathologischen Fällen gefundene, extreme Inaktivierungswerte auf Störungen dieses Gleichgewichtssystems zurückzuführen sind und diese Feststellung bezeichnet zugleich die weitere Richtung unserer Versuche.

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УСЛОВИЯ РАВНОВЕСИЯ СПОСОБНОСТИ КРОВИ ИНАКТИВИЗИРОВАТЬ ТРОМБИН

Автор: МИХАЛЬ ГЕРЕНДАШ

РЕЗЮМЕ

1. Скорость инактивизирования тромбина увеличивается „in vitro“ посредством гепарина прибавленного сыворотке, а если оба вместе действуют, тогда скорость постепенно падает на исходную величину.

2. Через действие киназы прибавленной сыворотке „in vitro“ инактивизирование тромбина уменьшается и постепенно возвращается к нормальной величине.

3. Внутривенозный гепарин производит быстрый подъем инактивизирования, которому также следует быстрая и сильная компенсация, по действию которой скорость инактивизирования может и снижаться ниже исходной величины, т. е. имеется возможность возникновения перекомпенсации.

4. На основании наших опытов установлено, что способность крови инактивизирования тромбин, повышенная гепарином, или пониженная киназой, в опытах так in vivo как и „in vitro“, вследствие компенсационных процессов, по истечению определенного времени снова возвращается к нормальной величине.

HEPARIN EFFECT AND THROMBIN INACTIVATION

BY

M. GERENDÁS, L. PÁLOS and I. CSEFKO

From the Hungarian Biological Research Institute, Tihany, Lake Balaton

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In previous communications we have dealt with investigations as to the disappearance of thrombin generating in blood during clotting, respectively as to the disappearance of manufactured thrombin preparations added to the blood. We have established — on the basis of our experiments — that the disappearance of thrombin is to be attributed to two processes: a suddenly occurring adsorption and a progressive inactivation following type of a monomolecular reactions. (*Gerendás*, 1946, 1948.) In these communications we dealt in the first place with the physical and chemical laws and properties of these processes, and also with the effect of substances inhibiting inactivation.

It is known that heparin produced by the organism or administered into the blood prolongs clotting time of the blood. However till now no uniform theory has been formed on the mechanism of the heparin effect.

Some of the authors see the role of the heparin in the inhibition of the formation of thrombin (Howell and Holt 1918). According to later researches it is however beyond doubt that the disappearance of the thrombin is partly also caused by heparin (Astrup, 1943, Jorpest, 1946, Quick, 1938, and others), whereas according to Seegers and his collaborators (1942), heparin does not increase the quantity of the disappearing thrombin, but intensifies the velocity of its disappearance.

In experiments described below we have investigated what kind of connection exists between heparin and the above-mentioned adsorptive thrombin inhibition and progressive inactivating process.

METHODS

The principle of experimental determination of the thrombin inactivation consists — according to our method — in adding a solution of connection exists between heparin and the above-mentioned ad-the oxalate-blood, plasma torbserum to be examined, and to observe on samples taken from it repeatedly the diminution of its activity during 10 minutes.

A standard solution from powdered thrombin is prepared, and diluted with distilled water in the proportion required for each experiment. 0.1 ml of this solution was taken and investigated in the following combination as to its clotting capacity:

Fibrinogen solution	0.1 ml.
Distilled water	0.1 ml.
Thrombin solution	0.1 ml.

The period between adding of the thrombin solution to the solution to be examined and the appearance of the first agglutinated clot which may be lifted with a glass-book, was considered as the clotting time. The experiments were carried out at room temperature.

For the preparation of the standard solution a quantity of thrombin was used, which showed in the above-mentioned solution with distilled water a clotting time of 12 seconds. This time serving as starting point corresponds to the time of activity at the beginning before the setting in of the thrombin inactivation.

To the blood, plasma or serum to be examined we added successively and in quantities detailed in the description of the experiments the activating ingredients in a glass-dish, and at last, the standard thrombin solution. After a lapse of 1, 2, 3, 5, 7, & 10 minutes of incubation time, samples were taken from the thrombin inactivating mixture and their thrombin activity in combinations similar to the above-mentioned samples was determined.

Fibrinogen solution	0.1 ml
Distilled water	0.1 „
Sample of mixture	0.1 „

The obtained clotting periods gradually lengthened indicating that the activity of the thrombin in the inactivating mixture gradually decreased as time progressed. The obtained time-data were graphically recorded on a logarithmic scale and a straight line was drawn between them. Thus it was made possible to interpolate the clotting times and we were able to establish the thrombin activity by the help of an empirical relation. From the reduction of thrombin inactivation we then calculated by the help of the formula concerning monomolecular reactions, ($k=1/t \cdot \log. \text{nat. } c_0/c$) the *reaction velocity constant* of the inactivation. It must be mentioned, that in order to simplify calculations a graphic method has been worked out, which will be dealt with more minutely elsewhere. (Gerendás, 1949, 1948 b.).

1. ROLE OF HEPARIN IN THROMBIN INACTIVATION

In the first place, the inactivating effect of the added heparin on thrombin inactivation was investigated through in vitro experiments. The thrombin inactivating capacity of a fresh rabbit-serum was established according to the following combination:

Serum	0.5 ml
Distilled water	0.2 „
Standard thrombin solution	0.5 „

The clotting times are shown by the normal curve of Fig. 1. The k value, calculated from the curve was: $k=0.531$.

It has been investigated subsequently in what proportion the velocity of inactivation changed if heparin was added to the inactivating solution.

The experiments were undertaken in the following combination:

Serum	0.5 ml
Distilled water	0.1 „
Heparin solution	0.1 „
Standard thrombin solution	0.5 „

The heparin solutions used for the mixture were chosen so that the heparine concentrations relative to the mixtures amounted to 0.3125, 0.625, 1.25, 2.50, 3.50, 5.0 and 10 $\mu\text{g/ml}$ respectively.

After experiments were completed it has been established that the inactivation curves obtained by heparin concentrations of 0.3125, 0.625 and 125 $\mu\text{g/ml}$, did not differ from the normal curves obtained without the addition of heparin. After these values however the curves

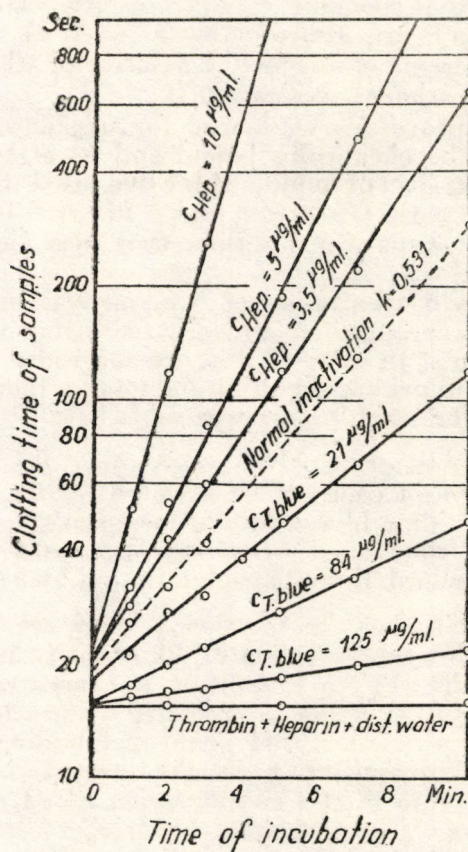


Figure No. 1. Increase of the thrombin inactivating capacity of rabbit serum on the influence of heparin, respectively its decrease on the effect of toluidine blue. The curve at the bottom shows that heparin does not produce thrombin-inactivating effect in a pure thrombin-fibrinogen system.

became steeper as the heparin concentration of the solution increased. (Fig. No. 1). This means that with the increase of the concentration of heparin velocity of the inactivation also gradually increases. The velocity constants calculated from the data (the values of k) show a steeply rising curve. (Fig. No. 2. Heparin curve).

As the time-curves of clotting (Fig. No. 1.) start from approximately identical clotting time values, it follows that there is no change in the adsorption. Consequently it may be established, that the effect of hepa-

run consists in the acceleration of the reaction-velocity the process of thrombin inactivation which follows the laws of a progressive, monomolecular reaction-type.

According to our investigations the inactivation-increasing effect of heparin takes place in oxalat-blood, oxalat-plasma and also in oxalate/serum obtained through cogulation by thrombin. We got similar results from the blood of man and of various animals, (ox, pig, hen, pigeon).

After these experimental results it seemed possible that the blood's own heparin contents are also playing a part in the normal inactivating process of plasma or serum (the velocity of which has been fixed in the previous experiments with $k=0.5$).

In order to prove this we looked for substances with whose help the heparin could be chemically bound and its effect thus eliminated. We investigated the effect of toluidine blue dye used for the histological demonstration of heparin (Holmgren and Willander, 1937) on the thrombin inactivation of heparinised serum. (See also Gerendás, Horn and Borsody, 1948).

Heparin in a concentration of 5 $\mu\text{g/ml}$ was used for these experiments, i. e. a concentration strongly increasing inactivation in our previous experiments. In spite of this, we succeeded in finding a combination with toluidineblue, neutralising totally the effect of the heparin employed. The combination was as follows:

Rabbit serum	0.5 ml
Heparin solution, 60 $\mu\text{g/ml}$	0.1 „
Toluidine blue solution, in various conc	0.1 „
Standard thrombin-solution	0.5 „

In this combination the reaction velocity amounted to $k=0.546$, with a toluidine-blue concentration of 40 $\mu\text{g/ml}$ (which is expressed in a figure corresponding to the system; at a concentration of 50 $\mu\text{g/ml}$ it amounted to $k=0.522$. From interpolated values it results that at a concentration of approximately 44 $\mu\text{g/ml}$ of toluidine blue, the velocity of inactivation is corresponding to the normal inactivation, (being $k=0.531$). According to this, a concentration of 44 $\mu\text{g/ml}$ of toluidine-blue neutralizes the effect of 6 $\mu\text{g/ml}$ heparin so that the effect of heparin in increasing inactivation is completely neutralized.

In the subsequent experiments we investigated whether the inactivation effected by the blood itself, — in which process a part was attributed to the heparin contents of the blood — has also been influenced (decreased) by the effect of toluidine-blue.

The combination used was as follows:

Serum	0.5 ml
Distilled water	0.1 „
Toluidine blue in varying conc.	0.1 „
Standard thrombin solution	0.5 „

We employed toluidine-blue in a concentration of 0.00125, 0.0052, 0.021, 0.042, 0.081, 1.25 and 2.50 $\mu\text{g/ml}$ per system, in the successive experiments.

After finishing and evaluating the experiments it has been established that velocity of inactivation was greatly reduced below the normal value by toluidine-blue. Toluidine-blue used in a very diluted solution proved effectless. Some of the curves demonstrating concentrations which diminish velocity of inactivation are shown on Fig. No. 1; the change of the reaction constant is shown by the toluidine-blue curve of Fig. No. 2.

As toluidine-blue also reduces in a large degree the inactivating capacity of the serum, it seemed beyond doubt that the heparin contents of the blood must have a part in it. Although inactivation could

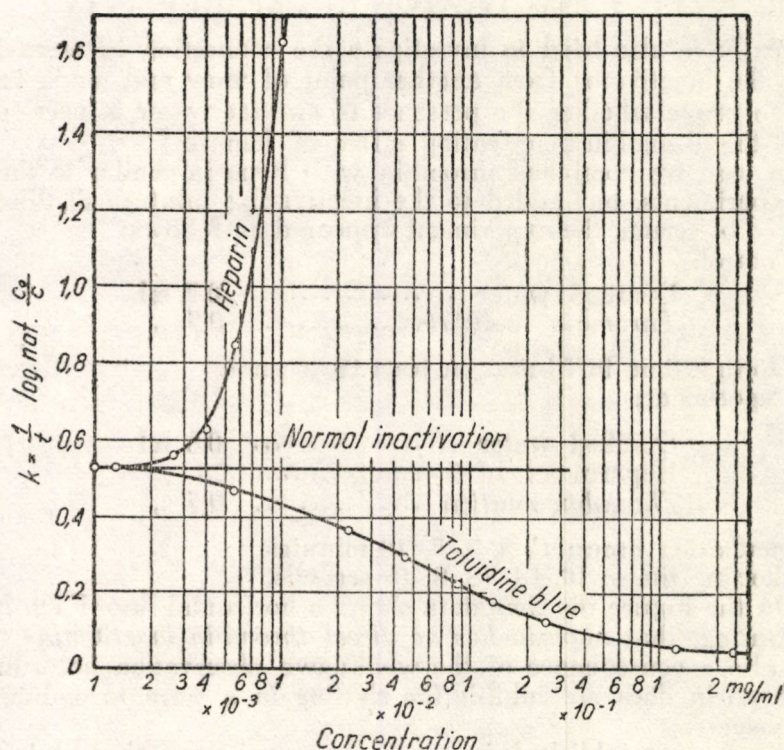


Figure No. 2. Change of value of the reaction velocity constant of thrombin inactivation as the effect of heparin, respectively toluidine-blue.

not be stopped entirely by toluidine-blue, the remaining slight inactivating effect was attributed to heparin liberated from the heparin — toluidine-blue compound by dissociation. Thus it may be established that the fermentative thrombin inactivation does not occur without heparin or only on a very small scale.

In connection with experiments on other subjects we also made the observation that in adding histamine to a violet coloured heparin-toluidine blue solution the original blue colour of the toluidine-blue reappears; consequently, histamine is also bound by heparine, the bond between histamin and toluidine-blue being even stronger than that

between histamin and heparin. (Gerendás, Csefkó and Udvardy, 1948 a). Based up on this observation the effect of histamin has been examined on normal serum and on serum treated with heparin, and an effect similar to that of the toluidine-blue has been observed. (Csefkó, Gerendás und Udvardy 1948, a) These experiments also prove that the fermentative inactivator does not work without heparin. It seems possible, that also the reciprocal heparin-kinase effect — investigated by Fischer and Astrup, (1935) Horn and Borsody (1948) — manifests itself in heparin being bound by kinase diminishing thus the effect of heparin on inactivation. (Csefkó, Gerendás, Udvardy, 1948).

2. ROLE OF INACTIVATOR IN HEPARIN-EFFECT

We have also tried to investigate the connection between heparin and the inactivator from another point of view and made investigations to prove whether the presence of an inactivator is necessary to produce the thrombin-inactivating effect of heparin?

In case we combined thrombin with heparin similar to the previous experiments, but added to the inactivating mixture distilled water instead of serum, the experiment appeared as follows:

Control:

Distilled water	0.7 ml
Thrombin solution	0.5 „

Clotting time in fibrinogen tests 18 seconds.

Experiment:

Distilled water	0.6 ml
Heparin sol. of 5 $\mu\text{g}/\text{ml}$	0.1 „
Thrombin solution	0.5 „

Incubating times: 1', 2, 3, 5, 10 minutes.

Clotting times: 19, 18, 18, 8, 18 seconds.

On the Figure the time data shows a horizontal line (Fig. No. 1) demonstrating, that *heparin has no direct thrombin inactivating effect*. This is also a consequence of the wellknown observation according to which heparin does not inhibit the clotting in a pure thrombin-fibrinogen system.

We have established in previous experiments that the inactivating ferment is thermolabile, and loses its entire activity when heated to 60° C (Gerendás, 1948). We now tried to determine, whether heparin had an inactivating effect on such heated plasma.

We kept ox serum for 10 minutes at a temperature of 60° C, cooled it subsequently to room-temperature, and undertook inactivating experiments in the following combination:

Heated, cooled and filtered serum	0.3 ml
Heparin solution, 100 $\mu\text{g}/\text{ml}$	0.1 „
Distilled water	0.1 „
Standard thrombin solution	0.3 „

Incubating time: 1, 2, 5, 10 minutes.

Clotting time of test: 24, 24, 25, 24 seconds.

This experiment proves that heparin does not develop its inactivating effect, if the thermolabile inactivating substance the plasma has been destroyed by heating.

DISCUSSION

The experiments described are proving that *heparin only exercises thrombin inactivating effect, respectively effect of increasing inactivation when inactivating ferment of the plasma is able to work.*

It now follows from our experiments that the inactivating ferment, discussed in detail in our above-cited publications — and heparin are closely connected with one another, and that the inactivator is needing heparin for its action, just as heparin cannot exercise its inactivating effect without the presence of the inactivator.

It consequently follows that the delay of thrombin-clotting in the plasma treated with heparin is due to the fact that thrombin has been inactivated during the clotting by the influence of heparin added to the plasma, and only fractions of it remained to take part in the clotting.

Howell and Holt have already demonstrated (1918), that heparine did not impede coagulation in a pure thrombin-fibrinogen system. According to them a plasma-factor is necessary for producing the clotting inhibition effect of heparin. This problem since the above-mentioned statement of *Howell and Holt* has had an extensive literature (*Jorpes*, 1946) yet without a uniform opinion having been reached by the authors.

In the course of our researches we have formed the opinion that inactivation of thrombin is effected by a thermolabile, fermentlike substance, equally present in the plasma and in the serum. The activity of this substance is increased as the effect of heparin and decreased as the effect of heparin-binding substances (toluidine-blue, histamine, kinase). From this we may conclude, that the thermolabile substance corresponds to the protein part of the thrombin-inactivating ferment, whereas heparin might be regarded as the prosthetic group of this ferment, or possibly as its activator.

After the conclusion of the experimental series as above, one of our collaborators (*Pálos*, 1949) observed, that heparin is protecting thrombin against oxydative- and heat inactivation. This protective effect of heparin is in an apparent contrast to our previous experimental results. It must however, be taken into consideration, that the results of *Pálos* were obtained in a pure heparin-thrombin system, whereas our experiments were performed in serum. This is possibly the explication of the effect of heparin accelerating inactivation of thrombin in presence of the thermolabile factor, whereas it seems to protect thrombin against inactivation in the absence of this factor.

In physiological conditions, of course, only the previous action is possible.

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ДЕЙСТВИЕ ГЕПАРИНА И ИНАКТИВАЦИЙ ТРОМБИНА

Автор: МХАЙЛ ГЕРЕНДАШ

РЕЗЮМЕ

Опыты *in vitro* над способностью гепарина к инаktivации тромбина и к предотвращению свертывания показали, что последний не влияет на адсорптивное исчезновение тромбина, но увеличивает в значительной степени быстроту инаktivации тромбина. (прогрессивная реакция первой степени).

Для осуществления инаktivации тромбина в крови требуется совместное действие двух факторов: Один из этих факторов термонабильное вещество встречающееся в равной степени в сыворотке и в плазме, другой фактор — гепарин.

Ни тот, ни другой фактор сам по себе не может инаktivировать тромбин без содействия со стороны другого фактора.

Мы считаем, что термонабильное вещество соответствует белковой составной части фермента, а в тоже время гепарин соответствует предстательной группе фермента.

HISTAMINE AND HEPARIN ANTAGONISM IN VIVO AND IN VITRO

BY

M. GERENDÁS and I. CSEFKÓ

From the Hungarian Biological Research Institute, Tihany, Lake Balaton

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In case rats or mice are administered intravenously large quantities of colloid solutions, — and this colloid solution is sufficiently labile — the animals show symptoms similar to anaphylactic shocks. This condition was called by *Lumière* an anaphylactoid shock. *Jancsó* has dealt with this question more intensively later (1928), in connection with his chemotherapeutic investigations on salvarsan derivatives, and demonstrated that also in the case of salvarsan an anaphylactoid shock was caused by the precipitation of the drug in the inner bloodstream, a supposition, which he was able to prove subsequently through *in-vitro* experiments. He observed that arsenobenzol derivatives causing a very strong shock and being very toxic in therapy precipitate in the moment of their mixing with blood-plasma, or eventually shortly after it. It has however been established at the same time that salvarsan derivatives are accumulated in the reticuloendothel (*RES*) cells according to their degree of intravasal precipitation. Lately *Jancsó* (1947) has established the connection between *RES* accumulation and histamine effect. The characteristic of the *Jancsó* phenomenon consists in the fact that on the effect of histamine the vesselwall of the endothel is transformed into *RES* and becomes capable of adsorbing and retaining Indian ink whether histamine is rubbed into the skin or administered subcutaneously, intraperitoneally or intravenously. *Jancsó* concludes from this fact that the hormone of the *RES* which introduces the accumulation is: histamine.

We found in our own, earlier investigations concerning this subject (*Csefkó, Gerendás, Udpardy*, 1948) that as the effect of histamine administered intravenously, the thrombin inactivating capacity of blood is temporarily shocklike, diminished, which means, that the inner substrate of the blood is tending towards clotting. Whereas the latest investigations of *Gerendás, Pálos* and *Csefkó* (1948) have established, that the heparin contained in the organism plays an important part in the raising of thrombin inactivation.

Based on these results we began the investigation as to the nature of anaphylactoid shock and as to the connection between the effects of histamine and heparin. We chose Indian ink as model-colloid.

Jancsó in his paper calls our attention to the fact, which has been also observed by us in our previous investigations, that in the production of the *Jancsó* phenomenon only defectless Indian ink protected by gelatine, and causing no anaphylactoid shock may be

used. There are, very great differences between Indian inks: some are of very labile construction, forming immediately thrombosis in the blood thus killing the animal, and therefore unutilizable for our purposes. We found, however, after elaborate researches certain preparations which precipitate in the small lungvessels only in form of small particles. This precipitation is so small that it doesn't cause any grave symptoms on the animal: difficult breathing is to be perceived for some minutes only. This Indian ink is at a critical point between stability and lability, and has been used in our subsequent experiments.

Our experiments were carried out on rats. The injection was administered — for the purpose of indisturbed operation — under a light aether anaesthesia which lasted no longer than the injection itself.

a. In case the rat is administered per 100 g of its bodyweight 1 ml of Indian ink of 10%, the animal wakes easily from its torpor only its respiration being slightly increased. From the Indian ink, and which after 15 minutes may only be observed in the eyes, and disappears entirely in 45 minutes. The animal moves lightly, reacts vigorously to pain, and defends itself. After 45 minutes it is bled to death by throat cutting. At the dissection spleen and liver are blackcoloured, saturated with Indian ink, the lungs are of a lightgrey colour, and there are no inky thromboses to be perceived anywhere else in the vessels. Other deformation are not observed.

b. In case the animals are administered three minutes before the above injection 2 mg of histamine per 100 g of body-weight intravenously, and thereafter given the Indian ink injection, they show at their awakening from the ether-torpor heavy, difficult respiration, they collapse, stay leaning to one side, and sometimes small spasms occur in their limbs. They do not move about actively, and do not defend themselves when pinched or seized. The initial grey colouring disappears only with great difficulty from the skin, and is still visible in the eyes after 45 minutes. At their bleeding to death — after 45 minutes — only very little blood is let out. At the dissection, the lungs are of a slate grey colour, the liver and spleen brownishblack, there is a great dilatation and stagnation in the big vessels of abdomen and intestines, and the Indian ink is to be found in the large bloodvessels in thrombotic clots. Consequently, the Indian ink causing no anaphylactoid shock is precipitated in the large vessels by histamine administered intravenously. There this precipitation effect thrombosis and general stagnation and in the moment of the administration of Indian ink the animals show symptoms of an anaphylactoid shock, whereas, the Jancsó phenomenon is characterized by the non-thrombuslike intracellular accumulation of Indian ink in the post-and praecapillary vessels. The difference is based on the different stability of the administered Indian ink. The Jancsó phenomenon is only to be observed in the peritoneum, in the soft connecting tissue under the skin in some parts of the small venes of the skin and in the mesenterium.

c. In case the animals are given three minutes before the administration of histamine at least the threefold quantity of heparin, (at

least 6 mg of heparin per 100 g of bodyweight, dissolved in distilled water) and histamine in the above dosis is injected subsequently, we may observe, that after the receiving of Indian ink the animals wake easily from the ether-torpor, the grey colouring disappears very quickly (in 10 minutes) from their skins, and the eyes too become colourless in 20 minutes. There is no sign of an anaphylactoid shock on the animals, — as contrasted with the animals of group b. When bled, to death 45 minutes later, bleeding is abundant. At the dissection liver and spleen are of a coal-black colour, the lungs are of a normal rose colour and conditions of the abdomen are entirely normal. Indian ink thrombuses are not to be found in the vessels, and there appears not even the Jancsó phenomenon, which is observed at group b). (With the exception of the duodenum, where it appears even when histamine is not administered).

d. In case histamine is given 3 minutes before the administration of heparin both in the above doses and lastly Indian ink, there is no external difference to be seen, as compared with the animals of group c). At the dissection, however, a difference between the two groups can be observed in as much as there is a very slight greyish tint in the colouring of the lungs which proves that Indian ink was precipitated in the small vessels.

The following conclusions may be drawn from our investigations: Histamine, or histaminelike substances are causing precipitation of the colloids (in the present case of Indian ink) in the blood. In the case of using Indian ink which is on the critical point between stability and lability it happens therefore, that the colloid, effecting no precipitation in normal circumstances, is precipitated nevertheless in small particles in the lungs. It is a well known fact that the lungs are, under normal condition, the organs with the highest histamine content, consequently histamine added to the organism is adsorbed most rapidly by the lungs. This is probably also the reason why the Indian ink in the critical condition between stability and lability, precipitates in small particles in the lungs even when it does not precipitate in the other organs. The action of histamine in promoting thrombosis or, as in our present experiments, in expressly producing it, appears, after the experimental results, to be proved. Thus it seems natural that, at the effect of heparin, this thrombotic process did not occur.

The suspending effect of heparin on thrombosis, and on the accumulation of RES, is therefore, beyond doubt, based on the antagonism between histamine and heparin.

It seemed therefore, probable that on basis of the above-said there occurs some chemical association between heparin and histamine, which could be eventually proved optically. It is known, that heparin gets a violet colouring with toluidine-blue. (Jorpes, 1936). We therefore investigated, whether this dye-reaction is influenced by histamine. We added a solution of toluidine blue to heparin which effected the characteristic violet colouring of the solution. If we repeated the same experiment — with the only change of giving previously histamine to the solution — the violet colouring did not take place, the solution kept its toluidine-blue colour unchanged; this means, that in

this case heparine was already associated to histamine and gave, consequently, no reaction with toluidine-blue. On farther investigations of the question it has also been proved, that the linkage between heparin and histamine was stronger than that between heparin and toluidine-blue. This was established by adding first toluidine-blue to heparin and obtaining thus the violet colour-reaction. In adding subsequently histamine to this solution the colour reaction was undone, and toluidine-blue colouring reappeared.

In order to investigate the proportions of the bond thoroughly, we have undertaken the following experiment:

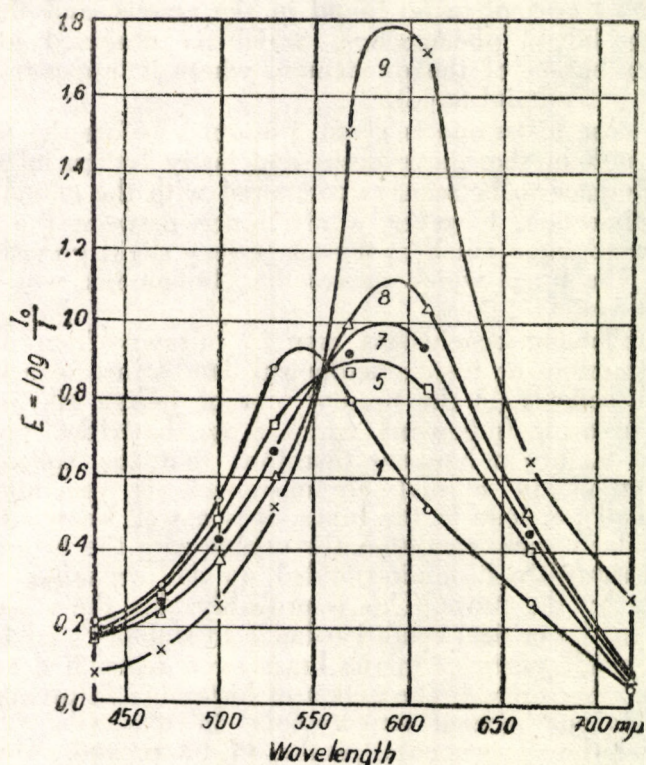


Figure No. 1. Changes of the spectrum of the heparin-toluidine-blue solution at the effect of histamine. Dates of the curves shown on Table No. 1.

We added to heparin solutions of equal quantities, histamine solution in gradually increasing quantities, and added to each sample an identical quantity, i. e. 0.05 %/00 %/ toluidine-blue solution. (Table No. 1.) We obtained thus a colour-series which showed according to the quantity of the histamine employed, beginning with the violet colour of heparin-toluidine-blue, gradually the transition from violet into toluidine-blue colour. The absorption spectra of the solutions were then determined by a Pulfrich-photometer, (Fig. No. 1.) which showed distinctly the transition of the two basic spectra into each other (On the Figure the absorption spectra of samples 1, 5, 7, 8, and 9 are shown.) The biggest change between the two spectra was observed at 610 m μ . The extinction variations obtained at this wavelength are

given on figure No. 2. It may be established from this curve, that the transition between the two modifications occurs at a histamine concentration of 10 mg/ml, which is approximately equivalent to molecule proportion of 2:1 between histamine and heparin; it seems, consequently, that for the neutralisation of one molecule of heparin two molecules of histamine were needed in this experiment. We are very well aware of the fact that this reaction is not specific in in vitro conditions, and a good many compounds are turning the violet colour of heparin-toluidine-blue into toluidine-blue again, and that a heat-effect, or the change of the pH decomposes also the heparin-toluidine-blue bond. Nevertheless the colour-reaction made the calculation of the molecule proportions possible — in the case of histamine. — The chemical investigation of the details of reaction are pendent.

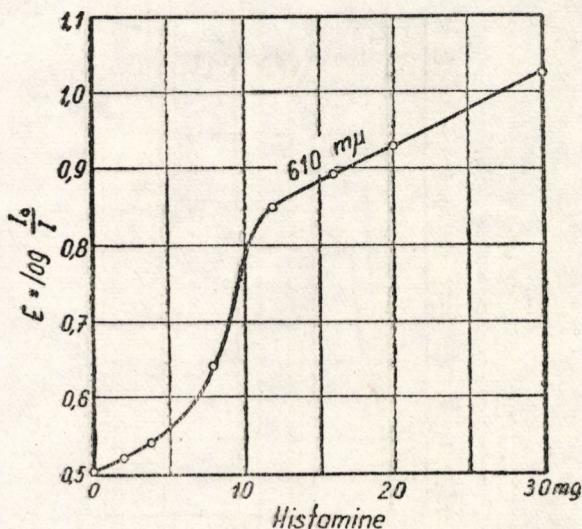


Figure No. 2. The variations of the extinction of the heparin-toluidine-blue solution at the effect of histamine at 610 mμ.

All the sings indicate consequently that the precipitation of the labile colloids in the blood is caused by the histamine circulating in the blood, or is at least in a great measure facilitated by its associating with the heparin present in the blood, and by increasing thus the coagulability of the blood. This is also proved by the observation that Indian ink on the critical point between stability and lability causes severe thrombosis in rats at the effect of histamine administered intravenously. Our opinion was already at the animal experiments, that the antagonistic effect of heparin is actually directed against histamine, and was not the consequence of the increase of stability of the colloids. This was also proved by the in vitro experiments described above. In this connection we also succeeded in clearing up the approximate quantitative proportions between histamine and heparin.

We established by our previously described experiments, that Indian ink of a sufficiently labile construction precipitates in the whole circulatory system, as the effect of histamine administered

intravenously and that thrombin, containing Indian ink may be observed in the big bloodvessels. This precipitation can be prevented by heparin.

We further investigated whether if animals were administered Indian ink, which subsequently accumulated by the RES, there were to be observed any signs in thrombin-inactivation and coagulation of the blood indicating the liberation of heparin. We wanted to elucidate by this, whether the organism defends itself on such occasions by mobilisation of heparin against precipitation and against thrombus formation.

In these experiments rabbits were given 5 ml of Indian ink of 15% per 1000 g bodyweight, protected by gelatine, (Indian ink Weber). Changes of the inactivation and coagulation of the blood were observed immediately after the administration.

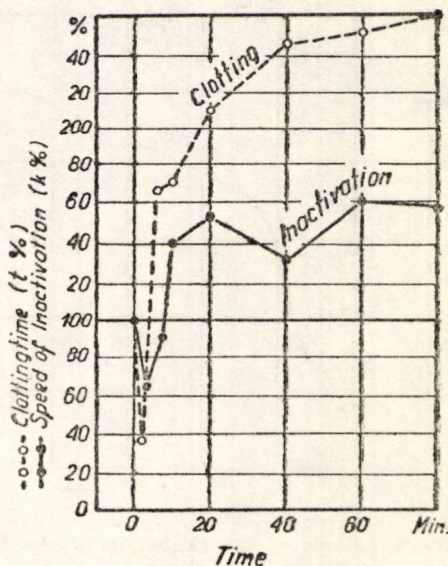


Figure No. 3.

Figure No. 3. shows the graphic demonstration of our experiments. (The medium values of the data of 8 experiments on animals.) The inactivation curve shows the percentual changes of the k values, expressing the velocity of the reaction, compared as to the initial values. The percentual changes of the clotting times expressed in seconds are demonstrated on the figure.

These experiments prove that inactivation is suddenly decreasing immediately after the injection of Indian ink, when Indian ink gets precipitated in the bloodstream on the surface of the RES cellules. Shortly afterwards, however, the inactivation is powerfully accelerated, and remains for a long time on a high level. The clotting times are undergoing a corresponding change, the coagulation is consequently accelerated at first, but later falls back beyond the initial value.

We succeeded, therefore, to demonstrate through these experiments that in the first phase of the accumulation when the precipi-

tation of the Indian ink is dominating, — and according to literary data — histamine gets liberated, inactivation suddenly decreases and clotting times are shortened. Immediately afterwards, however the action of a compensating phase may be observed which appears as well in the coagulation as in the inactivation. This compensation is evidently brought about by the liberation of heparin.

If we observe also the duration of the circulation of Indian ink in the blood, we can see that in the 25-th minute after the injection there is no more Indian ink to be proved in the circulation. These tests were undertaken with the blood-drop method, described by *Jancsó*. During this time, the Indian ink got partly stored by the RES, and partly precipitated on the walls of the cells. According to our opinion, the originating small thrombuses of Indian ink are causing the prolonged mobilisation of heparin as a defence action of the organism.

TABLE I.

Composition of the histamine- heparin- toluidine-blue solutions for the examination of the absorption spectra. Dates are given in ml.

No. of the samples	1	2	3	4	5	6	7	8	9
10 mg/ml heparin	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	—
10 mg/ml histamine	—	0.2	0.4	0.8	1.2	1.6	2.0	3.0	3.0
Distilled water	3.0	2.8	2.6	2.2	1.8	1.4	1.0	—	2.0
0.05 mg/ml toluidine blue	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Volumen	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0

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АНТАГОНИЗМ ГИСТАМИНА И ГЕПАРИНА IN VIVO И IN VITRO

Автор: МИХАЙЛ ГЕРЕНДАШ

РЕЗЮМЕ

Делая выводы из наших опытов, можно установить, что под действием гистамина осаждение коллоидов, добавленных к крови ускоряется. Этот процесс задерживает гепарин. Из этого следует, что гепарин и гистамин добавленные наружно, компенсируют свое действие с точки зрения инактивации и коагуляции крови.

Во второй части наших опытов мы изучали вопрос о том, что случается, если гистамин освобождается в ток крови в начале накопления. В этом случае инаktivация уменьшается и коагуляция ускоряется. Но после этого организм немедленно мобилизует гепарин, а действие этого гепарина проявляется и в инактивации, и в коагуляции.

На основе наших опытов мы пришли к выводу, что гепарин и гистамин компенсируют свое действие в организме отчасти путем своего влияния на коагуляцию крови, а отчасти потому, что организм отвечает на всякое действие гистамина мобилизацией гепарина, а — с другой стороны — на всякую мобилизацию гепарина организм отвечает действием гистамина.

Антагонизм между гистамином и гепарином можно доказать и действием гистамина на цветную реакцию толудиновой синьки с гепарином. На основе оптического исследования цветной реакции мы с приблизительной точностью установили, что в этом процессе 2 молекула гистамина соединяются с одним молекулом гепарина.

По нашему мнению гистамин и гепарин оказывают значительное и антагонистическое влияние на формацию и на предотвращение тромбоза и на процесс накопления (В ретикуло-эндотелиальной системе.)

HISTAMINE EFFECT AND TROMBIN INACTIVATION

BY

I. CSEFKÓ and M. GERENDÁS

From the Hungarian Biological Research Institute, Tihany, Lake Balaton

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Pharmacological investigations in connection with histamine have been carried out for a long time in order to establish, whether histamine had any influence on blood-clotting. The investigations, however, undertaken on experimental animals have led to very contradictory results.

Some authors, as for instance *Dale* and *Laidlaw*, (1910) did not observe any changes, whereas *Barger* and *Dale* (1922) found later, that histamine was able to produce intravasal blood-clotting. In experiments on dogs *Biedl* and *Kraus* (1912) found a clotting inhibitory effect, whereas *Modrakowsky* (1912) found an accelerating one. In the more recent literature on this subject there are not to be found either uniform or satisfactory dates. (f. i. *Guggenheim*, 1940). On investigations on humans *Dzsinich* and *Pély* (1934) made the observation, that blood-clotting at the highest degree of the histamine effect is very much protracted, but that it turns normal again after discharge of the reaction. According to *Howell* (1924) the quantity of heparin — the physiological substance of the organism preventing blood-clotting — increases to a great extent at the end of the peptone-shock-effect in dogs.

According to him this effect has to be attributed to the protecting mechanism of the organism trying to eliminate the shock-producing substance from the body. It follows from the above-said that the difference between histamine effect and pepton-shock can be defined as follows: the clotting of the blood is uncertain at the effect of histamine, whereas it becomes definitely retarded as the effect of a peptone-shock.

Jancsó (1931) established that the primary condition and introduction of the accumulation of the reticuloendothel-system (RES) consists in the precipitation of the colloids circulating in the blood or brought into it in the course of the experiments — because there is fine fibrin network formed around them, and accumulation is already brought about through the fibrin-colloid complex.

The further elucidation of the question has been considerably promoted by *Jancsó's* observation, (1947) according to which histamine is to be considered as the activator and the directing hormone of the RES.

Thus, according to *Jancsó*, the preliminary condition of the accumulation of RES by the cells is that a colloid-fibrin precipitation has to be effected in the blood and on the other hand, that the stimulant of this accumulation in the organism is histamine.

In consequence we had to accept the data of the literature establishing the accelerating effect of histamine in blood-clotting which

permits to assume that appearance of histamine in the blood leads to the precipitation of fibrin. We tried to clear up in our researches the coming about and the mechanism of this process.

The investigations on thrombin inactivation served as a further help in our experiments. According to recent investigations the thrombin inactivating capacity of blood is a very significant factor from the point of view of coagulability, (*Lenggenhager* 1941, *Gerendás*, 1946 and 1948.) and the shift in the formation or disappearance of thrombin as related to one-another promotes or inhibits the process of fibrinprecipitation. It was observed, that in case of a thrombin injection into the bloodstream, the organism protected itself against intravasal clotting by increased inactivation. (*Gerendás* and *Csapó* 1948). In opposition to this theory, it could be supposed, that histamine effects just a contradictory influence on inactivator decreasing its activity and promoting the coagulability of the blood, as well as the appearance of intravasal fibrin traces.

It has to be emphasized, that we have already established in our previous experiments that decreased inactivation is generally followed by increased coagulability (a shorter clotting time) and increased inactivation by decreased coagulability (a longer clotting time). This can be easily understood, as by diminution of inactivation the formation of thrombin is facilitated, and it remains longer in an active condition which means that its efficacy is increased.

EXPERIMENTS

In the first part of our investigations we studied in vivo experiments the effects of histamine on thrombin inactivation of the circulating blood. In the second part of our experiments our observations were supported by experiments in vitro.

EXPERIMENTS IN VIVO

We used rabbits for our in vivo experiments. In the thrombin inactivation tests 1 ccm of blood was extracted from the vene of the ear, or of the opened thigh vene of the anaesthetised animal.

The blood was left to clot and centrifuged 20 minutes subsequently. We examined thereafter the thrombin inactivating capacity of the serum separated from the coagulum. The principle of the thrombin inactivating test consists in our method to add thrombin of an exactly known activity to the serum, and to observe the decrease of its activity during 10 minutes.

We used for our investigations mixtures of the following composition:

Incubating mixture at 20 C°

Serum of the experimental animal	0.4 ml
Distilled water	0.1 „
Standard thrombin solution	0.4 „

After stirring the incubating mixture, samples were taken from it in the subsequent 1, 2, 3, 5, and 10 minutes, and their activity was examined on the following clotting-test:

at 20 C°

Clotting test

Oxalat plasma of ox	0.1 ml
Distilled water	0.1 „
Sample from incubating mixture	0.1 „

We put the mixture serving for the determination of the clotting time into the cavities of a china dish. The occurrence of the clotting was established by the help of a small glass loop. We measured the time elapsing from the adding of the thrombin till the formation of the first massive fibrin clot with a stop-watch. As a result of inactivation we obtained gradually increasing clotting times. From the clotting times we defined by the help of an empiric relation, their corresponding thrombin-activity and calculated, base on the dates thus obtained, the factor of the velocity of reaction, according to the following formula:

$$k = \frac{1}{t} \cdot 2.3 \cdot \log \frac{a}{a-x}.$$

For further details as to this method we refer to our previous publications. (Gerendás, 1949, 1950.).

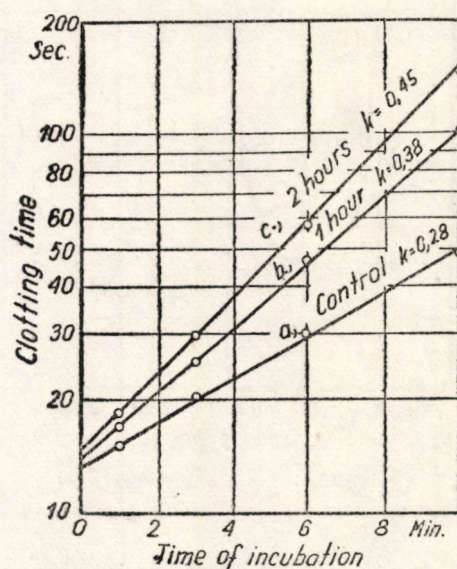


Figure No. 1. Change in the thrombin inactivating capacity of rabbit serum after intravenous infusion of histamine.

In one part of the experiments histamine was administered intravenously in infusions, in other cases by simple intravenous injections.

In case of infusions, 12mg of histamine dissolve in 12 ml. of distilled water were infused in a space of time of 20 minutes. Preseding the experiment, the thrombin inactivating capacity of the blood-serum of the rabbit has been established. The curve thus obtained (Figure No. 1, curve a) represent the control curve before the administration of

histamine. Then also measured the inactivation after the first and the second hour following to the administration of the histamine (Figure No. 1, curves b and c.)

The figure shows that the clotting times were prolonged i. e. the velocity of inactivation was increased. This phenomenon seemed to be contrary to the effect expected as it showed that histamine applied intravenously increased the effect of inactivation.

This phenomenon seems to be similar to that, described by Gerendás and Csapó (l. c.) occurring after the intravenous administration of thrombin. These authors found, that as the effect of the administra-

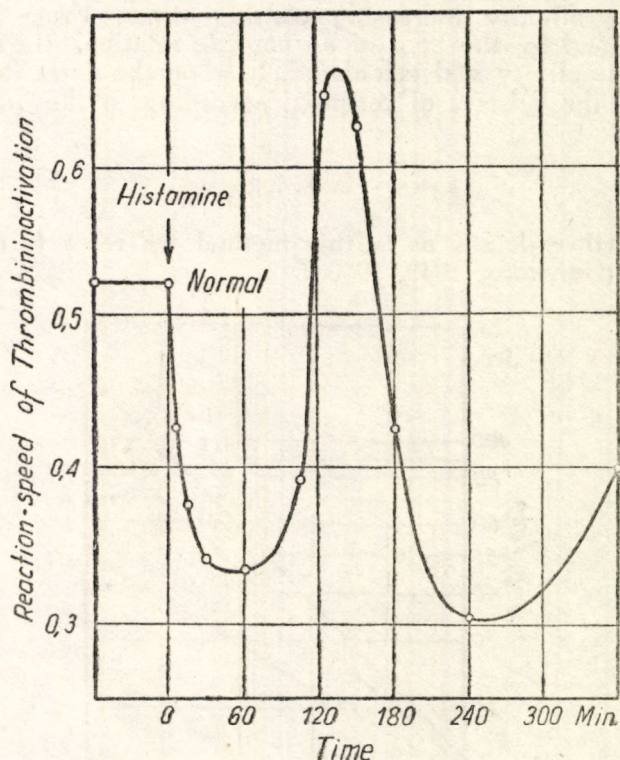


Figure No. 2. Change in the thrombin inactivating capacity of rabbit serum after an intravenous injection of 1.5 g of histamine.

tion of thrombin the organism in defence increased inactivation and retarded clotting. If increased clotting is effected by histamine, it can be just as well expected that the organism will eliminate it after a certain time, by some compensatory mechanism, and will even probably, overcompensate it. It seemed therefore probable that the primary histamine effect occurred during the hour following the puncture, and that have only observed a compensatory phenomenon instead. We therefore, repeated the experiment but instead of infusion we administered histamine intravenously (1mg per 1000 gr body weight), in 30 seconds.

Blood was drawn in the 3rd, 15th, 30th, 60th, 90th, 180th, 240th, and 360th minute after the injection and the thrombin inactivating ca-

capacity was determined by the above-described method. The reaction-velocity constants, calculated from these data, are shown on Figure 2. It can be observed that the administration of histamine is followed by a prompt decrease of the inactivation. This decrease of the inactivation continues for 60 minutes subsequently to the administration of histamine, then the speed of inactivation accelerates rapidly, and in the 100th minute it already exceeds the normal inactivation velocity. A maximum speed value is reached in about 130 minutes, which is followed again by a decrease of speed. The curve reaches, after several fluctuations, its normal value.

Also in case the animal was given a large dose of histamine, so that it perished in a histamine shock, thrombin inactivation of the blood-serum has been determined before the injection and after the death of the animal. We observed that the inaction of the later blood-sample was considerably weaker and that the coagulation of the blood tended decidedly towards the thrombotic direction.

We got similar results at the repetition of the experiments.

From the results of our investigations it becomes comprehensible why literary data about the effect of histamine on the blood-clotting are so contradictory. The authors were not aware of the fact, that they have been faced with phenomenon taking place periodically where it depended on the time sample-taking whether they obtained inactivation or increasing of the clotting.

It can be established as a consequence of the results of our experiments, that as the effect of histamine, the succession of two phenomena is determining the events taking place in the blood-stream. *The primary effect, — which lasts 0.5—1 hour — after the administration of histamine, is a decided thrombin inactivation, and a tendency of the coagulability of the blood towards increased clotting.*

The secondary effect, on the other hand, manifests itself in an increased thrombin inactivation. This can be considered as a compensatory activity of the organism, and leads to prevention of coagulation.

Our opinion concerning the observed phenomenon is resumed, as follows: The decrease of thrombin inactivation occurs in each case, when histamine gets suddenly, shock-like into the blood. In consequence of diminished inactivation the equilibrium of the coagulating system is altered, the quantity of thrombin increases, and fibrin is formed. Our investigations are thus explaining the observations of Jancsó (loc. cit.) as the fibrin generating in consequence of the above described process draws the alien colloids to be found in the circulation to itself, just as Jancsó has observed it in his experiments as the effect of histamine.

In consequence of this process however, the blood is getting into an over-coagulated condition and therefore the defensive phase is instantly setting in. Which increases inactivation and prevents thrombosis.

We however consider it possible that while the histamine takes such part in the introduction of accumulation, the coagulability of the blood is in certain cases directed in a too large degree into a thrombotic direction. This may lead not only to the precipitation of the alien colloids, but also to that of the thrombocytes, and may thus effect thrombosis.

The organism, tending constantly towards the maintenance of the inner equilibrium, is compensating the shift of the coagulation when it tends in a thrombotic direction. It is very probable that a greater quantity of heparin — the clotting inhibiting substance of the organism — is produced in these cases, and carried into the circulation. Histamine effect gets thus compensated by the heparine effect.

The above-said present a new aspect of RES accumulation, and thrombin is given also a part in its mechanism.

EXPERIMENTS IN VITRO

We carried out experiments in order to determine, whether the influence of histamine in increasing coagulation and inhibiting inactivation could also be demonstrated by experiments in vitro.

These experiments may be summarized in four points.

1. We investigated, whether histamine is influencing the clotting time of recalcinated rabbit-plasma containing oxalate. We used for the experiments rabbitblood, containing 2‰ of Natriumoxalate and from it obtained the plasma by centrifugating. The clotting times after the recalcination were obtained with the following combinations:

	I.	II.
Rabbit plasma containing oxalate	0.1 ml	0.1 ml
Distilled water	0.1 „	0.0 „
Histamine of various concentrations.	0.0 „	0.1 „
m/40 CaCl solution	0.1 „	0.1 „
		Water bath 37 C°

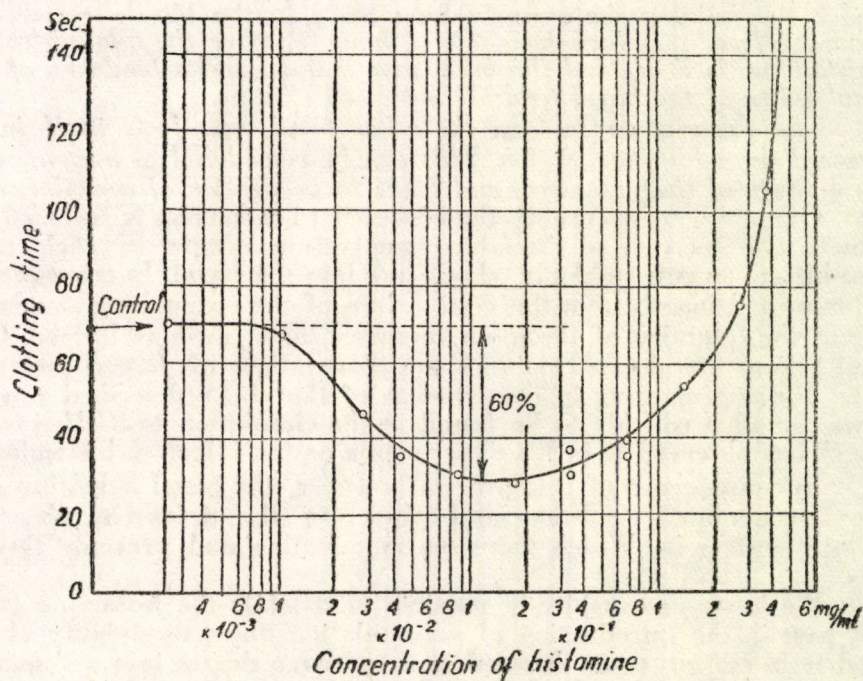


Figure No. 3. Changes in the clotting times of recalcinated oxalate plasma under the action of histamine.

By system No. 1. (control test, without histamine) the starting point of the curve has been established, whereas by system No. II—in using histamine solutions of various concentrations the dependence of the clotting time from the histamine concentration has been determined. (Fig. No. 3.). The histamine concentrations of the above systems are given in mg/ml.

No histamine effect has been observed at concentrations between 0,003—0,01 mg/ml. Beginning at a concentration of 0,01 mg/ml till 0,1 mg/l an increasing clotting-effect has been tested. (On the figure the clotting times get shorter). At a further increase of the concentration its accelerating effect on the clotting begins to decrease. From a concentration of 2,66 mg/ml of histamine a considerable increase of the clotting time could be observed, which means, a coagulation inhibiting effect.

It can be established from the results of these experiments that *histamine is effecting an accelarting influence on the clotting of recalcinated rabbitplasma at concentrations of 0,01—2,66 mg/ml* and there is to be observed a shortening of the clotting time of about 60% at the optimum concentration (0.1 mg/ml).

2. We examined subsequently, whether histamine is influencing the clotting time of the oxalated rabbit plasma, when coagulation is effected with thrombin.

The following combination was used to determine the clotting times:

	I.	II.
Rabbit plasma oxalate containing	0.1 ml	0.1 ml
Distilled water	0.1 „	0.0 „
Histamine sol. of various concentrations	0.0 „	0.1 „
Thrombin sol. of various concentrations	0.1 „	0.1 „

This series of experiments, as well as the further experiments were carried out at a room temperature (20 C°). Thrombin solutions in six different concentrations were used in the experiments. These solutions produced coagulation in the first series of experiments (control experiments, without histamine) in 15, 22, 30, 60, 100 and 150 secs, respectively. Subsequently the clotting times were determined in varying the concentration of the histamine solutions, and the curves of the coagulation were constructed thereafter based on these results. (Fig. No. 4.). The concentrations of histamine in the used combinations are given in mg/ml.

The curves are very similar to those obtained at the recalcination tests. The concentration of the thrombin solution employed was proportionate to the clotting increasing effect of histamine which means the weaker the concentration of the applied thrombin solution, the less quantity of histamine was need to produce a clotting increasing effect. The increasing effect of histamine was already observed at the weakest concentration (=0,003 mg/ml), in which coagulation was effected in 150 secs. (Curve No. I). The optimum effect of this curve appears at a histamine concentration of 0,66 mg/ml. whereas the inhibiting effect of histamine starts from concentrations of 2,5 mg/ml. onwards.

At the other curves the effect of histamine could only be observed at greater concentrations.

In comparing the curves it can be established that the clotting increasing effect of histamine is most developed in curve No. I. (smallest thrombin concentration) where the clotting time diminishes by 66% at the optimum concentration.

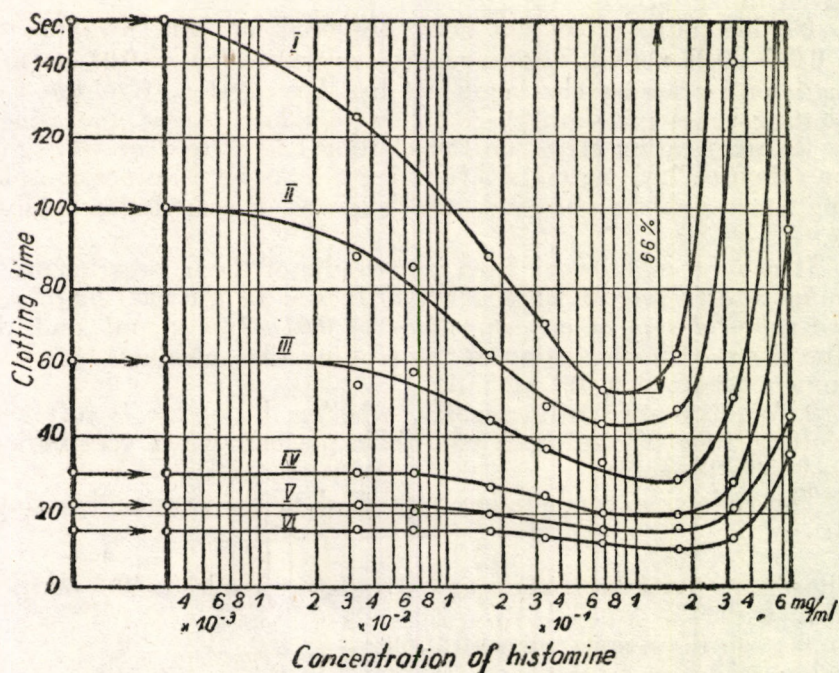


Figure No. 4. Changes in the clotting times at the effect of histamine on oxalate plasma clotted with thrombin.

3. After the accelerating effect of histamine on the coagulation of recalcinated plasma as well as at coagulation with thrombin was already established investigated subsequently, whether the accelerating effect of histamine appeared also in the clotting of pure fibrinogen by pure thrombin.

The following combination was used for the experiment:

	I.	II.
Fibrinogen (3 mg/ml	0.1 ml	0.1 ml
Histamine sol. in var. conc.	0.0 „	0.1 „
Distilled water	0.1 „	0.0 „
Thrombin sol. in var. conc.	0.1 „	0.1 „

The fibrinogen solution was prepared according to Laki's method. (Laki 1942). We prepared histamine solutions in concentrations of 0.0125, 0.05, 0.3125, 0.625, 1.25, 2.5 and 5.0 mg/ml. Thrombin solutions were chosen to clot system No. I in 15, 20, 30, 60, 120 seconds respectively. The data of the clotting are shown on Fig. No. 5.

The curves show that histamine has no clotting-accelerating effect in this system, but inhibiting effect at greater concentrations may be observed here too.

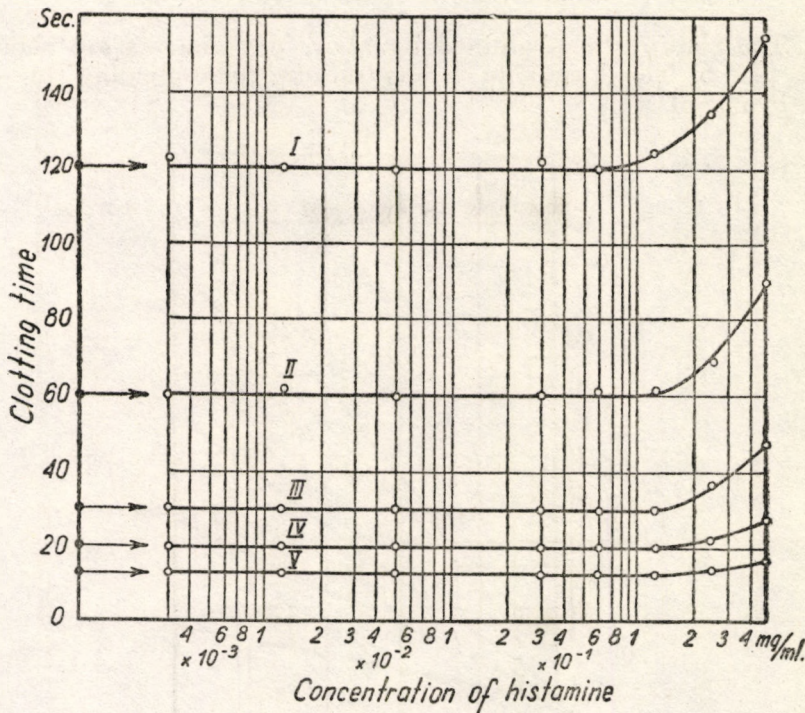


Figure No. 5. Changes in the clotting times effected by histamine on fibrinogen coagulated with thrombin. Histamine has no accelerating effect.

Thus we see that histamine in itself has no accelerating effect on the action of thrombin, and it may be concluded from the results of the experiments that for producing the accelerating effect of histamine some other factor or factors too are need in the plasma. There seem to be two possibilities: histamine has either an accelerating effect on the thrombin producing system, or it inhibits the action of the thrombin in activating system, Our subsequent experiments prove the later supposition.

4. We worked with the following combinations:

Inactivation of the serum without histamine (Control)

Serum. (ox)	0.4 ml
Distilled water	0.1 „
Stanard thrombin solution	0.4 „

Inactivation of histamine serum

Serum. (ox)	0.4 ml
Histamine sol. var. conc.....	0.1 „
Standard thrombin sol.	0.4 „

The activity of the samples was determined by the following test:

Fibrinogen solution 0.1 ml.
Sample taken from mixture.. 0.1 „

The clotting times obtained by above experiments are shown on figure No. 6. The histamine concentrations corresponding to system given in mg/ml.

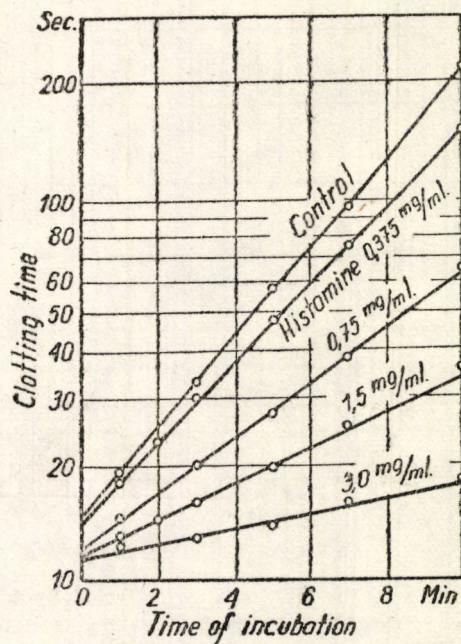


Figure No. 6. Decrease in the thrombin inactivating capacity of serum at the effect of increasing concentrations of histamine.

The curves are showing a diminishing inactivation in proportion to the increase of histamine concentration.

Histamine, consequently, reduces the velocity of the thrombin inactivating process. In order to elucidate this connection, we have calculated the velocity constant of the inactivating-reaction of the curves as obtained with each histamine concentration. The changes of the k values thus obtained are shown on Fig. No. 7. It is evident from the curve that the inactivation inhibiting effect of histamine begins at a concentration of 0.1 mg/ml. and that greater quantities of histamine are inhibiting inactivation almost entirely.

From these experiments in vitro it may also be seen that histamine is producing its clotting-accelerating effect by inhibiting the action of the thrombin-inactivating system of the blood. Thus thrombin generating in blood, or added to it, remains in greater quantities and for longer periods active and may consequently better produce its effect.

We cannot however explain the fact that according to our experimental results, a larger concentration of histamine is needed in vitro, than in vivo. We have injected at the intravenous histamine administration. 1/mg histamine per kg. of body weight, which corresponds approximately to a concentration of 0,01 mg/ml in the blood. This quantity of histamine reduces the thrombin-inactivation in the blood of the animal from $k=0.52$ to $k=0.35$. (Fig. No. 2.). The diminishing effect of histamine inactivation at in vitro experiments begins at a concentration of 0.1 mg/ml. only i. e. at an approximately tenfold concentration.

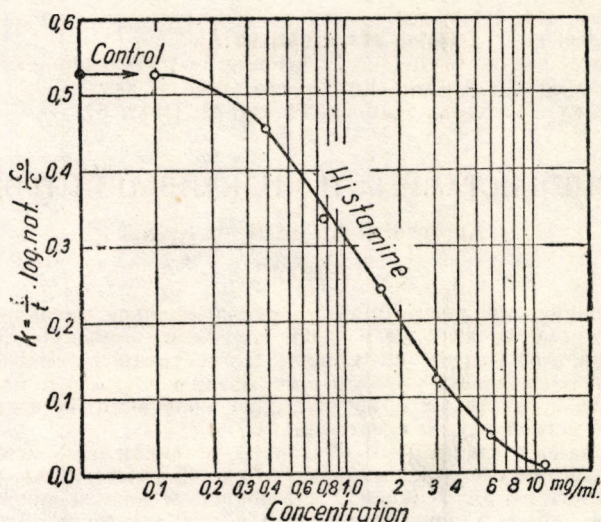


Figure No. 7. Diminution of the velocity constant of the thrombin inactivating reaction at the effect of histamine.

As an explanation of this difference it might be supposed, that activity of histamine is greater in circulating blood, than in serum, in which the humoral and cellular factors have already undergone a big change during the process of coagulation.

It might be further assumed as a consequence of our experimental results that histamine in itself is not responsible for the influence on the inactivation, but it liberates probably some substance or substances in the organism, producing a histamine like effect, or increasing the effect of histamine. This our opinion is based on the fact that the maximum effect of histamine is observed an hour after its administration, whereas the well known pharmacological effects of histamine manifest themselves already some minutes after injection. It might be consequently assumed that the effect of histamine on blood-coagulation is to a certain degree an indirect effect, and this explains also the big differences between the in vivo and in vitro experiments. In spite of these facts it seems beyond doubt that histamine exercises a significant effect on the thrombin inactivating capacity of the blood.

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ДЕЙСТВИЕ ГИСТАМИНА И ИНАКТИВАЦИЯ ТРОМБИНА

Автор: ГЕРЕНДАШ МАХАЙЛ

РЕЗЮМЕ

Мы установили, что гистамин внутривенно вначале уменьшает способность к инаktivации тромбина сыворотки проб, взятых из крови. (способность крови к свертыванию растет.) Позднее способность к инаktivации становится выше нормального уровня (способность крови к свертыванию падает) и только несколько часов спустя, (после некоторых компенсаторных колебаний) кровь снова приобретает нормальную способность к свертыванию.

На основе вышеуказанных мы объясняем механизм накопления в ретикуло-эндотелиальной системе следующим образом: Под действием гистамина освобождающегося в физиологических условиях, способность крови к инаktivации крови падает, уровень тромбина в крови возрастет, а внутри сосудов возникает преципитат фибрина. Этот преципитат тянет к себе инородные коллоиды.

Мы установили также, с помощью опытов *in vitro* что гистамин тормозит свертывание плазмы путем рекальцинации или же с помощью тромбина, а причиной этого действия является ослабление инаktivации тромбина.

