

Der Zoologische Garten Praha und der Zoologische Garten Dvůr Králové

**HOME-RANGE KONZEPTION BEI EINIGEN HUFTIEREN
IN DEN BEDINGUNGEN EINES SAFARI-PARKS**

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Abstract: The behaviour and the annual home-range conception of herds in some species of ungulates in the conditions of the modified Safari-Park has been described.

Seit 1969 baut man in dem Zoologischen Garten Dvůr Králové einen Safari-Park, der aber von den üblichen Konzeption anderer Safaris (cf. Ruhe, 1970) ganz abweicht und der die von Hediger (1971) zur Recht aufgehobenen Einwände völlig beseitigt. Es sind zwar grosse bis sehr grosse durch Gräben begrenzte Gehege vorhanden, den meisten Tieren steht aber auch ein System von räumigen, elektrisch geheizten und automatisch regulierten Stallungen mit kleinen „klassischen“ Gehegen zur Verfügung, wo die Tiere im Winter, d. h. etwa vom Ende September bis Anfang Mai ohne Zutritt der Besucher leben. Dorthin kann man auch jederzeit trüchtige Weibchen, aggressive Männchen oder schwache, bzw. verletzte Tiere abtrennen und separat behandeln.

Da manchmal die Sommergehege von den Winterubikationen ziemlich weit entfernt sind, müssen die Tiere, bzw. die Herden zweimal im Jahre durch einen etwa 1,5 bis 6 m breiten Gang gehen.

Im Folgenden werden die Ergebnisse unserer Erfahrungen bei solchen Arten beschrieben, die 1. in grossen Herden gehalten werden, 2. mehrere Jahre ihre Lebensräume wechselten, also mindestens 7, meistens aber 11 „Wanderungen“ durchgeführt haben, 3. den längsten Weg absolvieren müssten.

Auf dieser Stelle möchte ich allen meinen Mitarbeitern im Zoo Dvůr Králové meinen herzlichsten Dank für die vielseitige Hilfe aussagen; ganz besonders aber danke ich den Herren Dipl. Biol. J. Janeczek und V. Novotný, die bei der Manipulation mit den Tieren als zuverlässige Organisatoren tätig waren.

Elen-Antilope, *Taurotragus oryx pattersonianus*

Eine Herde von durchschnittlich 25 Stück (Bestand im Januar 1975, 6, 20) absolvierte in den Jahren 1969—1971 vier Strecken je etwa 500 m, in 1971—1974 sieben Strecken je etwa 1500 m in einer anderen Richtung und in neue Ubikationen. Mit den adulten Exemplaren kamen keine Probleme vor und nach einer einzigen „Wanderung“ orientierten sich die Tiere ausgezeichnet und gingen ganz selbstständig und meistens ganz spontan ohne Treiben. In der Zeit der „Wanderung“ kommen Änderungen in der Rangordnung vor, die Streitigkeiten sind vergessen, was in dem neuen Lebensraum

noch 1 bis 3 Tage dauert, ehe sich die Rang-Kriterien neu ausbilden. Das entspricht etwa den Beobachtungen, die Talbot & Talbot (1963) oder Estes (1966) bei den saisonmässig wandernden Gnus durchgeführt haben.

Anders war es mit Jungtieren. Die z. B. in den Winterubikationen geborene Kälber (die Mehrzahl der Geburten kam im November—Dezember vor, also ganz abweichend von den 94 Geburten in London oder 272 Geburten in Askanya Nova [Zuckerman, 1952; Treus & Lobanov, 1971]) wollten im Frühling mit ihren Müttern die Stallungen nicht verlassen und regelmässig muss man die 5—6 monatige Kälber fangen und aus der Ubikation heraus-holen. Der Weg war den Jungtieren ganz fremd und es wurde als feindlich angesehen. Manchmal sind uns einige Kälber entwischt, was bei Alttieren niemals geschah.

Rothschild-Giraffe, *Giraffa camelopardalis rothschildi*

Eine etwa 20 köpfige Herde (Bestand im Januar 1975, 6, 21) schaffte 10mal den Weg je etwa 1500 m. Die Tiere gingen niemals so spontan wie die Elenantilopen, liessen sich aber ganz leicht und problemlos treiben, ohne Furcht zu haben und ohne zu scheuen. Man muss aber die ganze Herde zusammen, höchstens auf zwei kleinere Herden geteilt zusammen bewegen. Die Individuen, die einsam bleiben, scheuen.

Mähnenlose Zebras, *Equus quagga* ssp.

Steppenzebras sind in unserem Safari-Park durch drei Rassen in etwa 100 Exemplaren vertreten; es ist hier aber nur die grösste Herde behandelt (Bestand im Januar 1975, 5, 21). Die Mähnenlosen Zebras machten ebenso wie die Elen-Antilopen in den Jahren 1969—1971 vier Strecken je etwa 500 m und in den Jahren 1971—1974 sieben Strecken je etwa 1500 m in einer anderen Richtung. Die Tiere gingen selbstständig, spontan, nur in einem schnelleren Tempo als die Elenantilopen. Die Hengste, die wegen starker Rivalität nicht zusammen gehalten werden konnten, gingen zusammen mit der Herde, ohne zu kämpfen und ohne jeden Zeichen des Drohens. Die Fohlen hielten immer einen Körperkontakt mit den Stuten, so dass keine ähnliche Probleme vorkamen, die bei den Elenantilopen beschrieben werden.

Weissbartgnus, *Connochaetes taurinus albojubatus*

Eine etwa 10köpfige Herde (Bestand im Januar 1975, 4, 6) absolvierte siebenmal die gleiche Strecke je etwa 500 m. Die Tiere gallopierten blitzschnell und kopflos durch den Gang, kehrten oft zurück und schienen nicht ganz orientiert zu sein. Da es sich um die Tiere von Athi-Plains, bzw. Kajiado handelt, die zu der territorialen, stationären Population gehören (cf. Walther, 1966), scheint unseren Weissbartgnus eine solche „Wanderung“ ganz fremd zu sein und sie konnten sich nicht in den 6 Beobachtungsjahren umstellen. In den Sommergehegen kamen nur geringe Streitigkeiten vor, desto schärfer war aber der Kampf in den nicht so raumigen Winterubikationen, wo wir immer die Bullen separieren müssen, da oft zu schweren, ja sogar tödlichen Verletzungen kam. Die Kälber, die im Sommergehege geboren werden, lebten in der Herde, in Winterubikationen muss man aber diese nach dem Absetzen separieren, da oft die ganze Herde ein sehr feindliches Verhalten den Jungen gegenüber aufwies.

Kleine Kälber, die noch bei der Mutter standen, leiteten nach der Auslassung in das grosse Gehege durch „Raumschreck“, so dass es sich bewährte, solche Jungen, durch Tranquilizer (meistens Acetylpromazin) beruhigen und in diesem Zustand übersiedeln.

DISKUSSION

Die Elenantilopen und Steppenzebras sind Tiere, die sich in freier Wildbahn oft in grosse Herden vereinigen und die dann auch Wanderungen durchführen, die entweder durch die Saison oder durch die Trockenheit verursacht sind (cf. Astley-Maberly, 1963; Dorst & Dandelot, 1970 u. a. m.). Bei solchen Tieren kommt auch in den Bedingungen eines Safari-Parks (es ist der von uns modifizierte Typ gemeint) ein Verhalten vor, beim welchen die Tiere die Sommer- und Winterplätze samt dem verbindenden Weg als ein „lifetime-range“ (sensu Jewell, 1966) oder „annual home range“ (sensu Jay, 1965) ansehen.

Bei den Jungtieren der Elenantilopen scheint das Erkundungsverhalten (exploratory behaviour) sehr wichtig zu sein. Die Kälber bilden nämlich in der Herde eine selbständige „Schule“ (nursery herd) und sind an ihre Mütter ziemlich wenig gebunden. Bei der „Wanderung“ schliessen sie sich dann der Herde nicht ein und lehnen das Betreten eines unbekanntes Gebietes ab.

Die soziale Einheit einer Steppenzebras-Herde ist eine kleinere non-territoriale Familien- oder Haremgruppe (Klingel, 1967, 1972), obwohl manchmal Aggregationen solcher Gruppen vorkommen, die sich koordiniert bewegen (Hendrichs, 1972). Die Fohlen sind fest an ihre Mutterstuten gebunden und folgen diesen auch in eine für sie völlig unbekanntes Umgebung vertrauensvoll nach.

Die Giraffen bilden gewöhnlich Gruppen von bis zu 25–30 Tieren (Astley-Maberly, 1963; Hendrichs, 1972), manchmal trifft man aber noch grössere Versammlungen (Dorst & Dandelot, 1970). Es ist eine schwach ausgebildete Rangordnung vorhanden (Backhaus, 1961), die Tiere leben sehr friedlich untereinander. Die Kälber bilden manchmal „Schulen“ (Smithers, 1966; Hendrichs, 1972). Wenn bei der „Wanderung“ die Giraffen zusammen in einer Herde gehen, kommt es zu keinen Schwierigkeiten. Die Tiere, die allein bleiben, scheuen. Die bisher in Safari-Park geborenen Jungtiere haben die Winterubikationen — ihrer Neugierigkeit und Vertrauens zum Menschen wegen — leicht mit der ganzen Herde verlassen und sind ihren Müttern gefolgt.

Die schwierigste Arbeit ist mit den Weissbartgnus, was auch einige Erfahrungen Ruhe's (1970) bestätigen. Die Tiere sind leicht reizbar und ihre angeborene Sozialstruktur (s. o.) kann man nur in einem sehr beschränkten Mass modifizieren. Bisher haben wir z. B. keine entsprechende Einrichtung für die Winterhaltung der ganzen Gruppe entwickelt. Interessant wäre, eine Wanderpopulation mit der stationären zu vergleichen. Laut Talbot & Talbot (1963) leben in der Wanderpopulation mehrere Bullen zusammen, ohne eine Animosität zu zeigen.

ZUSAMMENFASSUNG

Nach den Versuchen in einem modifizierten Safari-Park (grosse Freigehege im Sommer, räumige, geheizte Winterhäuser mit kleinen Gehegen für Winter, die mit den Sommergehegen nicht direkt verbunden sind) akzeptieren

die Elen-Antilopen und die Steppenzebras das Sommergehege, das entfernte Winterhaus und den verbindenden Weg als ein „lifetime range“, bzw. „annual home range“. Bei den Giraffen ist ein solches Aufenthaltsgebiet nicht so stark ausgeprägt. Weissbartgnus, die aus einer stationären Population stammen, in welcher die Bullen territorial sind, konnten sich nicht in den 6 Beobachtungsjahren auf eine solche Konzeption des Aufenthaltsgebietes umwandeln.

Es ist auch das Verhalten der Jungen bei erwähnten Arten beschrieben.

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Zoologische Abteilung des Nationalmuseums, Praha und der Zoologische Garten,
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NEUE FUNDE SELTENER CHILOPODEN-ARTEN IN DER TSCHECHOSLOWAKEI
(MYRIOPODA: CHILOPODA)

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Abstract: New findings of *Lithobius purkynei* Dobroruka, 1957, *Lithobius tatricus* Dobroruka, 1958, *Lithobius lapadensis* Verhoeff, 1900 and *Lithobius saalachiensis* Verhoeff, 1937¹⁾ in the ČSSR are noted. The redescription of *L. purkynei* is given here because of the first find of males in this species.

Die Chilopoden-Fauna der ČSSR ist sehr reich und interessant, da es sich auf diesem Gebiet mehrere Faunenelemente begegnen. Die intensivere Erforschung in den letzten Jahren hat neue Erkenntnisse gebracht und mehrere neue Arten wurden beschrieben oder als neu für unseres Gebiet gemeldet. In diesem Beitrag geben wir neue Fundorte vier bisher nur selten gesammelten Arten an. Das Material ist in der Kollektion des Nationalmuseums Praha (Evertebrata) aufbewahrt.

Lithobius purkynei Dobroruka, 1957

Bisher nur aus der typischen Lokalität bekannt, wo 5 ♀♀ gefunden wurden (Dobroruka, 1957). Am 15. 6. 1975 wurde diese Art zum zweitenmal gefunden. Es wurden 2 ♂♂ und 5 ♀♀ in Ostböhmen, in der Reservation Vřešťovská bažantnice gesammelt und am 24. 7. 1976 noch ein adolescentes ♀ auf derselben Lokalität gefunden. Die Lokalität ist ein alter, ursprünglicher Auen-Laubwald (Tilio-Quercetum) mit starkem Kräuter-Unterswuchs. Die Steinläufer wurden in der Durchsicht des spärlichen abgefallenen Laubes gesammelt. Da zum erstenmal auch die ♂♂ gefunden sind, und jetzt schon insgesamt 13 Exemplare zur Verfügung stehen, kann man die Originalbeschreibung erweitern und ergänzen.

Beim ♂ sind die Füße des 15. Beinpaars glatt und rund, ohne jede Zierde. Die Bestachelung des 15. Beinpaars war in der Originalbeschreibung dorsal 10200, ventral 01310 angegeben. Jetzt haben wir ventral auch 01320 oder 01321 (beim Adolescent 00220) gefunden, was aber der üblichen Variabilität entspricht. Alle Originalstücke hatten 4 dunkle, auffallende Ocellen. Alle Exemplare aus Vřešťovská bažantnice haben noch einen kleinen Ocellus

1) The correct name of *Lithobius saalachiensis* Verhoeff, 1927 should be *Lithobius borealis* Meinert, 1968 (non Meinert, 1972, non Stuxberg, 1876, non Verhoeff, 1937), see Eason 1974, *Zool. J. Linn. soc.* 55: 6-7. To prevent further misinterpreting of the name *L. borealis* in the Czechoslovak fauna I shall use the synonym *L. saalachiensis* up to the prepared revision of Czechoslovak Chilopoda.

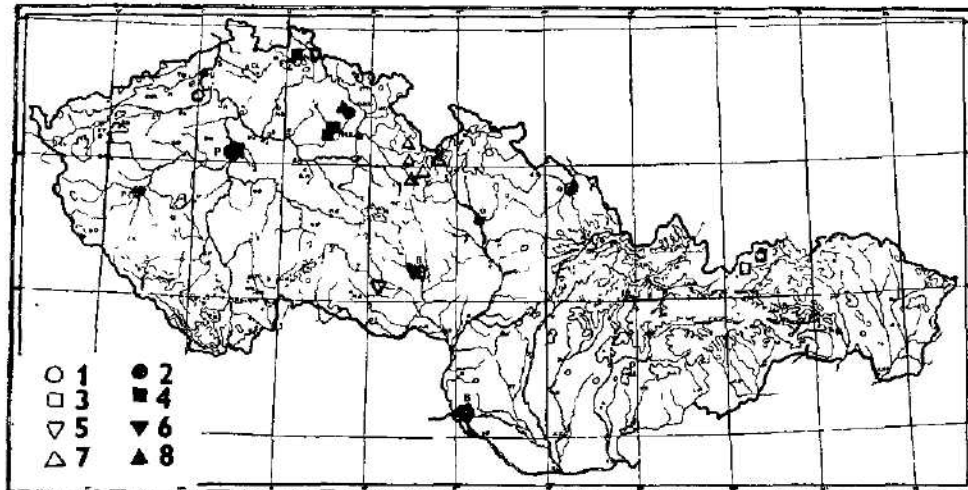
ventro-oral, so dass 4 grosse und 1 kleiner Ocellus vorhanden sind. Die Ocellen sind dunkel, auffallend. Ventropräfemoralstachel beginnt bei allen neu gefundenen Exemplaren auf dem 8. Beinpaare. Sonst stimmen diese Exemplare mit solchen aus der Typen-Lokalität völlig überein.

Die erweiterte Beschreibung lautet also wie folgt:

Länge 9–11 mm, Farbe hellgelb bis schmutziggelb. Antennen mit 36–42 Gliedern, Koxosternum der Kieferfüsse mit 2 + 2 Zähnen. Ocellen 4–5 jederseits, dunkel, auffallend von der gelben Grundfarbe abstechend. Tergite 9., 11. und 13. mit kräftigen Zahnfortsätzen. VPA auf dem 5.–8. Beinpaar. Koxen aller Beine ohne Lateralstachel. Endklaue doppelt. Endbeine des ♂ ohne Zierden. Bestachelung des 15. Beinpaares dorsal 10200, ventral 01320–1 (beim Adolescent 00220 gefunden).

Lithobius tatricus Dobroruka, 1958

Die Art wurde aus der Hohen Tatra beschrieben (Dobroruka, 1958), dann auch in Belanské Tatry und Spišská Magura gefunden (Dobroruka, 1971). Dass diese Art eine weitere Verbreitung haben kann, hat der Fund eines Exemplares in Isergebirge gezeigt (Dobroruka, 1958). Jetzt haben wir in Isergebirge weitere 2 Exemplare bei Maxov (Bez. Jablonec n. N.) gefunden (21. 6. 1975). Interessanter sind aber zwei weitere Funde dieser Art in Ost-Böhmen bei Nový Bydžov (1 Ex.) und Králíky (3 Ex.), da diese Lokalitäten in der Ebene liegen. Die Art wurde hier am 27. 7. 1975 gesammelt. Weitere Angaben über die Verbreitung dieser Art sind sehr erwünscht.



Karte 1. *Lithobius purkyni*: 1 – bisher bekannte Lokalität, 2 – neuer Fund; *Lithobius tatricus*: 3 – bisher bekannte Lokalitäten, 4 – neue Funde; *Lithobius lapidicola*: 5 – bisher bekannte Lokalität, 6 – neuer Fund; *Lithobius saalachiensis*: 7 – bisher bekannte Fundorte, 8 – neuer Fund.

Lithobius lapadensis Verhoeff, 1900

Seit 1955, wann ein ♂ und 2 ♀♀ auf der Mohelno-Steppe gesammelt worden waren (Dobroruka, 1956, 1959), wurde diese Art auf unserem Gebiet nicht mehr gefunden. Erst im Juni 1975 sammelte Frau Dr. J. Bártíková 1 ♀

unter den Steinen auf dem Gebiet des Zool. Gartens Brno auf Mniší hora. Die Art soll wahrscheinlich auf den warmen Lokalitäten Südmährens häufiger vorkommen.

Lithobius saalachiensis Verhoeff, 1937

Für die ČSSR erstmal durch Borek (1958) gemeldet, der diese Art aus Nordost-Böhmen und Nordwest-Mähren kennt. Wir haben diese interessante Art in vier Exemplaren am 15. 6. 1975 in der Reservation Vřešfovská bažantnice in Ostböhmen gefunden, wo diese Art im alten Auen-Walde (Tilio-Quercetum) lebt, also verschieden von den bisherigen Funden auf den Rändern des Nadelwaldes.

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**OBSERVATIONS ON THE CEPHALINE GREGARINE, GREGARINA
CYLINDROSA SP. N. FROM SUPELLA SUPELLECTILIUM (BLATTODEA),
FOUND IN INDIA**

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Abstract: The morphology and life history of a new cephaline gregarine (Protozoa : Sporozoa), *Gregarina cylindrosa* sp. n. from the blattodean insect *Supella supellectilium* (Serv.) are given. The parasite is characterised by a small, globular epimerite, biassociative sporadins, cylindrical cysts dehiscing by sporoducts liberating cylindrical spores. It has the following ratios: — LP : TL = 6.5, WP : WD = 1 : 1.3.

INTRODUCTION

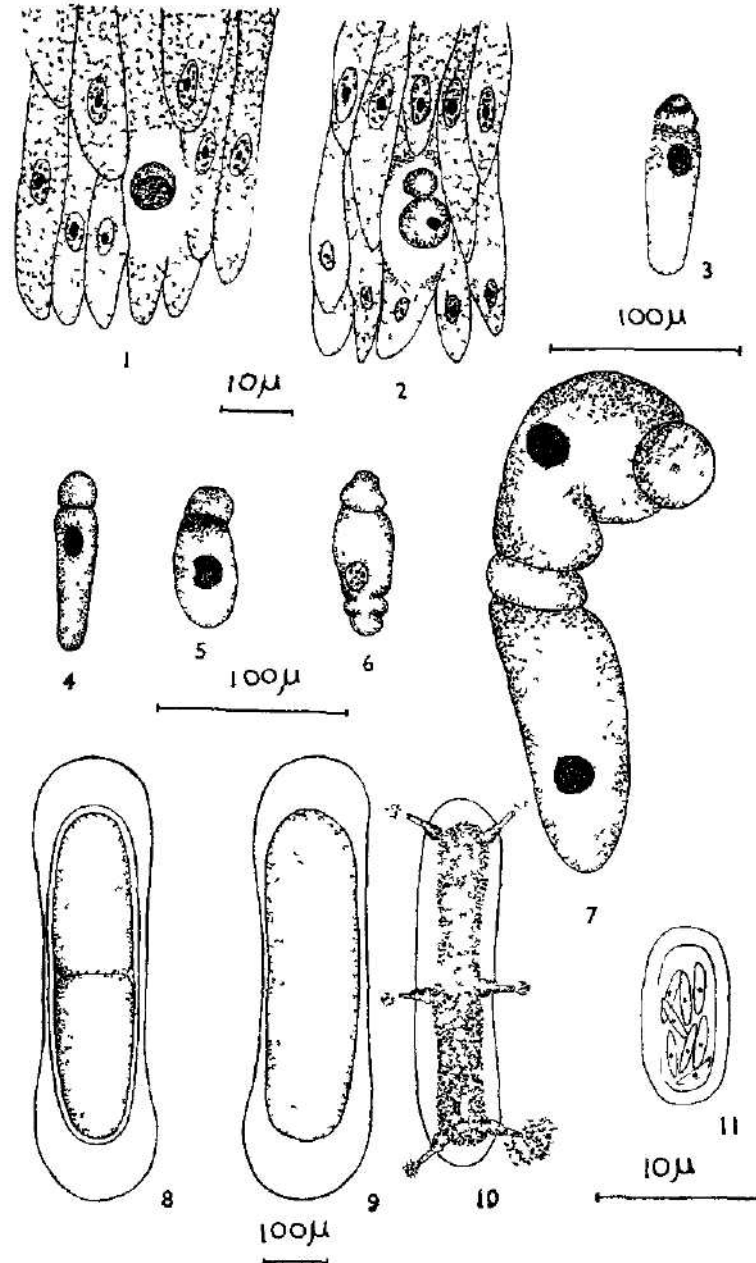
The genus *Gregarina* (Protozoa : Sporozoa) was established by Dufour in 1828. Watson (1916) and Kamm (1922) revised the generic characters of the genus *Gregarina* Dufour as sporadins biassociative, epimerite simple globular or cylindrical papilla, cyst dehiscence by spore ducts, and spores barrel shaped or dolioform. Since the publications of these monographs on the cephaline gregarines, various workers have recorded a number of species belonging to the genus *Gregarina* Dufour from different parts of the world (Kudo, 1966). From India, important contributions in this regard were made by Ganapati and Mrutyunjayadevi (1954), Uttangi and Desai (1961), Devdhar (1962), Devdhar and Deshpande (1971), Amoji (1975) and Chakraborty (1975).

While studying the cephaline gregarines from insects of Kalyani, West Bengal, we have found gregarines in the mid gut of *Supella supellectilium* (Serv.). We are describing it as *Gregarina cylindrosa* sp. n.

MATERIAL AND METHODS

The host insects, *Supella supellectilium* (Serv.) (Blattodea : Blattellidae) are abundantly found in and around Kalyani. They were brought alive to the laboratory, their alimentary canal was dissected out and placed on a slide with a drop of 0.5 per cent saline solution. In most of the cases, the parasites could be seen even under the dissecting binocular as white bodies within the alimentary canal of the host. For observing the locomotion of the gregarines, smears were observed directly under the microscope. For permanent preparations, smears were fixed in Schaudinn, Carnoy as well as Bouin and subsequently stained in Heidenhain haematoxylin. For studying the endogenous stages of development of the gregarine, portions of the gut of the heavily infected hosts were fixed in Bouin and 5 μ m thick sections were stained as before. Cysts were collected from the hind gut as well as from faecal pellets of the host with the help of a micro-pipette and placed on depression slides with 0.5 per cent saline solution. The slides were kept inside a moist chamber for avoiding dessication. The exogenous stages of development were observed under the microscope at regular intervals of six hours beginning from 18 hours.

All figures were drawn with the aid of a Camera Lucida. The ratios used in this paper are the ratios of length of protomerite to total length and width of protomerite to width of deutomerite.



Figs 1-11 Camera Lucida of *Gregarina cylindrosa* sp. n. 1 - First intracellular stage of development within the mid gut epithelium. From a section. 2 - Second intracellular stage, from a section. Formation of two segments in the body may be noted. 3 - A fully grown trophozoite. 4-6 - Sporadins. 7 - Sporadins in association. 8 - A freshly collected cylindrical gametocyst with two equal gamonts. 9 - Development of the gamonts in the moist chamber. The septum between the two individuals has been removed. 10 - Spores coming out from six sporoducts. 11 - A fully developed spore with eight sporozoites.

OBSERVATIONS

Development of the Trophozoite:

The study of the haematoxylin-stained sections reveal that prior to becoming free inside the mid gut, the trophozoite grows intracellularly. The earliest stage within the gut epithelial cell (Fig. 1) exhibits a slightly oval shape with a measurement of $6\ \mu\text{m} \times 5\ \mu\text{m}$. The spherical nucleus measures $1.5\ \mu\text{m}$ with a centrally placed endosome. As the parasite grows further, an ectoplasmic partition appears which separates it into a spherical protomerite with a short, narrow neck at the base and the deutomerite which is also spherical in outline (Fig. 2). It contains the spherical nucleus. The measurements of the various parts of the gregarine at this stage are as follows (in Microns):

LP = 3.5–6.0 (mean 4.7), LD = 7.0–14.5 (mean 10.7),
 WP = 3.5–5.0 (mean 4.2), WD = 6.5–9.0 (mean 7.7), Nucleus 1.5.

Morphology of the trophozoite:

The trophozoite is characteristically solitary and lives freely within the lumen of the mid gut (= cephalin stage). The body is elongated (Fig. 3) with a hemispherical epimerite measuring $7.5\ \mu\text{m} \times 12.5\ \mu\text{m}$. The protomerite is somewhat rectangular, typically broader than long and measures $12.5\ \mu\text{m} \times 25.0\ \mu\text{m}$. The deutomerite is elongated and cylindrical in shape with a constriction at the septum. Its posterior extremity is rounded. The average dimension of the deutomerite is $70.0\ \mu\text{m} \times 27.5\ \mu\text{m}$. The pellicle is moderately thick without epicyteal striations. The nucleus is spherical or elliptical, with a diameter of $17.5\ \mu\text{m}$ in the average. The endosome is big and the nucleoplasm is filled with masses of chromatin granules. The position of the nucleus in the cytoplasm may vary.

Sporadins and association, Gamont:

The sporadins are biassociative but solitary sporadins are also common (Fig. 4–6). These can occasionally change the shape of their body as evident by shortening of their body length (Fig. 5), or some buldings on the sides

Table 1. Showing the principal measurements of *Gregarina cylindrosa*

Structures	Mean	Range
LE	7.5	—
LP	30.9	12.5 to 60.0
LD	171.2	70.0 to 330.0
TL	203.3	90.0 to 390.0
WE	12.5	—
WP	50.9	25.0 to 100.0
WD	65.4	27.5 to 140.0
Nucleus	23.0	17.5 to 30.0

LP : TL = 1 : 6.5, WP : WD = 1 : 1.3.

Abbreviations: L = length, E = epimerite, P = protomerite, D = deutomerite, T = total, W = width.

(Fig. 6). The association (syzygy) between the gamonts is always of caudo-frontal type (Fig. 7). The primite is always larger than the satellite. The characters of the cytoplasm as well as the nucleus are almost similar to those of the trophozoite. The principal measurements of the gregarine are presented in Table I.

Gametocyst and spore:

The cyst appears milky white in colour under the dissecting binocular when examined immediately after its collection. The enclosed gametocytes are equal in size. The cyst is characteristically cylindrical with a measurement of $600.0\ \mu\text{m} \times 150\ \mu\text{m}$. There is a gelatinous transparent ectocyst, widest at the poles. The ectocyst is $30.0\ \mu\text{m}$ thick and reaches a thickness of upto $105.0\ \mu\text{m}$ at the sides (Fig. 8).

The septum between the gametocytes disappears within 24 hours (Fig. 9). At 48 hours of development within the moist chamber the cyst develops six sporoducts (Fig. 10), located symmetrically, which measure $40\ \mu\text{m}$ in length and $10\ \mu\text{m}$ in breadth in the average. The sporoducts exhibit slight dilatations at their bases. Through these sporoducts spores are liberated singly and not in chains.

The spores are cylindrical and measure $10\ \mu\text{m} \times 5\ \mu\text{m}$. The eight elongated sporozoites are developed inside the spore at 100 hours of development (Fig. 11).

Seasonal intensity and site of infestation:

The host insects are obtained throughout the year and on an average 20 per cent of them carry infection with this gregarine. The usual seat of infection is the mid gut. It seems that the gregarines do not cause any damage to their hosts and are commensals.

SYSTEMATIC POSITION

The gregarine under report belongs to the family *Gregarinidae* Labbé, 1899, in having sporadins in association, simple epimerite and cysts with ducts. Furthermore, in having a small, globular epimerite, cysts opening by sporoducts and cylindrical spores, it undoubtedly belongs to *Gregarinoidea* Fantam, 1925. But, because of the following features it cannot be assigned to any known species of the genus *Gregarina*:

- i) LP: TL and WP: WD values do not agree with any other species,
- ii) its cylindrical gametocyst is very characteristic, and
- iii) no any other species of gregarines has been described from *Supella supellectilium* (Serv.) in India.

In the light of the above discussions, it is, therefore, proposed to establish a new species for the gregarine, and the name *Gregarina cylindrosa* sp. n. is given to stress the cylindrical shape of the gametocyst (Gk. *Kylindros* = roller).

Holotype: On slide no. TK-1/1, from a smear of the mid gut content of *Supella supellectilium* (Serv.), collected by T. K. Kundu from Kalyani, West Bengal, India on 12. 8. 1974. Deposited at the Zoology Department, Kalyani University.

Paratypes: Many, on slide no. TK-1/1, and on other slides. Other particulars are the same as for the holotype material.

DISCUSSION

In their systems of classification, Grassé (1953), Chakravarty (1959), and Geus (1969) have stated that the members of the family *Gregarinidae* Labbé have extracellular development. In older classifications as well as that of Kudo (1966), however, no mention is made about the development in the definition of the family *Gregarinidae*. Recently, Chakraborty (1975) has described three new species of the genus *Gregarina* and in all of them, the development was intracellular. Thus, the intracellular development of *G. cylindrosa* also does not seem to be a unique one. Further, all other features of the gregarines agree with the characters of the family *Gregarinidae* as defined by the above-mentioned authors. Future studies will probably answer if it is necessary to give a new definition of the family *Gregarinidae* to include these forms in this family.

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**DIE FAKTOREN, DIE DIE SCHWANKUNGEN DER WESTGRENZE
DES VERBREITUNGSAREALS VON APODEMUS AGRARIUS
(MAMM., MURIDAE) BEDINGEN**

JOSEF KRATOCHVÍL

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Abstract : Factors affecting the variability of distribution of *Apodemus agrarius* in the western part of its European territory are discussed, as well as the question of the time of its colonization of the present western part of its European territory. The boundaries of this region, from Finland in the north to Greece in the south, are delimited and indicated on a map. —

Durch Mitteleuropa verläuft die Verbreitungsgrenze der Art *Apodemus agrarius* (Pallas, 1778) (weiter nur *A.a.*). In den letzten Jahren ist die Frage der westlichen Verbreitungsgrenze dieser Art in den Vordergrund des Interesses zahlreicher Theriologen gerückt. Man stellt fest, dass diese Grenze unbeständig ist, stellenweise zurückgeht und dass das Verbreitungsgebiet von *A.a.* schrumpft. An anderen Stellen dehnt sich die Grenze anscheinend wieder aus, das Verbreitungsgebiet vergrössert sich. Ausserdem wird konstantiert, dass das Vorkommen an den Grenzabschnitten nicht einheitlich, sondern zerrissen ist, und dass sich dort vom geschlossenen Areal getrennte Populationsinseln bilden.

Alle diese Tatsachen treten in den Vordergrund und weisen auf die Unbeständigkeit dieses Areals, wenigstens an manchen Abschnitten hin. Man darf also voraussetzen, dass dort Faktoren zur Wirkung kommen, die die Existenz der Art *A.a.* hemmen oder unmöglich machen; man findet nämlich Populationen der Brandmaus nur an bestimmten Biotopen, die ihren Umweltansprüchen entsprechen, und sogar nicht immer an allen diesen Biotopen. Zejda (1967), der das Vorkommen von *A.a.* an verschiedenen Biotopen der an die polnischen Ebenen grenzenden Tieflandgebiete der ČSSR studierte, schliesst, dass „ihre Verbreitung wahrscheinlich vor allem von der Frequenz dieser Biotope, besonders der Ufervegetation abhängt.“

Die älteste Nachricht über die Änderung des Vorkommens der Art *A.a.* in Mitteleuropa verzeichnete Ursin (1952) auf den dänischen Inseln Lolland und Falster, wo die Brandmaus vertreten ist,* und auf der Insel Bornholm, wohin sie nach Ansicht des Autors vom Menschen eingeführt wurde. Auf

*) Bohme & Reichstein (1966) nennen *A. a.* noch von der Insel Seeland und Siivonen (1968) verzeichnet das Vorkommen dieser Art auch auf den grossen Inseln in der Bucht von Riga.

dem dänischen Festland (der Halbinsel Jütland) war sie früher bei Ribe und zwischen Kolding und Fredericia bekannt (Ursin, 1952 — Karte 4; Mohr, 1954), sie ist dort aber im Laufe der ersten Jahre unseres Jahrhunderts verschwunden. Weitere Nachrichten von den Änderungen des Vorkommens und von der Verbreitung der Brandmaus findet man in den Arbeiten folgender Autoren: Kratochvíl, 1962, 1976a; Böhme & Reichstein, 1966; Hanák, 1972; Niethammer, 1976; Görner, 1976; Schmidt & Topál, 1976, aber auch Dulić (1962). Man darf deshalb als erwiesen annehmen, dass die Westgrenze des Verbreitungsgebiets *A.a.* an manchen Abschnitten instabil ist, und kann voraussetzen, dass sie sich auch in der Zukunft ändern wird. Deshalb halten die unten genannten Autoren es für nötig und höchst angebracht, den Stand der gegenwärtigen Verbreitung *A.a.* in Europa von der Ostsee im Norden bis auf die Balkanhalbinsel im Süden nach allen verfügbaren Daten so genau als möglich aufzunehmen (1976): B. Petrov (Beograd) umreißt die Verbreitung in der Föderativen sozialistischen Republik Jugoslawien; E. Schmidt & G. Topál (Budapest) auf dem Gebiet der Ungarischen Volksrepublik; J. Kratochvíl (Brno) auf dem Boden der Tschechoslowakischen sozialistischen Republik; J. Niethammer (Bonn) in der Bundesrepublik Deutschland und M. Görner in der Deutschen demokratischen Republik.

In der vorliegenden Studie ziehe ich die Summe meiner Erfahrungen über die ökologischen Milieuansprüche der Brandmaus (*A.a.*), die ich im Flussgebiet der Ploučnice in Böhmen, der Odra in Schlesien und Mähren, im Flussgebiet der Orava und des Váh in der westlichen Slowakei und des Bodrog in der östlichen Slowakei gewonnen habe. Ich vergleiche sie mit dem Wissensstand nach der Literatur, denn es ist das Ziel meiner Studie, eine Untersuchung und Wertung jener ökologischen Bedingungen zu bieten, von denen ich annehme, dass sie die Existenz und die Schwankungen des Populationspiegels im Westabschnitt des europäischen Verbreitungsareals *A.a.* bedingen. Ich betone allerdings, dass keine dieser Bedingungen an sich, ohne Zusammenhang mit den anderen, zur isolierten Wirkung kommt.

Das tschechoslowakische Gebiet eignet sich besonders gut für die Beantwortung dieser Fragen. Vor allem verläuft die Verbreitungsgrenze der Brandmaus (*A.a.*) durch den grössten Teil ihrer nördlichen Grenzgebiete. Die betreffende Landschaft ist orographisch sehr bunt, Bergkämme wechseln mit feuchten Tälern, die die tschechoslowakische Staatsgrenze nicht selten fast senkrecht schneiden und so Kommunikationen mit dem Gebiet der Nachbarstaaten ermöglichen. Einen Grossteil der Grenzlinie entlang verläuft auch die Wasserscheide zwischen den Einzugsgebieten der Ostsee und des Schwarzen Meeres. Es gibt hier ausgedehnte, dicht geschlossene Wälder, von Verkehrswegen durchschnittene Wälder und Wälder, die die Landwirtschaftstätigkeit des Menschen angegriffen hat. Manche Teile der Landschaft sind wirtschaftlich kultivierte Ebenen mit feuchten oder trockenen Abschnitten, es handelt sich also geradezu um eine Art Laboratorium für die Untersuchung der ökologischen Umweltansprüche der Art *A.a.* Ausserdem gehört dieser Grenzstrich in orographischer Hinsicht teils dem Sudeten- teils dem Karpatengebiet an, die sich beide an umfangreiche Tiefländer — das Pannonische und das polnisch-deutsche — anschliessen.

Herrn Ing Jan Zejda, CSc., mit dem ich die Problematik der Handschrift konsultiert habe, spreche ich meinen besten Dank aus.

WANN HAT APODEMUS AGRARIUS DEN WESTTEIL
SEINES EUROPÄISCHEN AREALS BESIEDELT?

Sekuläre Änderungen in der Zusammensetzung und Verbreitung der Fauna Europas haben sich unter dem Einfluss klimatischer Faktoren in der letzten Entwicklungsstufe unseres Planeten, während des Pleistozäns und Postpleistozäns, abgespielt. Im Einklang mit der Ansicht jener Autoren, die Stein (1955) gut zusammengefasst hat, als er *A.a.* als Art östlicher Herkunft wertet, können wir annehmen, dass die gegenwärtig in Mittel- und Südeuropa lebenden Populationen dieser Art Nachkommen jener Einwanderer sind, die in den heutigen Abschnitt des westlichen Verbreitungsareals der Brandmaus in Europa relativ vor kurzem gekommen sind. Petrov (1976) äussert sich zu dieser Frage folgendermassen: „*A.a.* ist in den westlichen Teil der Balkan-Halbinsel und nach Italien vor relativ kurzer Zeit vorgedrungen.“ Bauer (1960) vertritt eine ähnliche Ansicht über die Anwesenheit dieser Art im Pannonischen Becken und hält sie in der Grossen ungarischen Tiefebene für einen jungen Einwanderer (zit. Petrov, 1976). Niethammer (1976) schreibt zwar, *A.a.* lebe schon lange auf dem Gebiet der BRD, bestätigt aber, dass einwandfrei bestimmte fossile und subrezente Belege ihrer Anwesenheit in Mitteleuropa fehlen, und Kowalski (1959) nennt *A.a.* unter den Säugern des polnischen Pleistozäns überhaupt nicht. Es ist unmöglich, verlässlich zu bestimmen, wann diese Art nach Mittel- und Südeuropa vorgedrungen ist. Die Tatsache, dass sie auf manchen Ostsee-Inseln in der Nähe des Festlands vorkommt, führt Böhme & Reichstein (1966) zur Ansicht, dass sich die Dauer der Anwesenheit dieser Art in Europa nach der Zeit schätzen lässt, als sich diese Inseln vom Festland trennten, und spricht von einem Alter von rund 7.000 Jahren. Die Tatsache, dass Funde der Brandmaus auf der Insel Bornholm als Ergebnis der Einschleppung durch den Menschen gelten, lässt auch Zweifel an der Ursprünglichkeit des Vorkommens auf anderen Ostsee-Inseln hochkommen, denn auch dorthin konnte sie ja aus dem Festland eingeführt worden sein.

Sofern das westliche Verbreitungsgebiet in Europa nicht nur durch die Küste der Ostsee begrenzt wird, bildet es drei Zweige (Abb. 1): einen nördlichen, einen mittleren und einen südlichen. Der nördliche Zweig zieht aus dem Gebiet der UdSSR in die Grenzgebiete Finnlands, mit der Tendenz sich längs dem Finnischen Meerbusen auszudehnen (Siivonen, 1968); der mittlere erstreckt sich vom Gebiet zwischen der Ostsee, den Karpaten und Sudeten gegen Westen; der südliche Zweig zieht vom Schwarzen Meer in westlicher Richtung über das ganze bulgarische Staatsgebiet (Atanasov & Pešev, 1963) nach Jugoslawien, und reicht von hier aus teilweise auch nach Italien (Ostvenezien — Toschi, 1965), Griechenland (nur unweit der jugoslawischen Grenze im Vardarflussgebiet — Ondrias, 1966) und in die Europäische Türkei (Kahmann, 1961; Osborn, 1962).

Als historisch ältesten können wir den südlichen Zweig ansehen (schon deshalb, weil er von der Front der kontinentalen Vereisung am weitesten entfernt war). Er erfasste auch das Pannonische Becken und von hier aus einen grossen Teil der Ostslowakei. Am jüngsten ist wohl der mit der Kultivierung der Landschaft durch den Menschen am intensivsten verbundene nördliche Zweig, die in diesen Gebieten später stattgefunden hat als in Mitteleuropa. Auf diesem Zweig des Verbreitungsgebiets kann man den Beginn der Besiedlung durch *A.a.* anfangs ohne ein Zutun des Menschen voraussetzen, des-

sen Tätigkeit diese Besiedlung allerdings später intensivierte. Wann dies geschehen ist, weiss man nicht genau, es handelte sich wohl um einen zwar älteren, aber noch rezenten Vorgang. Rechstein (1974) belegt das Vorkommen der Brandmaus aus dem 11. Jahrhundert im Norden der BRD; Schaefer (1974) aus dem 18. Jahrhundert in grossen Seehöhen der Hohen Tatra. Erinnern wir uns aber abermals daran, dass sowohl fossile als auch subrezente eindeutig bestimmte Existenzbelege dieser Art in Mitteleuropa fehlen.

DIE URSACHE DES SCHWANKENS DER VERBREITUNGSGRENZEN VON *APODEMUS AGRARIUS* IN EUROPA

Die Verbreitung der Lebewesen ist weder auf dem Festland noch im Wasser eine konstante Gegebenheit mit bestimmten, dauernden Grenzen (mit Ausnahme natürlicher Hindernisse). Die Umweltbedingungen, die die Verbreitung einer Art bestimmen, ändern sich nicht nur im Laufe des Jahres, sondern — und dies besonders — in grösseren Zeiträumen. Ausserdem wirken auch biotische Faktoren, besonders die Tätigkeit des Menschen auf der einen, die Dynamik des Artmetabolismus auf der anderen Seite, denn es ist eine allgemein gültige Eigenschaft der Arten, neue Gebiete zu besiedeln, in denen sich ihnen Existenz- und Vermehrungsmöglichkeiten bieten. Deshalb äussert sich die Variabilität der Verbreitung am deutlichsten am Rand der Vorkommensgebiete, wie man dies exemplarisch bei *A.a.* erkennt. Das habe ich in meiner Arbeit aus dem Jahr 1962 gesagt, in der ich die Verbreitung der Brandmaus in der ČSSR präzisierte. Nun will ich versuchen, Faktoren ausfindig zu machen, von denen ich annehme, dass sie Änderungen des europäischen Verbreitungsgebiets dieser Art, besonders seines Westrands, bedingen. Ich bin mir dessen bewusst, dass man die bei der Untersuchung der gegenwärtigen Populationen gewonnenen Erfahrungen nicht ohne weiteres auf die Vergangenheit übertragen darf, umso weniger, als es nicht genau bekannt ist, welche die zöologische Lage jener Gebiete war, die der Mensch in die heutige Kulturlandschaft Europas verwandelt hat.

Temperaturfaktor und Höhenverbreitung von *Apodemus agrarius*

Keiner der Autoren hält die Art *A.a.* in Europa für thermophil. Kratochvíl & Rosický (1954) machen auf die mittlere Julitemperatur aufmerksam, die aber in enger Beziehung zur hinreichenden Feuchtigkeit des Milieus steht, eines der für die Existenz und Fortpflanzung *A.a.* bei genügenden Nahrungsquellen mitentscheidenden Faktoren. Sie unterstreichen aber zugleich, dass in verschiedenen Landstrichen Populationen unter verschiedenen Temperatur- und Feuchtigkeitsbedingungen leben und schliessen, dass eine hohe Temperatur des Milieus kein einschränkender Existenzfaktor der Brandmaus ist, wenn das Milieu nur hinreichend feucht ist. Allgemein gilt *A.a.* als Tieflandsbewohner und Petrov (1976) spricht von Fluss- und Bachtälern sowie tieferen Teilen des Landschaftsreliefs. Trotzdem geht *A.a.* auch hoch in die Berge, wie folgende Literaturbeispiele zeigen: In Jugoslawien haben wir im J. 1952 die Brandmaus in Popova Šapka im Šar-Planina-Gebirge in einer Höhe von 1.750 m ü.d.M. gefunden und Petrov (1976) hat das bestätigt. Auf dem Boden der Slowakischen sozialistischen Republik wurde

sie im Jahr 1962 von Kratochvíl im Malá-Fatra-Gebirge in einer Seehöhe von 1.000 m ü.d.M. gefunden, Hanák & Mazák (1962) fanden sie in demselben Gebirge in einer Höhe von 1.550 m ü.d.M. Mrciak (1962) spricht von einem Fund an den Nordhängen der Hohen Tatra in der Gemeinde Javorina in 1.023 m ü.d.M. und Dudich (1966) fand sie auf der Babia gora in 1.200 m ü.d.M. Herr Dr. J. Palášthy, CSc. hat mir unlängst mitgeteilt, dass sich im Museum in Prešov Exemplare *A.a.* befinden, die Ing. A. Mošanský, CSc. auf dem Berge Šimonka (ca 1.090 m ü.d.M.) im Slánské Gebirge (Ostslowakei) gesammelt hat (Kratochvíl, 1976b). Im Beskid-Żywiecki-Gebirge, Polen, stellten sie Chudoba & Haitlinger (1971) zahlreich in niedrigeren Lagen, weniger oft in Vorgebirgslagen und nur selten in Hochgebirgslagen fest, am höchsten in 1.330 m ü.d.M. In der Tschechischen sozialistischen Republik wurde sie in hohen Lagen nur in Nordböhmen, im Ostteil des Krkonoše-Gebirges, gefunden; beispielsweise bei Pomezní boudy in Höhen von 1.030—1.040 m ü.d.M. (Miles, 1971). Petrov (1976) sagt über das Vorkommen in den Bergen: „*A.a.* ist in der Regel kein Bewohner höherer Gebirgsregionen, sondern dringt dorthin nur unter bestimmten Bedingungen auch bis zu relativ grosser Höhe vor.“ Diese besonderen Bedingungen sind Freischläge in dichten Waldverbänden und eine hinreichend hohe Milieufeuchtigkeit. Die Bedeutung solcher Freischläge für das Vordringen in Gebirgsregionen betonen Hanák (1972) und Mrciak (1962). Petrov (1976) belegt dies am Beispiel Popova Šapka im Šar-Planina-Gebirge, wohin *A.a.* an Bachläufen entlang und infolge der durch Weidewirtschaft herabgesetzten oberen Waldgrenze in Höhenlagen vorgedrungen ist. Das Vorkommen in Höhenlagen muss als Ausnahme gelten und liegt an der Grenze der Existenzmöglichkeiten nicht nur im Westabschnitt des Verbreitungsgebiets, sondern auch in Mittelasien, wo *A.a.* Höhen von 1.700 m ü.d.M. erreicht (Gromov, in Sokolov, 1963).

Dieses Tatsachenmaterial weist eindeutig darauf hin, dass *A.a.*, was seine Ansprüche an die Temperaturbedingungen des Milieus anbelangt, eine breite ökologische Valenz besitzt. Die Art kann auch in Gebirgsregionen leben, wo es allerdings nicht mehr zu einer übermässigen Vermehrung kommen kann, wie im Tiefland. *A.a.* ist demnach — als Art östlicher Herkunft — eine eurytherme, keineswegs eine stenotherme Form. Tiefere Milieutemperaturen sind an und für sich kein Hindernis ihrer Existenz und Verbreitung, können diese aber indirekt beeinflussen. Schaefer (1974) hält die Zeit zwischen 1300—1700 für wärmer als die Gegenwart. Nach Ansicht dieses Autors war in den Jahren 1780—1790 die Durchschnittstemperatur in Mitteleuropa um etwa 1,0—1,3° C höher als heute; die Waldgrenze lag damals in der Hohen Tatra höher (bis 1.800 m ü.d.M.), was auch die Existenzbedingungen der Brandmaus in diesen Hochgebirgslagen änderte. Andererseits ist bekannt, dass *A.a.* nicht in warmen Steppen und Halbwüsten lebt (Gromov, in Sokolov, 1963; Ščepot'jev, 1966). Warme und trockene Gebiete könnten also eine Verbreitungsbarriere in Mitteleuropa bedeuten, das Zurücktreten bis Verschwinden dieser Art aus der Landschaft verursachen, wie man dies am Beispiel der Ungarischen Volksrepublik sieht (Schmidt & Topál, 1976). Auch in diesem Zusammenhang ist zu betonen, dass bestimmte Temperaturerhöhungen an und für sich noch keine solche Barriere vorstellen. Sie wirken eher indirekt, durch Änderungen der Feuchtigkeit, der Pflanzendecke, damit auch der Ernährungsbasis, und können deshalb *A.a.* ebenfalls aus der Landschaft verschwinden lassen.

Die Milieufeuchtigkeit

Nach den Erfahrungen vieler Autoren aus verschiedenen Teilen des Verbreitungsgebietes *A.a.* ist bekannt, dass diese Art sehr ausgeprägte Ansprüche auf eine bestimmte und beträchtlich hohe Feuchtigkeitsstufe besitzt, sie ist also ausgesprochen hygrophil (Kratochvíl & Rosický, 1954). Schmidt & Topál (1976) erklären die Schrumpfung des ungarischen Verbreitungsgebietes infolge einer Änderung der Milieufeuchtigkeit, denn *A.a.* ist eine feuchtigkeitsliebende Art und zieht sich aus den trockensten Gebieten zurück oder ist dort stellenweise schon verschwunden. Dieser Rückzug fällt ins Auge, wenn man den Stand bis etwa 1945 mit dem Jahr 1975 vergleicht (Abb. 1, 2), auch wenn das Schwanken des Populationsspiegels im Laufe der Jahre in Betracht zu ziehen ist, weil die Autoren ihren Schlüssen mehrjährige Untersuchungen zugrundlegen. Die Ansprüche *A.a.* an die Milieufeuchtigkeit erkennt auch Petrov (1976) nach Untersuchungen in Jugoslawien an. Diesem Autor zufolge besiedelt *A.a.* vor allem das Tiefland, meist Fluss-, Bachtäler usw., wo sich eine Ufervegetation befindet. Er sagt ausdrücklich, dass diese Art an trockenen Stellen selten ist oder fehlt. Zejda (1967) befasste sich mit der Frage des Vorkommens der Brandmaus an verschiedenen Biotopen der schlesischen Ebenen in der ČSSR, die in das polnische Tiefland übergehen. Er gelangte zur Ansicht, dass *A.a.* in Uferbiotopen und den an sie grenzenden lichten Wäldchen ständig und auf einem hohen Populationsspiegel anwesend ist, besonders im Frühjahr beim Eintreten der Fortpflanzungsperiode. Zu ähnlichen Folgerungen gelangten Kratochvíl & Rosický (1954). Das reiche Vorkommen *A.a.* in Schilfbeständen erwähnen mehrere Autoren, beispielsweise Zejda (1967), der diesen Beständen hohe Bedeutung beimisst, wenn sie verstreut in Geländemulden (an Bahndämmen, auf Feldern, keineswegs aber als reine und umfangreiche *Phragmites*-Bestände) auftreten, weil dort *A.a.* im Vergleich mit anderen Biotopen eine überdurchschnittliche Populationsdichte im Laufe des ganzen Jahres aufweist. Das Vorkommen in Schilfbeständen haben wir in Ungarn bei Kis Balaton, in der Ostslowakei usw. nachgewiesen. Gromov (in Sokolov, 1963) schreibt von „gut durchfeuchteten Biotopen *A.a.*“, Piechocki (1966) hat diese Art im Ausland gefunden, Böhme & Reichstein (1966) in feuchteren Ökosystemen. Diese Autoren konstatieren, dass die Brandmaus in Schleswig-Holstein, an der Ostseeseite der Jütischen Halbinsel, zahlreicher ist als an der atlantischen Seite und zwischen den beiden Seiten in trockenen Moränen und Sanddünen fehlt. Kratochvíl & Rosický (1954) machen darauf aufmerksam, dass es nicht darauf ankommt, ob die Feuchtigkeit den Niederschlägen oder dem hohen, in Geländemulden zutage tretenden Grundwasserspiegel zuzuschreiben ist. Den hohen Grad von Hygrophilie halten diese Autoren für die markanteste bionomische Eigenschaft der Brandmaus, die sie von allen anderen Arten der Gattung *Apodemus* unterscheidet. Sie verweisen auch auf die Forschungsergebnisse Šviridenkos (1949) und bemerken, dass *A.a.* in feuchten Gebieten eurytop ist, und halten einen bestimmten Feuchtigkeitspiegel des Milieus für einen die Existenz *A.a.* bedingenden Hauptfaktor. Diesen Schluss muss ich mit folgender Feststellung ergänzen: Der über das Leben und die Existenz einer Art in der Natur letzten Endes entscheidende Faktor ist eine entsprechende Ernährungsbasis. In unserem Fall ist es nebensächlich, ob die Brandmaus in feuchten Ökosystemen deshalb vorkommt, weil sie dort eine gute Ernährungsbasis findet und dabei auch

eine relativ hohe Milieufeuchtigkeit verträgt, oder ob sie zu ihrer Existenz eine relativ hohe Milieufeuchtigkeit braucht, die zugleich eine gute Nahrungsbasis bedingt. Bei der Beantwortung unserer Frage entscheiden vielmehr die ökologischen Ansprüche der Brandmaus an das feuchte Milieu, die sie hauptsächlich an Uferökosysteme binden und eine Infiltration den Fluss- und Bachläufen entlang ermöglichen. Das Vordringen an Wasserläufen erscheint als stimulierender Faktor der Verbreitung und des Rückzugs dieser Art in der Landschaft. Damit lässt sich auch die Tatsache erklären, dass *A.a.* die Flüsse und Bäche entlang stromaufwärts bis zur Wasserscheide, und nach ihrer Überschreitung stromabwärts noch weiter vorgedrungen ist. So hat diese Art nach und nach die angrenzenden Stromgebiete der Flüsse besiedelt, die verschiedenen Meeren zueilen (Abb. 2; Kratochvíl, 1976a).

Der Boden

Die Tatsache, dass *A.a.* hohe Ansprüche an eine bestimmte, das ganze Jahr dauernde Feuchtigkeitsstufe stellt, bedingt sekundär auch die Ansprüche an den Charakter des Bodens. Die kritische Periode für die Brandmaus ist sicher die trockene Jahreszeit. Es ist deshalb günstig, wenn der Boden, wo sie lebt, imstande ist Feuchtigkeit anzusaugen und zu halten. Deshalb ist *A.a.* in Gebieten mit feuchten, oft schweren, Nässe bindenden Böden ein dauernder Bestandteil der örtlichen Fauna. Das gilt auch für den Karpatenteil der ČSSR: Als Beispiele kann man das Karpatengebiet Ostmährens nennen, wo Zicháček (1974) die Böden als überwiegend feucht bis mässig feucht charakterisiert, oder das Orava-Gebiet, wo die Böden dieselbe Beschaffenheit haben, reichlich Wasser ansaugen und lange durchfeuchtet sind. Solche Böden pflegen an unbestellten, mit feuchtigkeitsliebender Vegetation bewachsenen Stellen zu liegen; allerdings handelt es sich nicht um Geländemulden, in denen das Grundwasser zutage tritt. Diese Folgerungen stimmen mit dem Ergebnissen Zejdas (1967) überein, wenn er über die Litoralvegetation als geeignetes Milieu dieser Art spricht, denn die litorale Bodenzone ist reich durchfeuchtet und erfüllt deshalb die Milieuansprüche der Art *A.a.* Wasser durchlassende und deshalb leicht austrocknende Böden limitieren die Existenz *A.a.* besonders in der trockenen Jahreszeit. Das geht auch aus den Feststellungen von Böhme & Reichstein (1966) in Jütland hervor.

Nestbaumöglichkeiten

Die Existenzfrage der Baumöglichkeit entsprechender Nester *A.a.* im Ökosystem wird in der Literatur kaum erörtert. Diese Frage berühren Kratochvíl & Rosický (1953) und haben nach Untersuchungen an verschiedenen Standorten im ganzen Verbreitungsgebiet *A.a.* in der ČSSR ermittelt, dass Erdlöcher im Boden, unter Baumwurzeln und Wurzeln grösserer Sträucher, unter Steinen oder auf Feldern, ausgeackerten Steinhaufen, an Rainen und Vegetationsstreifen, unter Lehmhaufen u.a. als Neststandorte der Art *A.a.* anzusehen sind. Sie fanden keine Oberflächennester im Gras, unter trockenen Pflanzenresten o.ä. Dies beweist, dass zu den dauernden Existenzbedingungen der Art *A.a.* im Gelände Standorte mit landwirtschaftlich un bearbeitetem Boden gehören. Damit steht die Tatsache im Einklang, dass Zejda (1967) in Feldern ein starkes Übergewicht der Männchen (70 %) offenbar deshalb gefunden hat, weil der bestellte Boden *A.a.* keine hinreichende Möglichkeit bietet, Nester anzulegen; deshalb bestehen die Populatio-

nen der Brandmaus in Feldern hauptsächlich aus Einwanderern. Mit dieser Frage hängt auch eine andere, ebenfalls von Zejda ermittelte Tatsache zusammen, dass er höhere Bestandszahlen der Weibchen *A.a.* in Schilfpflanzengesellschaften (kleineren Umfangs mit Unkraut vermischt, in Feldern verstreut u.ä.) nicht etwa deshalb gefunden hat, weil die Weibchen diese Schilfbestände nur wegen ihrer Feuchtigkeit aufsuchen, sondern weil sie Neststandorte mit hinreichender Feuchtigkeit und Nahrung auf einem durch landwirtschaftliche Operationen ungestörten Boden vorstellen. Ähnlich ist die Lage in Uferpflanzengesellschaften, wo das Geschlechterverhältnis zumindest ausgeglichen ist. Mit der Frage der Neststandorte hängt die eindeutige Feststellung zusammen, dass *A.a.* auf umfangreichen Feldflächen ohne Raine, Buschwerk, Remisen usw. nicht lebt, was Niethammer (1976) deshalb mit Recht hervorhebt, weil diese Art dort keine dauernde Fortpflanzungsmöglichkeit besitzt, auch wenn sie ab und zu besonders in Getreidefelder eindringt (Zejda, 1967; Petrov, 1976). Die Anwesenheit geeigneter Neststandorte ist deshalb eine *conditio sine qua non* der Existenz der Brandmaus im Gelände.

Die Pflanzendecke

In den Arbeiten vieler Autoren über *A.a.* findet man direkte oder indirekte Notizen über die Bedeutung der Vegetationsdecke für das Vorkommen und die Verbreitung dieser Art. Sehen wir von der Frage der Ernährungsbasis als Existenzbedingung auch für *A.a.* ab, die sich von der Art und Zusammensetzung der Pflanzendecke nicht trennen lässt, gleich ob man nun an die pflanzliche oder tierische Nahrungskomponente der Brandmaus denkt (Holišová, 1967). Kratochvíl & Rosický (1953) demonstrieren, dass die Vorstellung, *A.a.* sei ein typischer Feldbewohner, irrig ist, dass diese Art vielmehr Standorte mit Buschwerk, Kleinwäldern und Hainen mit feuchtem Mikroklima braucht. Zejda (1967) unterstreicht die Anwesenheit litoraler Pflanzengesellschaften und die Wichtigkeit in der Landschaft verstreuter und mit Unkraut durchwachsender sporadischer Schilfbestände. Auch Petrov (1976) hält Täler mit Wasserläufen und Sträuchern für reich besiedelte Standorte *A.a.* und Niethammer (1976) nennt die Pflanzendecke einen wichtigen Faktor des Vorkommens und der Verbreitung dieser Art, nennt aber andererseits bestimmte Formationen der Pflanzendecke als Hindernisse dieser Verbreitung. Alle Autoren, die *A.a.* in der Natur beobachtet haben, stimmen darin überein, dass der Wald ein wichtiger Faktor der Existenz und Verbreitung der Brandmaus ist. Kratochvíl & Rosický (1954) halten höhere Lagen mit zusammenhängender Waldbedeckung für Hindernisse ihrer Verbreitung. Die Beziehung dieser Art zum Waldbiotop wird auch in der Sowjetliteratur diskutiert. Gromov (in Sokolov, 1963) fasst dies folgendermassen zusammen: Die Brandmaus weicht zusammenhängenden Wäldern aus, hält sich an freie und strauchige Biotope. Zu ähnlichen Folgerungen gelangte Görner (1973), der sagt, *A.a.* dringe niemals tief in Wälder ein, und vor allem in den Wintermonaten. Auch Niethammer (1976) ist der Meinung, dass *A.a.* geschlossene Waldflächen meidet. Beträchtliche Aufmerksamkeit widmete dieser Frage Petrov, der im Jahr 1976 seine Erkenntnisse folgendermassen zusammenfasst: „*A.a.* ist folglich kein echter Waldbewohner . . . dessen Anwesenheit im Wald, auf diese oder jene Weise, durch die menschliche Tätigkeit bedingt ist.“ Der Forscher erinnert daran,

dass *A.a.* nur in die Ränder der Waldkomplexe eindringen kann und auch in den Laubwäldern Nordjugoslawiens meist nur am Rande lebt. Zejda (1967) stellt nach langfristigen Untersuchungen fest, dass *A.a.* in Waldkomplexen nur zufällig erscheint. Alle diese Tatsachen und Erwägungen führen zum eindeutigen Schluss: Einheitliche, vom Menschen nicht oder nur wenig gestörte Waldkomplexe, vor allem mit Nadelbaumbeständen, hemmen die Verbreitung der untersuchten Art *A.a.*, besonders wenn es sich um Wälder in höheren Lagen handelt. Eine andere Situation kann in der von Laubwäldern bedeckten Ebene herrschen, vor allem dort, wo den lichten Wald ein Wasserlauf durchfließt, wie dies auch Petrov (1976) am Südrand des europäischen Verbreitungsgebiets im Šar-Planina-Gebirge zugibt, wo *A.a.* über den Waldgürtel vorgedrungen ist.

Auch die mit Grasflächen bedeckten Biotope spielen im Leben der Art *A.a.* eine wichtige — meist negative — Rolle. Dichte Grasflächen werden von *A.a.* nicht besiedelt, aber auch niedrige und schütterere Grasflächen sind schwach frequentiert, besonders wenn sie trocken sind. In diesem Sinne haben die Forschungsergebnisse Zejdas (1967) und Ščepot'jevs (1966) konstantiert, dass *A.a.* in trockenen Grassteppen nicht erscheint. Die Pflanzendecke ist nach Zejda (1967) wichtig, er stellte *A.a.* an Sturzäckern und Stoppelfeldern überhaupt nicht fest, obwohl dort eine hinreichende Ernährungsbasis vorhanden war.

Wir können deshalb behaupten, dass die Pflanzendecke ein wichtiger Existenzfaktor der Art *A.a.* ist. Zusammen mit anderen Faktoren bedingt sie die Verbreitung der Brandmaus im Gelände, in schütterten Strauchbeständen oder mit Unkraut durchschossenen Schilfbeständen, unter den weiteren Bedingungen, dass das Mikroklima solcher Standorte genügend feucht ist. Nur dann ist auch eine Ernährungsbasis an Samen von Unkräutern und Gehölzen und an animalischer Nahrung gesichert. An zusammenhängenden monotonen Biotopen, sei es nun Wald- oder Grasflächen, lebt *A.a.* wenig oder überhaupt nicht, besonders wenn sie trocken sind (z.B. Grasbestände, trockene Föhrenwälder, monotone Biotope der Kultursteppen z.B. ausgedehnte Getreideflächen u.ä.), in geschlossenen Waldkomplexen auch dann, wenn sie ein hinreichend feuchtes Mikroklima besitzen. Diese Biotope können deshalb für *A.a.* Verbreitungsschranken sein, ebenso wie Räume ohne jegliche Pflanzendecke.

Die menschliche Tätigkeit als Faktor,
der die Verbreitung der Art *Apodemus agrarius*
in der letzten Entwicklungsphase der Erde
beeinflusst hat

Es wurden Faktoren erörtert, von denen wir annehmen, dass sie auf diese oder jene Weise die Existenz und Verbreitung der Brandmaus *A.a.* in der Landschaft beeinflussen. Wir wissen, dass keiner dieser Faktoren isoliert wirkt und dass auch sie, besonders in der kultivierten Landschaft, durch die Tätigkeit des Menschen beeinflusst werden. Schon in der bisher erwähnten Literatur findet man zahlreiche Belege. Gromov (in Sokolov, 1963) stellt fest, dass *A.a.* „široko naseljaet osvoennye čelovekom rajony lesopolja“. Auch ich schreibe das Eindringen der Brandmaus auf das Gebiet der Tschechoslowakischen sozialistischen Republik an vielen Stellen ausschliesslich der menschlichen Tätigkeit zu. So waren einst die tiefen Wälder, die beson-

ders höhere Lagen der Grenzgebiete der ČSSR bedeckten, zweifellos feste Schranken gegen die Einwanderung der Art *A.a.* aus den benachbarten Nordgebieten, und sind dort, wo sie nur wenig gestört erhalten blieben, noch heute als Schranken des Eindringens dieser Art anzusehen (Abb. 2). Zu den Faktoren, „die als Schranke wirken“ nennt Niethammer (1976) auch „geschlossene Waldungen“. Sowie sie vom Menschen verändert werden, hören sie auf zu funktionieren. Die Eingriffe in die Ganzheit dieser Waldbarrieren, besonders im Gebirge, werden zur Erklärung des Vorkommens der Brandmaus im gebirgigen Grenzland der ČSSR nicht nur von uns (Kratochvíl & Rosický, 1954), sondern auch von Mrciak (1962), Hanák (1972) u.a. herbeigezogen. Ein besonders lehrreicher Fall ist das Vorkommen *A.a.* in der Gemeinde Javorina am Nordhang der Hohen Tatra in einer Höhe von 1.023 m ü.d.M. Diese Gemeinde wurde erst 1759 gegründet und man bahnte ihr Zugangswege von Norden durch den Waldgürtel, die schrittweise auch für landwirtschaftliche Zwecke erweitert wurden. So wurde auch der Weg zum Eindringen der Brandmaus frei. Ähnlich erklärt Hanák (1972) die Entstehung der Population *A.a.* im Grenzland des östlichen Krkonoše-Gebirges. Ein anderes ebenso überzeugendes Beispiel aus dem Orlick-Gebirge im Bergzug Hrubý Jeseník: in den dortigen Nadelwäldern lebte *A.a.* nicht und man fand Individuen dieser Art nur selten am Waldrand. Zur Zeit der Kolonisation wurde im Nordteil dieser Wälder die Gemeinde Rejvíz gegründet, ein Teil des Waldes gerodet und man erbaute Zufahrtswege, die später im Interesse der Landwirtschaft erweitert wurden. *A.a.* lebt nun im Areal von Rejvíz an entsprechenden Standorten bis zur Waldgrenze dieser Enklave.

Wir sahen in den vorhergehenden Abschnitten, dass die menschliche Tätigkeit die Anwesenheit der Art *A.a.* in der Landschaft oft begünstigt. Zejda (1967) hat die Wanderung der Populationen *A.a.* im Tiefland Schlesiens, einer Fortsetzung der benachbarten polnischen Ebene, beschrieben und erklärte die Bedeutung der vom Menschen geschaffenen Einrichtungen und menschlichen Siedlungen oder der von ihm beeinflussten Biotope für *A.a.* im Laufe des Jahres. Die Existenzgrundlage dieser Art sind hier nach Zejdas Ansicht Pflanzengesellschaften der Litoralzone und verwandte Ökosysteme. Die Wanderungen werden besonders in Zeiten der hohen Populationsdichte *A.a.* aktuell und die Bindung an litorale Pflanzenformationen weist auf die Verbreitungswege der untersuchten Art im Raum hin, auf die bereits früher auch andere Autoren aufmerksam gemacht haben.

Wir können nun die ganze Problematik folgendermassen zusammenfassen: In der Vergangenheit hatte der in die Waldbiozöosen eingreifende Mensch einen grossen Einfluss auf die Änderungen und Ausweitung des Verbreitungsgebiets der Art *A.a.* Gegenwärtig kann man diese Vorgänge als beendet ansehen. Umsomehr tritt heute der Mensch als Landwirt in den Vordergrund, der die Landschaft kultiviert, Wasserläufe reguliert, durchfeuchtete Flächen entwässert, zerstückelte Grundstücke zu einer monotonen Einheit zusammenlegt, in der die von Zejda (1967) als wichtige Standorte der Art *A.a.* beschriebenen Stellen verschwinden. Wo diese Vorgänge fortgeschritten sind, dort verschwindet auch *A.a.* aus der Landschaft, wie dies in der Ostslowakei der Fall ist (Kratochvíl, unveröff.), oder im Tiefland Ungarns (Schmidt & Topál, 1976). Obwohl wir die letztgenannten Folgerungen mit Reserve aufnehmen, weil sie sich in hohem Mass auf Eulengewöllanalysen stützen, bleibt die Sachlage bestehen: In der Ungarischen Volksrepublik ist die Brand-

maus *A.a.* auf dem Rückzug. Sie zieht sich auch aus dem Norden der Bundesrepublik Deutschland zurück. Wir nehmen an, dass die Lage an manchen Abschnitten der westlichen Verbreitungsgrenze stabil ist (beispielweise in der BRD — Niethammer, 1976), an anderen Stellen verbreitet sich die Art *A.a.* sogar in neue Räume usw. Petrov (1976) lehnt für das Gebiet Jugoslawiens die These vom Rückzug und der Schrumpfung ihres Areals ab.

Dies alles sind manchmal mehr oder weniger genaue Feststellungen, manchmal nur Erwägungen und Vermutungen. Die Zukunft wird zeigen, wie sich das Verbreitungsareal der Brandmaus in der immer intensiver kultivierten Landschaft Europas entwickeln wird. Die in Acta Sci. Nat. Brno 3/76 veröffentlichten Arbeiten B. Petrovs, E. Schmidts und G. Topáls, J. Kratochvíls, J. Niethammers und M. Görners bieten in dieser Hinsicht gute Unterlagen.

SCHLUSSFOLGERUNGEN

1. *Apodemus agrarius* ist im europäischen Westabschnitt seines Verbreitungsareals eine junge Faunenkomponente. Diese Art ist östlicher Herkunft und gelangte in die untersuchten Gebiete. Zuerst besiedelte sie die Balkanhalbinsel, erst im Spätpleistozän drang in das untere Stromgebiet des Po-Flusses und gegen Norden nach Pannonien vor. Den Raum zwischen der Ostsee und den Gebirgszügen Mitteleuropas besetzte sie im Postpleistozän. Der jüngste Abschnitt ihres Verbreitungsareals liegt im Norden.

2. In Europa ist *A.a.* eine hygrophile und eurytherme Art. Sie bewohnt vor allem die Ebenen, dringt aber auch in höhere Berglagen vor und hat sich über Wasserscheiden hinaus von einem ins andere Flussgebiet ausgedehnt. Die Brandmaus lebt an Biotopen mit feuchtem Mikroklima, mit feuchtigkeitsliebender, meist Unkrautvegetation, einschliesslich schütterer, mit Unkrautpflanzen durchmischter Busch- und Schilfbestände. Dort findet sie hinreichende Ernährungsquellen und der landwirtschaftlich unbestellte Boden bietet ihr auch gute Möglichkeiten des Versteckens und der Anlage von Erdnestern. Von hier aus dringt *A.a.* in Felder und im Herbst in ländliche Siedlungen ein.

3. Grosse monotone Vegetationsflächen, besonders wenn sie trocken sind, hemmen das Vorkommen und die Verbreitung von *A.a.* Dichte, umfangreiche Waldkomplexe, vor allem Nadelwälder, stellen der Verbreitung dieser Art Barrieren entgegen, auch wenn das Mikroklima feucht ist.

4. Als der Mensch die Wälder zu roden begann, ermöglichte diese Tätigkeit die Ausbreitung der Brandmaus *A.a.*, besonders an Flüssen und Bächen entlang. Gegenwärtig verwandelt der Mensch die Landschaft in wirtschaftliche hochproduktive Gebiete, entwässert feuchte Stellen, reguliert Flussläufe, erweitert die bestellten Bodenflächen, legt kleine Felder, Raine und Remisen zu ausgedehnten monotonen Hufen zusammen. Im Zuge dieser Massnahmen verschwinden die den Milieuanprüchen von *A.a.* angemessenen Standorte. In derartigen Landschaften tritt diese Art zurück oder verschwindet völlig.

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Die Abbildungen sind am Ende des Heftes zu finden.

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**A REDESCRIPTION OF BARBUS BISCARENSIS BOULENGER, 1911
(CYPRINIDAE; OSTEICHTHYES) FROM THE CENTRAL SAHARA
(HOGGAR MOUNTAINS OF ALGERIA)**

Department of Systematic Zoology, Charles University, Prague

FISHES OF CZECH SAHARA EXPEDITION OF 1973

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Received April 12, 1976

Abstract: *Barbus biscarensis* Boulenger, 1911 has been redescribed from a sample of 112 specimens collected during October 1973 from the Central Sahara of Algeria. The results broadly agree with those of Boulenger (1911) and Almacá (1970) but differ in having wide range of variation in morphometric and meristic characters. Such variations can be attributed to a comparatively large sample at my disposal.

INTRODUCTION

Boulenger (1911) was the first to describe *Barbus biscarensis*. His description is based on seven specimens procured from different localities and museums (Biskra and Pool of Ifedil — Paris Museum, Ain Drohe and Wed Biskra — apparently British Museum). He divided *B. callensis* of Günther (1868) into *B. biscarensis* and *B. callensis*. Pellegrin (1939) described the morphometric and meristic characters of *B. biscarensis*. He was followed by Almacá (1970) who established the validity of *Barbus biscarensis* as a distinct species. But the description of all these authors is based on a comparatively small material, hence the species is redescribed basing results on the study of 112 specimens.

MATERIAL AND METHODS

Czech Sahara Expedition of 1973 was supported by the Czech Ministry of Culture of Czechoslovak Government and organized by the Association for Protection of Nature called "TIS". Dr. V. Skořepa collected the material from Oua-n-Tazzait (23°28' North width and 5°46' East length) near Edjif Mellen, Tamada Oasis, in October 1973.

A sample of 112 specimens ranging in total length from 74—157 mm (body length 57—125 mm) was examined. An equal number of fish had to be discarded because the serrated ray was found broken. The measurements have been recorded according to the scheme drawn by Dr. V. Skořepa with regard to characters used in the taxonomy of the North African barbs. The last ray of the dorsal and the anal fins has been counted as double. It may be pointed out that the actual dissection revealed that whereas the last rays have jointed radials, the interspinous elements basals) are separate.

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RESULTS AND DISCUSSION

The results of the morphometric and meristic analyses are presented in Table I and shown graphically (Fig. 1). It can be seen from the figure that whereas the mean values are different in each case, the majority of the characters show overlappings in their respective ranges. Moreover, the range of variation is very large in some characters and very small in others.

The meristic characters also show similar variations although these are not as high as in the morphometric features. The meristic formula can be described as:

Table 1. Biometrics of *Barbus biscarensis*

Character	Average	Range
Total length in mm.	96.2	74-157
Body length in mm.	76.8	57-125
In % of body length		
Depth of body	22.9	20-25
Length of head	29.1	27-32
Depth of head	18.6	16-21
Width of head	16.6	14-18
Predorsal distance	56.8	54-61
Length of caudal peduncle	17.7	15-20
Minimum depth of body	10.4	8-12
Preventral distance	53.9	49-56
Preanal distance	76.8	74-80
P-V distance	27.9	26-31
V-A distance	23.3	20-27
Length of dorsal fin	13.6	12-16
Depth of dorsal fin	20.5	18-23
Length of anal fin	6.6	5-9
Depth of anal fin	20.5	17-25
Length of pectoral fin	21.1	18-24
Length of ventral fin	17.6	15-20
Length of caudal	25.7	22-31
Length of head in mm	22.1	17-37
In % of head length		
Depth of head	64.2	57-72
Width of head	56.9	50-63
Diameter of eye	19.5	14-24
Preorbital distance	31.9	25-40
Postorbital distance	48.7	44-54
Interorbital distance	32.0	27-38
Length of cirri 1/11	24.3/30.0	17-33/21-36
Length of caudal peduncle in mm	13.6	10-24
In % of caudal peduncle length		
Minimum depth of body	58.7	47-73
In % of total length		
Length of head	23.2	21-25
Depth of body	18.3	17-20
Lateral line scales	48.7	46-52
Dorsal fin rays	IV/8	IV/7-9
Anal fin rays	III/6	III/6
Ventral fin rays	10	10
Pectoral fin rays	18.2	18-20
Number of serrations	21.1	17-26
Scales around caudal peduncle	15.9	15-18

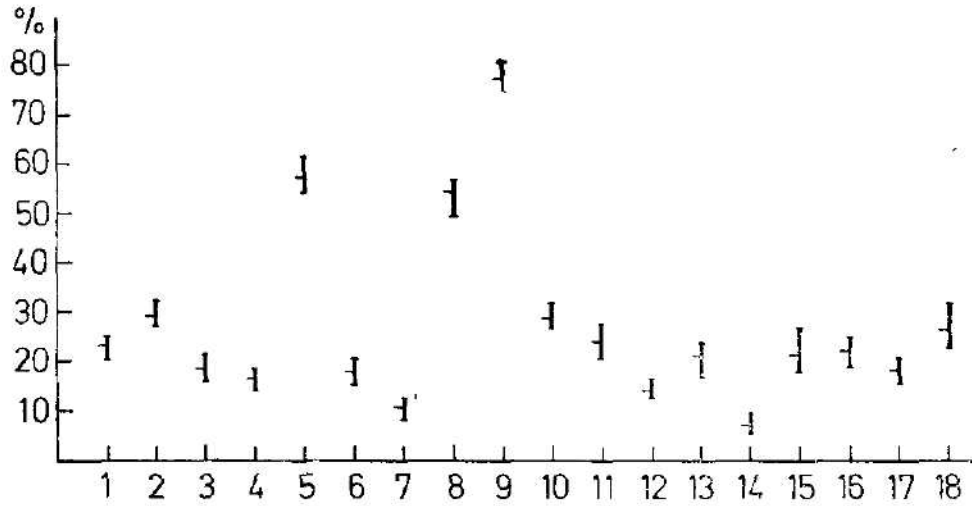


Fig. 1. Graphic representation of morphometric characters of *Barbus biscarensis*. Ranges — vertical lines, means or averages — horizontal lines. 1—18 in % of body length where: 1. Depth of body, 2. Length of head, 3. Depth of head, 4. Width of head, 5. Predorsal distance, 6. Length of caudal peduncle, 7. Minimum depth of body, 8. Preventral distance, 9. Preanal distance, 10. P—V distance, 11. V—A distance, 12. Length of dorsal fin, 13. Depth of dorsal fin, 14. Length of anal fin, 15. Depth of anal fin, 16. Length of pectoral fin, 17. Length of ventral fin, 18. Length of caudal.

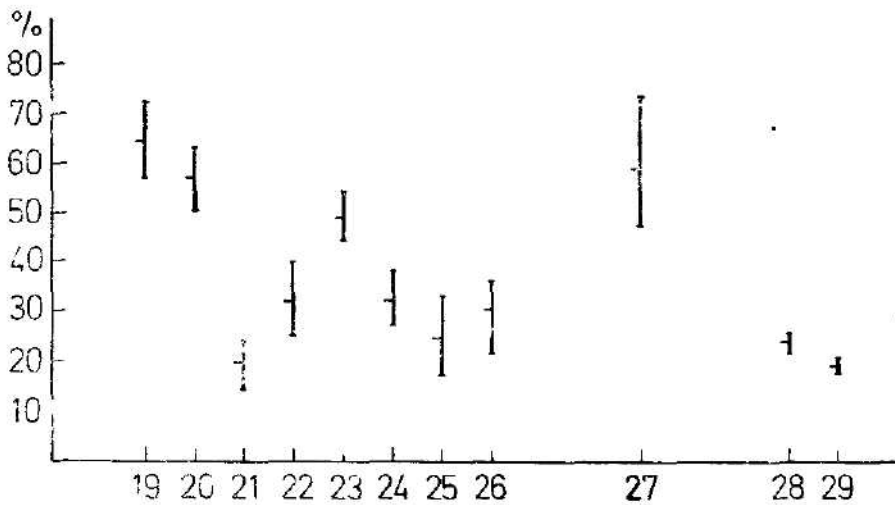


Fig. 2. Graphic representation of morphometric characters of *Barbus biscarensis*. Ranges — vertical lines, means or averages — horizontal lines. 19—26 in % of head length where: 19. Depth of head, 20. Width of head, 21. Diameter of eye, 22. Preorbital distance, 23. Postorbital distance, 24. Interorbital distance, 25. Length of cirri I, 26. Length of cirri II, 27. In % of caudal peduncle length — minimum depth of body, 28. and 29. in % of total length where 28. Length of head, 29. Depth of body.

D. IV/7—9, A. III/6, V. 10, P. 18—20, 1. 1. 46—52, 1. tr. $8\frac{1}{2}/5\frac{1}{2}$.

Figure 1 shows that length of the caudal peduncle almost equals the head depth; the ventral fin may arise in advance or opposite or away from dorsal fin; the distance between the insertion of the ventral and anal fins is, in most cases, much less than the distance between the insertion of pectoral and ventral fins, but sometimes it is almost equal or slightly more; length of the pectoral fin is always smaller than the height of the longest anal fin ray, the latter is generally more than the height of dorsal fin ray (last undivided serrated ray); the interorbital distance and both the cirri are generally longer than the diameter of the eye.

Morphometric and meristic characters occupy a key position in the taxonomy of fishes. Hence the present results are interesting in themselves when compared with other authors.

Boulenger (1911) described the occurrence of 7—8 divided dorsal rays and 5 divided anal rays. The number of lateral line scales, according to him, is 48—51 and 1. tr. $8\frac{1}{2}-10\frac{1}{2}/5\frac{1}{2}-7$. Pellegrin (1939) and Almaca (1970) described 47—51 and 47—52 lateral line scales respectively, the latter author gave 1. tr. as 7—9/5—7 and stated that rarely three undivided dorsal rays are present. In the present collection only one specimen was noticed with three undivided dorsal rays and I am inclined to think it as a case of abnormality. Boulenger (1911) described 20—22 scales around the caudal peduncle but I have recorded 15—18. He described body depth 22.2—25 percent and head length 25—28.6 percent in total length. Preorbital distance, diameter of eye and interorbital distance have been described as 33.3, 20—25 and 33.3—36.4 percent respectively in head length. In case of body depth and head length the present ranges are smaller but larger in other cases. Boulenger (1911) stated the serrated portion as 0.5—0.66, and length of pectoral fin 0.67—0.75 of head length. In the present case the range are 0.37—0.53 and 0.65—0.81 respectively. An interesting feature is that the length of the denticulated part of the ossified dorsal ray in head length decreases with the increase in the length of the fish. This observation is in conformity with the results of Almaca (1970).

It may thus be seen that though in the broader sense the present results are in agreement with earlier authors, yet differ in having wide ranges. Therefore, the range of variation should be extended.

Acknowledgements

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SUMMARY

A sample of 112 *Barbus biscarensis* was examined from the Central Sahara of Algeria.

A wide range of variation has been recorded in many morphometric characters.

The meristic formula has been redescribed as: D. IV/7—9, A. III/6, V. 10, P. 18—20, 1. 1. 46—52, 1. tr. $8\frac{1}{2}/5\frac{1}{2}$.

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**THE GROWTH OF THE SHEATFISH, SILURUS GLANIS
IN CZECHOSLOVAKIA**

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Abstract: The growth of 48 specimens of *Silurus glanis* Linnaeus, 1758 was ascertained using vertebrae. Back-calculation method was used for the reconstruction of the growth histories. All specimens were caught by anglers and represented their trophies. Therefore, smaller specimens could not be studied. The material is not of homogenous origin. The smallest specimen measured 83 cm and the largest 230 cm in total length and belonged to 6+ and 30+ year classes respectively.

INTRODUCTION

There are very few notes on the growth of the sheatfish not only in Czechoslovakia but also in the European literature, regardless of the fact that the fish attains the largest size in the freshwaters of these countries and has received wide publicity. First reports from Czechoslovakia are those of Hrbáček, Hruška and Oliva (1952); Hruška and Oliva (1953) and Hruška (1954). The second period of sheatfish studies began with Hochman (1966, 1967) and ended with Sedlár and Geczö (1973).

Čihař (1961) studied 3 specimens of *S. glanis* from Slapy valley water reservoir on the river Vltava. Balon (1966) examined 2 large specimens from the river Morava's inundation lake Centnus. Mihálik (1968) summarized, in a semipopular guide book, the general biological data on sheatfish, using information concerning growth from Berg (1949) and above cited authors. Similarly Horoszewicz (1971) published a semipopular book in Polish and used the data of Bizjajev (1952) and Hochman (1966) along with his own observations.

MATERIAL AND METHODS

Vertebrae of *Silurus glanis* were collected from 1952—1975 for the study of age and growth. The heads of most of the sheatfish were brought to the preparatory laboratory "DIPRA" in Prague, where Dr. J. Porkert removed the first few vertebrae and presented them to us. Further details were collected from the anglers themselves.

The vertebrae were boiled for a few minutes in soap solution to remove the flesh and then dried. From the piece of the vertebral column, generally a vertebra was separated either with the help of a saw or a sharp scalpel. The remains of the notochord were removed from the centrum of the vertebra using the sharp tip of the scalpel. The rest of the body of the vertebra was cleaned using the edge of the scalpel till the rings were visible clearly under the stereomicroscope. Generally a drop or two of acetone were applied with a tooth brush to further clean the surface of the vertebra.

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It was then examined under the Carl Zeiss Stereomicroscope SM XX which was adjusted to give magnification of $166\ \mu\text{m}$ (eye piece 2.5, objective 0.63). The vertebra was so placed under the stereomicroscope that the neural spine faced away from the observer. Thus when viewed through the ocular tube the maximum of the radius of the vertebra was in line with the ocular micrometer divisions. The surface of the vertebra was illuminated with a movable light fitted to the stereomicroscope.

On the body of the vertebra, translucent and dark rings could be noted. Each dark ring was considered corresponding to an annulus or year mark and measured from the middle of the centrum to its outer margin. It was easy to recognize the annulus immediately around the centrum and in the middle of the body of the vertebra. Near the margin of the vertebra there was a lot of overrowing and this made the reading a little difficult. In such cases, each dark ring was followed along its course and measured where it crossed the scale of the micrometer. False rings could be identified because of their discontinuity. For the methods of measurements and reading annuli see Figure 1.

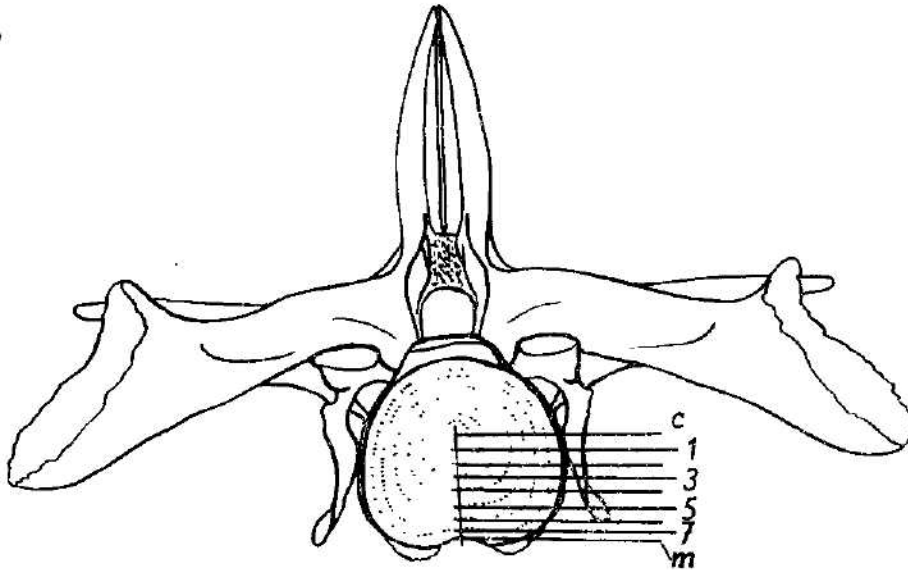


Fig. 1. Schematic diagram of the vertebra showing the method of measuring the annuli. c — centrum, m — margin, original drawing by Dr. K. Hensel.

The maximum radius of each vertebra was noted in ocular divisions and then plotted against the respective fish length. The fish were then grouped at 10 cm interval and the corresponding lengths and radii noted. The average at each 10 cm interval was calculated and plotted. By eye estimation a line was drawn passing through the maximum average values. The line was then extrapolated to cut the abscissa and to find out the possible length at which the ossified vertebrae are likely to form in the fish. This value was used as a correction factor for back-calculating lengths at different annuli (Fig. 2).

In the laboratory of the Department of Systematic Zoology, Charles University, Prague, a few fertilized eggs of *S. glanis* were obtained on 7th June 1950. These eggs were then reared. All eggs hatched on 9/6/1950. On 18/6/1950 all the larvae had lost yolk sac and started feeding on small plankton. Different stages of the fish were collected and preserved. From this collection individuals of 25/6/1950 and 1/7/1950 were examined. Two to three specimens, stained in alizarine were dissected under the stereobinocular and the ossification of the vertebral column was followed. It was seen that fully formed ossified vertebrae were present in all individuals of 1/7/1950, whereas the vertebral column of 25/6/1950 individuals was unstained. It is obvious that the ossification took place between the 17th and 25th day after hatching. Such individuals measured about 20 mm in length which was in close agreement with the graphical value. Hence in back-calculations 2 cm was used as a correction factor.

Length-weight relationship has been calculated by using the formula $W = cL^n$ where W is weight in kilograms, L = length in centimeters, n an exponent expressing relationship between W and L , and C is a constant. The logarithmic form of the equation is $\log W = \log c + n \log L$. 70 specimens were used and the relationship was found out to be

$$\log W = -5.9532 + 3.3645 \log L.$$

The minimum harvestable size was determined from the crossing point of the length increment in percentage of the length of the first growth season curve and the length in percentage of the length of the final growth season curve (based on back-calculated lengths using correction factor).

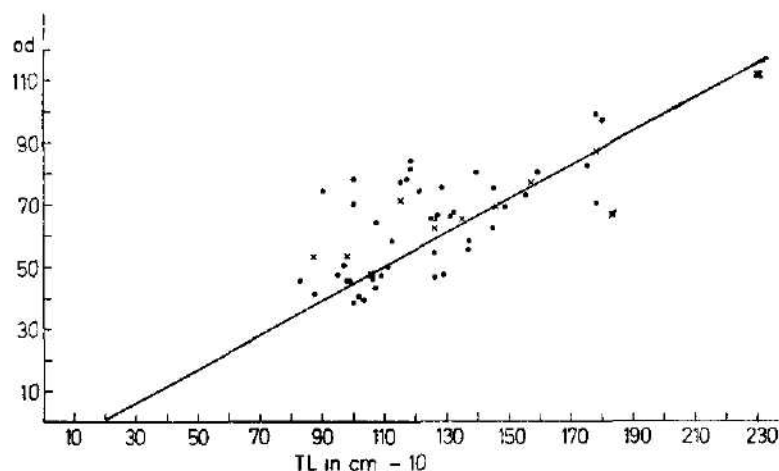


Fig. 2. Vertebral radii — total length relationship. The vertebral radii are in ocular divisions (od), total length (TL) is in cm. Solid circles = actual values, crosses = average values.

RESULTS

Examination of the vertebrae of 48 specimens of *S. glanis* ranging in length from 83 cm to 230 cm, collected during the years 1950—1975, shows that the fish has a life span of more than 30 years (Table 1). Individuals varying in age from VI to XXX years have been recorded. Considerable overlapping of length range in the age groups was noticed. Similarly there was a wide variation in the average length of each year class at the time of formation of respective annuli. For example, the first annulus was observed from 8 to 21 cm, the second from 13 to 35 cm and so on. In Table 1 only the average back-calculated lengths (based on 48 specimens) are given because the number of specimens in each age group was small and some of the year classes were missing. Thus beginning with VI+ year we had the distribution of the individuals as follows:

VI —2, VII —3, VIII —2, IX —3, X —5, XI —2, XII —3, XIII —5, XIV —5, XV —4, XVI —2, XVII —3, XVIII —1, XIX —1, XXI —3, XXII —2, XXIII —1, XXX —1.

The absence of certain age groups is caused by the fact that the material was the prized trophies of the anglers from different localities of Czechoslovakia at varying time interval and the authors were dependent on the anglers for the material.

Thus the wide range in which the respective annuli are formed in different age groups can be explained on the basis that our sample was small and

Table 1. Back-calculated lengths in cm, specific rate of linear growth, index of species average size and empirical weights in kg of *Siturus glanis* from Czechoslovakia

	l_1	l_2	l_3	l_4	l_5	l_6	l_7
a) With correction factor:							
Smoothed average lengths	12	22	36	48	60	71	80
Annual increment	10	14	12	12	11	9	
Specific rate of linear growth	83.3	63.6	33.3	25.0	18.3	12.7	10.0
Index of species average size							7.5
Weight in Kg	0.005	0.036	0.195	0.605	1.07	1.89	2.82
b) Without correction factor:							
Smoothed average lengths	10	20	34	47	59	69	79
Specific rate of linear growth	100.0	70.0	38.2	26.5	16.9	14.5	10.1
Weight in Kg	0.002	0.026	0.158	0.471	1.01	1.71	2.70

	l_8	l_9	l_{10}	l_{11}	l_{12}	l_{13}	l_{14}	l_{15}
a) With correction factor:								
Smoothed average lengths	88	96	103	110	117	123	129	136
Annual increment	8	7	7	6.4	6	6	7	6
Specific rate of linear growth	9.1	7.3	6.8	6.4	5.1	4.9	5.4	4.4
Index of species average size								
Weights in Kg	3.88	5.20	6.59	8.22	10.1	12.0	14.1	16.8
b) Without correction factor:								
Smoothed average lengths	87	95	102	109	116	123	129	136
Specific rate of linear growth	9.2	7.4	6.9	6.4	6.0	4.9	5.4	3.7
Weight in Kg	3.73	5.02	6.38	7.97	9.84	12.0	14.0	16.8

	I ₁₆	I ₁₇	I ₁₈	I ₁₉	I ₂₀	I ₂₁	I ₂₂
a) With correction factor:							
Smoothed average lengths	142	149	157	163	171	175	178
Annual increment	7	8	6	6	4	3	6
Specific rate of linear growth	4.9	5.4	3.8	4.9	2.3	1.7	3.4
Index of species average size							
Weight in Kg	19.4	22.8	27.2	30.9	36.3	39.2	41.5
b) Without correction factor:							
Smoothed average lengths	141	149	157	163	171	175	178
Specific rate of linear growth	5.7	5.4	3.8	4.9	2.3	1.7	3.4
Weight in Kg	19.0	22.8	27.2	30.9	36.3	39.2	41.5

	I ₂₃	I ₂₄	I ₂₅	I ₂₆	I ₂₇	I ₂₈	I ₂₉	I ₃₀
a) With correction factor:								
Smoothed average lengths	184	195	199	205	214	216	224	226
Annual increment	11	4	6	9	2	8	2	2
Specific rate of linear growth	5.9	2.1	3.0	4.4	0.9	3.7	0.9	0.9
Index of species average size								
Weight in Kg	46.4	56.4	60.4	66.8	77.2	79.7	90.0	92.7
b) Without correction factor:								
Smoothed average lengths	184	194	198	205	213	216	224	226
Specific rate of linear growth	5.9	2.1	3.0	4.4	0.9	3.7	0.9	0.9
Weight in Kg	46.4	55.5	59.4	66.8	76.0	79.7	90.0	92.7

spread over a period of 25 years. Moreover, it was not homogenous and hence the growth can not be taken as uniform throughout these years.

The average back-calculated length at the time of the formation of first annulus has been found to be 12 cm. This can be justified on the assumption that the ossification of the vertebral column was observed at about 2 cm. In the first few years fish grows quite fast, the rate of growth then falls showing occasional spurts.

The specific rate of linear growth varies from 0.9 to 83.3 and the index of species average size has been calculated to be 7.5 cm (Table 1). The wide range in the specific rate of linear growth is an indication of the uneven growth in *Silurus glanis*. Obviously the growth depends upon many complex ecological and physiological factors.

The length-weight relationship was calculated using 70 specimens, 48 of these were those utilized for the age and growth, and the rest from published data. *) The logarithmic form of the equation is $\log W = -5.9532 + 3.3645 \log L$, showing thereby that the weight increases more than the cube of the length (Fig. 3). Basing on this equation weights were calculated at each

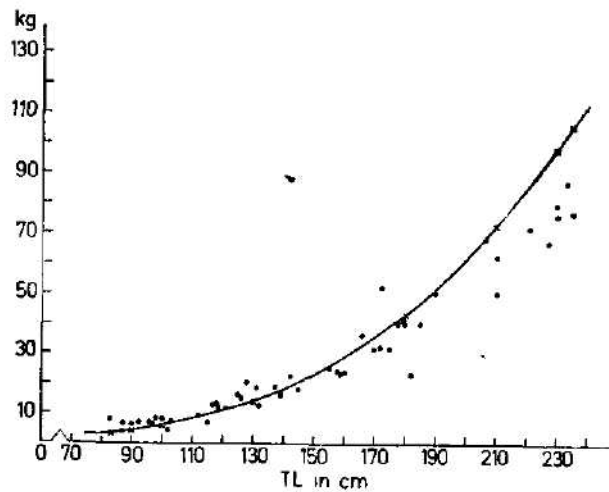


Fig. 3. Length-weight relationship. Length is in cm. and weight in in kg. Solid circles = observed weights, crosses = empirical weights.

back-calculated length (with correction factor and without) and are shown in Table 1. From Figure 3 it can be seen that at higher lengths the observed weights are different from the empirical weights. It may be possible that in nature this phenomenon occurs, but this needs further confirmation.

The minimum harvestable size appears to be more than a meter when the fish has attained a size of about 116 cm and a weight of about 10 kilogram. Therefore it may be worth while to increase the legal limit of length of catching the sheatfish from 70 cm to at least a meter in Czechoslovakia.

*) From angler's magazine "Čs. rybníkáři" in period 1965—75.

The data on the stomach contents reveal that *S. glanis* is piscivorous feeding on roach, rudd, bream and tench. Of these, roach appears to be a favourite food item. Caddisfly and Mayfly were of rare occurrence. When the stomachs were empty, the intestine had the remains of the feed and was found harbouring Acanthocephalan parasitic worms.

Nothing can be said about the sex ratio, because the sex of only 14 females and 20 males was made known. It is also not possible to say whether males or females live longer.

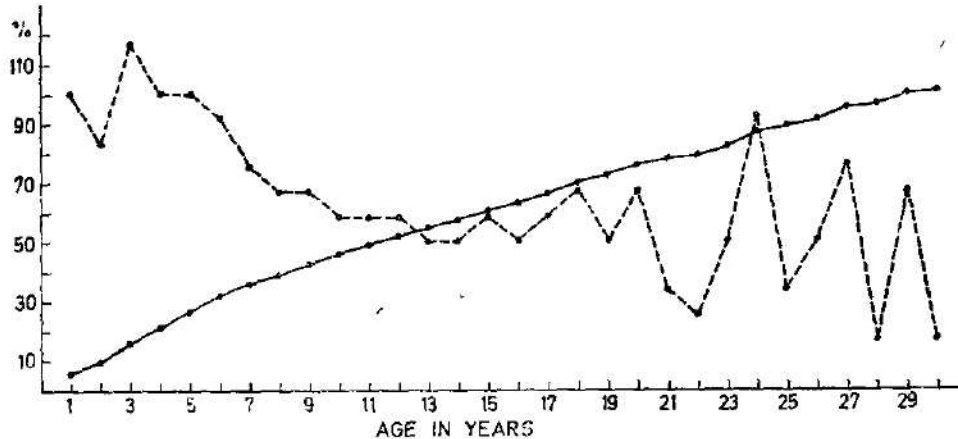


Fig. 4. Graph showing harvestable size. Lower curve — total length in percentage of the length of the last growth season, upper curve — length increments in percentage of the first growth season.

DISCUSSION

Menon (1950) in his paper on the use of bones, other than otoliths, in determining the age and growth-rate of fishes reviewed the literature in a remarkable way and added his own comments on the use of opercular bones. From the papers of Menon (1950) and Appelget and Smith, Jr (1951) it is evident that since the time of Reibisch (1899) and Heincke (1904) vertebrae have been successfully used for determining the age and rate of growth of fishes. In the appendix to Menon's paper (1950) Hart stated that the measurement of concave surfaces such as those of vertebral centra is not easy and for purposes of back-calculations one should work on flat bones whenever possible. However, he further writes that in almost all the fish (*Phycis* [*Urophycis*] *blennoides* Brün.) examined he found the vertebrae useful for determining age and rate of growth.

Appelget and Smith Jr. (1951) and Lewis (1949) used vertebrae for studying growth of *Ictalurus lacustris punctatus* and *Ameiurus melas melas* respectively. Frank (1955), Hensel (1966), Hochman (1966), Kirka (1969), Černý (1974), Chitravadivelu (1974), Frank (1974) and Pivnička (1974) also found the use of vertebrae to be a very useful tool for studying age and growth of catfishes.

Menon (1950) remarked that the causative factor in the formation of rings on the bones is not definitely known. Hickling (1933) attributed the

Table 2. Comparison of back-calculated lengths

	I ₁	I ₂	I ₃	I ₄	I ₅	I ₆	I ₇	I ₈	I ₉
North part of Aral lake, Berg, 1949, 125 sp. males	18	29	40	50	61	71	78	87	92
females	20	31	41	51	60	70	78	86	89
South part of Aral lake; Berg, 1949	—	—	65	61	72	79	86	92	104
Bohemia + Moravia; authors, 48 sp.	12	22	36	48	60	71	80	88	96
River Dyje, Moravia; Hochman, 1966, 4 sp.	14	33	50	65	76	88	96	—	—
Vranov riverine lake, Moravia; Hochman, 1966, 17 sp.	11	24	37	49	60	71	81	—	—
Orlík riverine lake, Bohemia; Hochman, 1966, 51 sp.	13	25	39	53	64	75	85	93	101
Bohemia; Hrbáček, Oliva, Hruška, 1952, 1953, 1954, 43 Sp.	—	—	—	—	99	95	111	103	126
Slapy riverine lake, Bohemia; Čihař, 1961, 3 sp.	17	31	49	65	79	90	—	—	—
River Don, USSR; Bizjajev, 1952, 600 sp.	23	55	76	91	106	118	128	138	147
*River Vistula, Poland; Horoszewicz, 1971	18	38	58	70	80	90	100	108	117
Backwater Centnus, Lower part of river Moravia, Slovakia; Balon 1966, 2 sp.	15	29	39	43	52	61	72	84	93
River Váh, Slovakia; Sedlár-Geczó, 1973, 117 sp.	11	24	36	47	55	63	70	76	81
River Nitra, Lándor; Sedlár-Geczó, 1973, 25 sp.	13	25	39	51	59	69	77	83	95
Backwater Lion, Danube; Sedlár-Geczó, 1973, 25 sp.	17	37	52	66	74	82	88	94	101
River Váh, Neded; Sedlár-Geczó, 1973, 2 sp.	10	17	26	38	51	63	74	87	96

* Calculated from the graph, fig. 35, p. 101.

formation of the rings on the otoliths of hake to a physiological rhythm in the fish based on its reproductive cycle. Lewis (1949) is of the opinion that vertebral and scale marks are caused by the same factor.

Clear dark rings were noticed in all the vertebrae of *S. glanis* and they were interpreted as year marks. In the peripheral region, due to overcrowding, there was some difficulty but this was overcome by following the rings along their course.

Lewis (1949) observed a wide range of 32–89 mm in one year class and stated that to guess the age of the fish from length frequency distribution is rather difficult. Appelget and Smith Jr. (1951) observed greatest increment in the second year of life than in any other year in *Ictalurus lacustris punctatus*. They did not observe Lee's phenomenon of apparent change in rate of growth of this catfish.

Hochman (1967) stated that the unnatural variation in average lengths of *S. glanis* in different year classes, in the Orlík valley reservoir, is caused by different and varying representation of fishes showing different growth rate.

Table 1 clearly indicates the quick growth of *S. glanis* during the first six to seven years of life, thereafter up to 20th year the growth varies from 6–8 cm per year. After a quick growth from 23rd to 24th year there was a sudden drop. The fish lives more than 30 years. Table 2 presents the back-calculated lengths with the data of other authors. Our results appear to be very near to the data of Hochman (1966) and Balon (1966) up to the 21st year of life. It appears that *S. glanis* in the lower part of the river Morava grows very slowly. Berg (1949) reported fast growth of the sheatfish from Aral Lake.

in cm of *S. glanis* from various localities.

	l ₁₀	l ₁₁	l ₁₂	l ₁₃	l ₁₄	l ₁₅	l ₁₆	l ₁₇	l ₁₈	l ₁₉	l ₂₀	l ₂₁	l ₂₂	l ₂₃	l ₂₄	l ₂₅	l ₂₆	l ₂₇	l ₂₈	l ₂₉	l ₃₀	
99	97	102	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
90	107	112	117	117	125	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
111	112	127	130	136	148	140	175	195	—	—	—	195	215	—	—	—	—	—	—	—	235	—
103	110	117	123	129	136	142	149	157	163	171	175	178	184	195	199	205	214	216	224	226	—	—
109	115	122	128	133	139	144	150	155	160	165	170	—	—	—	—	—	—	—	—	—	—	—
100	—	137	134	140	—	—	159	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
155	165	172	180	187	194	197	208	212	216	227	230	233	236	242	245	—	—	—	—	—	—	—
120	127	130	135	135	157	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
99	106	113	122	132	138	145	151	157	163	167	173	170	174	178	180	182	184	186	188	—	—	—
87	95	99	106	111	121	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
112	120	124	130	130	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
102	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
127	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

An interesting feature of the data of earlier authors (Berg, 1949; Bizjajev, 1952; Hrbáček et al., 1953; Hruška and Oliva, 1953; Čihař, 1961; Hochman, 1966, 1967; Horoszewicz, 1971; Balon, 1966; Sedlár and Geczö, 1973) is that they did not take the correction factor into consideration. Bizjajev (1952) using straightline relationship of direct proportionality formula between vertebral radius and fish length compared the calculated lengths of 600 specimens of *S. glanis* with the empirical lengths of 739 specimens and found a fair agreement between the two. He also found identical rate of growth in both sexes in the first four years. In the later years the rate of growth varies.

It may be stated here that Černý (1974), Chitravadivelu (1974), Frank (1974) and Pivnička (1974) have used the correction factor in the African catfishes studied by them from the Lake Kariba.

According to Hochman (1967) the harvestable size of *S. glanis* in the Orlik and Slapy localities appears to be more than 100 cm but less than 110 cm at the age of 9 years. According to our observations it comes to be 116 cm (with correction factor) or 129 cm (without correction factor) at the age of 12 or 14 years.

The specific rate of linear growth has been compared with the data of Bizjajev (1952), Hochman (1966) and Sedlár and Geczö (1973) and has been found to be greatly different between l_2 and l_1 (Table 3). This is because these authors did not use the correction factor. Looking at the length of 245 cm in 25 years from the river Don, USSR (Bizjajev, 1952) it appears that *S. glanis* grows very fast, but in fact the specific rate of linear growth is quite the opposite, except between l_2 and l_1 , when compared with our data. Our own data, calculated without the use of correction factor, shows that the specific rate of linear growth is high between l_2 and l_1 . This shows that it is influenced by avoiding the correction factor. However,

Table 3. Comparison of specific rate of linear growth of *S. glanis* from various localities, calculated using the data of earlier authors along with ours

Authors/localities	l ₁	l ₂	l ₃	l ₄	l ₅	l ₆	l ₇	l ₈	l ₉	l ₁₀	l ₁₁	l ₁₂	l ₁₃	l ₁₄	l ₁₅
Bizjajev, 1952: USSR	139.1	38.4	19.7	16.5	11.3	8.5	7.0	6.5	5.4	6.5	4.2	4.7	3.9	3.7	1.5
Hochman, 1966: Bohemia	92.3	56.0	35.9	20.7	17.2	13.3	9.4	8.6	7.9	5.5	6.0	4.9	3.9	4.5	3.6
Sedlár and Geozó, 1973: Slovakia	118.2	50.0	30.6	17.0	14.5	11.1	8.6	6.6	7.4	9.2	4.2	7.1	4.7	9.0	—
Authors, 1976: Bohemia + Moravia	100.0	70.0	38.2	25.5	16.9	14.5	10.1	9.2	7.4	6.9	6.4	6.0	4.9	5.4	3.7
*)	83.3	63.6	33.3	25.0	18.3	12.7	10.0	9.1	7.3	6.8	6.4	5.1	4.9	5.4	4.4
*) With correction factor.															
Authors/localities	l ₁₆	l ₁₇	l ₁₈	l ₁₉	l ₂₀	l ₂₁	l ₂₂	l ₂₃	l ₂₄	l ₂₅	l ₂₆	l ₂₇	l ₂₈	l ₂₉	l ₃₀
Bizjajev, 1952: USSR	5.6	1.9	1.9	5.1	1.3	1.3	1.3	2.5	1.2	—	—	—	—	—	—
Hochman, 1966: Bohemia	4.2	3.3	3.2	3.1	3.0	—	—	—	—	—	—	—	—	—	—
Sedlár and Geozó, 1973: Slovakia	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Authors, 1976: Bohemia + Moravia	5.7	5.4	3.8	4.9	2.3	1.7	3.4	5.4	2.1	3.5	3.9	1.4	3.7	0.9	—
*)	4.9	5.4	3.8	4.9	2.3	1.7	3.4	5.9	2.1	3.0	4.4	0.9	3.7	0.9	—

it may be stated that "Rosa Lee's phenomenon" could not be observed in the older age groups. Similarly the calculation of weights, based upon the back-calculated lengths, shows difference only in the early age groups but are almost the same in later years of life. Therefore, comparing the results, we feel that the correction factor for back-calculating lengths from vertebrae in sheatfish can be omitted.

Hochman and Krčál (1957) reported from Southern Moravia an average length of 181 mm and average weight of 58.2 gm in the first year of life, and length of 380—600 mm and weight of 350—1340 gm in the second year of life of *S. glanis* from a pond.

Mihálik (1957) writes that in one of the ponds in Moravia at the end of first summer of life *S. glanis* had an average size of 14 cm and weight of 12—15 gm. Earlier Unger (1933) reported from Hungary that *S. glanis* in the first year of life ranged from 20—30 cm and weighed 50—100 gm. According to our calculations, based on the empirical formula, the weight of one year old fish varies from 2—5 gms and the length 10—12 cm. Such variations in the length and weight can be attributed only to the complex ecological and physiological factors.

Acknowledgements

We are indebted to Dr. Jan Porkert who furnished us with most of the material for present study. For kind cooperation we are grateful to many anglers, who very kindly gave all the relevant data regarding their trophies. The senior author (Dr. K. K Tandon) is also thankful to UNESCO and to Prof. G. P. Sharma, Head of the Department of Zoology, Panjab University, Chandigarh (India), for enabling him to carry out this work in Prague.

SUMMARY

Vertebrae of 48 specimens of *Silurus glanis* were studied for the age and growth.

The specimens were the prized trophies of the anglers.

The sample was collected from 1950 to 1975.

The fish has a life span of more than 30 years.

The optimal harvestable size has been found to be about 116 cm.

The length-weight relationship shows that the fish grows more than the cube of its length.

The use of correction factor does not influence the back-calculated lengths and weights in fish more than 100 cm in length.

The "Rosa Lee's phenomenon" has not been noticed in the older age groups.

The results have been compared with the published data and have been found to be in general agreement.

The method of studying age and growth from vertebrae appears to be quite sound.

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**MORPHOLOGY OF THE POST-EMBRYONAL STAGES OF LIACARUS CORACINUS
(ACARINA: ORIBATEI, LIACARIDAE)**

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Abstract: A morphological description and drawings of the developmental stages of *Liacarus coracinus* (C. L. Koch, 1841) (Oribatei, Liacaridae) from larva to the adult stage, including leg-chaetotaxy. Description of scaps. Established differences between gnathosoma of the immature stages and the adult.

INTRODUCTION

During the past few years I was doing experiments with laboratory culture of the Oribatei, family *Liacaridae*, in order to establish their biology, their need of food, their environment, and also the morphology of their immature stages. The present work is concentrated on the description of the developmental stages of the species *Liacarus coracinus*. Although the morphology of the adult stage of this species is already known, I am indicating — for the confrontation of morphological characteristics of the immature stages, also these characteristics of adult form.

Biological data will be treated in the following article.

MATERIAL AND METHODS

The examined larvae, nymphs and adult mites were all from the laboratory culture. The initial material — adult individuals of *L. coracinus* were picked up from the forest humus (*Picea excelsa*, *Carpinus betulus*, *Acer* sp., *Populus tremula*, *Corylus avellana*) in Vrané n. Vltavou, about 20 km South of Prague.

Preservation and treatment of the objects for examination under the optic microscope and drawing was done according to the methods described by Grandjean (1949), Balogh (1959) et al. For the examination and drawing of the adult stage were used newly born individuals, before pigmentation. When it was necessary to use older adults, I made their depigmentation, in cold peroxide, to avoid the formation of bubbles inside the body and pushing out of the interior organs through the genital and anal openings. For a detailed examination of particular organs some objects were mechanically dismembered. The designation of setae and organs in the drawings and in the text is according to Grandjean (various works cited) and Trávě (1961).

DESCRIPTION OF DEVELOPMENTAL STAGES

Larva (Fig. 1—4)

is after hatching almost glass-transparent, with a shiny, smooth integument, although it has fine transversal wrinkles on notogaster. Later on its pigmentation becomes mat-whitish up to amber-yellow. The pigmentation of the whole body is almost the same with the exception of distal parts of chelicerae

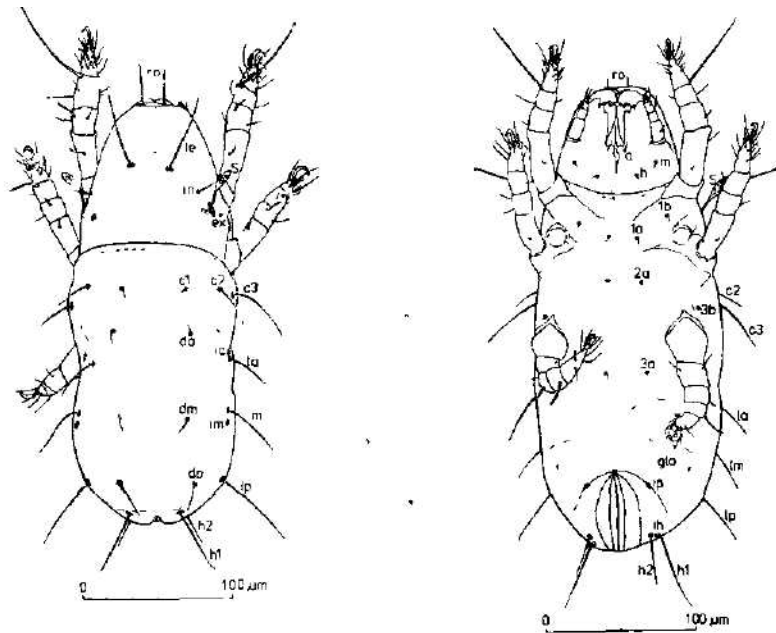


Fig. 1-2 Larva of *Liacarus coracinus*. 1 - dorsal aspect, 2 - ventral aspect.

and rutellae which are on their distal tips very sclerotised, and already before hatching are dark-brown even black-brown. The remainder of gnathosoma, epimeres, legs and prodorsum are slightly sclerotised. Their cuticle has a very finely granulated surface. The integument of hysterosoma is very thin, easily deformable and not sclerotised. Its transversal wrinkles make possible the growing in the period before the molting. The wrinkles are successively disappearing and in the molting period the surface of the hysterosoma is smooth and stretched. The body is not covered by cerotegument.

The size of the body of larvae and their organs is shown in Table 1. The indicated dimensions are the smallest and the largest from a selection of 30 individuals. The great diversity of size may have several causes — quality of food, living environment and genetic factors. The difference of size is also caused by different age of larvae. The length of the body was measured from the anterior point of rostrum to the end of hysterosoma (the extension of chelicerae can be very variable). Tarsus of legs was measured without ambulacrum and claw. Pedipalps are usually bent archwise upward and the indicated length is the connecting link of their final points, because the bending is generally constant. The length of the Claparède's organ was measured from outside, from the furrow between legs I and II.

The shape of the body is almost bag-like and corresponds to the covering of the deutovum. Gnathosoma is directed forward. Around the circumcapitular suture the chelicerae are grown into the rostral tectum in the line *en* (Fig. 21) by an elastic membrane which enables their sliding back and forward while they are taking food. On the bottom the circumcapitular suture forms the boundary between the mentum of infracapitulum and the 1st epimere of the proventer. On the hips it is receding backward and is breaking (bowing) in an obtuse angle near the acetabula of leg I.

Table 1. Comparison of sizes in developmental stages of *Liaccarus coracinus* (μm)

Organs measured	Larva	Protonymph	Deutonymph	Tritonymph	Adult
The body: length	188-317	286-405	400-517	594-885	650-935
The body: width	99-125	135-143	208-242	275-319	363-583
The body: height	104-113	151-182	208-232	307-429	308-484
Prodorsum: length	68-82	89-130	156-161	185-189	132-209
Tarsus I.: Length without ambulatorium	36-39	29-39	42-47	52-57	55-80
Chelicera: length	83-94	108-120	114-154	121-192	143-218
Pedipalp: length	48-60	60-53	56-60	62-63	75-110
Width between rostral setae	13-14	17-34	39-40	36-42	48-65
Width between lamellar setae	28-29	37-41	50-55	52-59	40-50
Width between inter-lamellar setae	70-72	89-94	120-131	132-156	99-132
Width between sensilli	76-81	99-112	144-152	161-195	208-275
Diameter of the bothridiae	10-13	13-16	17-19	19-21	21-34
Sensillus: Diameter of its "head"	6-7.8	6.5-8	7-9	7-9	8-10.5
Sensillus: Diameter of its stalk	1.2-1.5	1.8-2.1	2.1-2.5	2.1-2.6	3-4.1
Genital plates: length	-	39-41	52-55	55-93	78-93
Genital plates: width	-	16-23	26-29	31-46	80-110
Anal plates: length	65-80	73-76	104-105	140-161	121-160
Anal plates: width	23-27	29-42	40-47	47-57	115-154
Claparède's organ: diameter	14-18	-	-	-	-
Claparède's organ: length	5-8	-	-	-	-

Chelicerae

are functionally and morphologically identical in all developmental stages (Fig. 21). The non-movable part carries seta *cha* almost dorsally, slightly paraxially, and seta *chb* laterally at the anti-axial side. Both setae are barbed, *cha* is longer and stronger and reaches almost to the distal point of the chelicera. Trägårdh's organ at the paraxial side is of usual form. On the same side of the chelicera, not far under the implantation of the seta *cha*, is an apophyse carrying a spinelike point. Bäumlér (1970) calls a similar point on *Hermannia gibba* a fissure, and designates it *f*. I used the same designation for this growth of unknown function. Marshall and Reeves (1970) found eight growths of the same shape and on the same place on *Trichthonius majestus*.

Very sclerotised are distal parts of chelicerae around biting facets with 3 teeth. They are black-brown. The adjacent part is of light-brown colour which changes in the following region in a yellowish colour, because it is much less sclerotised. Proximal region behind the suture, which Grandjean (1954a) marked *en*, is not sclerotised. Suture *en* passing through the point *b* on the dorsal wall, behind which the chelicera stands a little up, forms at the same time a boundary behind which is the proximal part of chelicera grown to the proterosoma by an elastic membrane. This membrane forms on the

chelicerae a kind of fold, so that they may slide forward. During the metamorphosis into a higher stage, the cuticle of *chelicera* cracks on the suture *en* to the points *a* and *c*, which are the most distant points of the interior cuticular ribs.

Pedipalps

(Fig. 22) are five-segmented, ambulacrum is missing. Trochanter does not carry any setae, femur has seta *l'*, genu seta *d*, tibia setae *d*, *l'*, *l''*. Tarsus has three non-pair setae *cm*, *acm*, *sul* and six pair-setae (*ul*), (*ll*), (*vt*), and a unique solenidion ω , which is from the top very close to the tarsus, but it is not fusing with the seta *acm* in a 'corne double'. Anteroculminal seta is sitting on a low apophyse and is slightly directed antiaxially. Urtimal setae are eupathidia, they are short, conic. True setae are whip-like, glabrous and short, with the exception of the dorsal setae and anteroculminal seta, which are long. Larval chaetotaxy of pedipalps is (0-1-1-3-9). On the superior wall of the proximal part of tarsus of the pedipalp is developed a lyrifissure, the same as on *leg-tarsi*.

Infracapitulum

(Fig. 23) is *anarthric*, identical in all immature stages. Rutellum is *atelebasic*. It has three teeth of the same structure as the dental plates of *chelicerae*. On the inner side of the rutellum, at the place of the suture between the 2nd and 3rd tooth, exists, from above, a crest of short, strong spines, bent in a bow toward the centre of the little saddle, which is reaching, from above, to the half height of the rutellum. This porous saddle forms at the same time, by its front side, the boundary between the rutellum and *genae*. The function of the little crest is to push and hold the food scratched by the rutellum and cut by *chelicerae*. Setae *a*, *m*, *h* are glabrous, pointed at tip and quite long. On the lateral lips there are 2 pairs of barbed, bent upward oral setae *or1*, *or2*. Labrum is triangular, with rounded point. Mentotectum has a form of a narrow crescent and is not divided.

Proterosoma

is relatively large, occupying more than 1/3 of the length of the body. It has a shape of a blunt cone. It is separated from the hysterosoma by a well developed dorsosejugal suture. Hysterosoma is passing over it from above by a pleat forming a fold. During the growing period this fold is progressively leveled. On the hips the developed sejugal suture can disappear because of a larger circumference of the body. Ventrally it fuses with the sejugal apodema.

Rostrum is completely indiscernible, on the contrary, the anterior edge of the prodorsum between rostral setae may even recede a little backward (Fig. 1). On the sides of prodorsum are transparent cuticular ribs which Grandjean (1954b) marked *nl* (nervure latérale apodématique).

Rostral setae, as well as lamellar and translamellar setae, are whip-like, weakly barbed, pointed at tip. The longest are the lamellar setae, rostral setae are 1/3 shorter than the lamellar setae, and the interlamellar setae are only half as long as the rostral setae. Exobothridial setae are very short. Cup-like bothridia are sunk under the surface of the cuirass of the body. Their opening is bordered by an almost cuticular ringlet. Sensillus is clavate-

-shaped and is covered, except the stalk, by fine spines. It passes through a cup-like cavity of the bothridium and is anchored under it by a few thick-set curved spirals of the stalk.

Notogaster

is not discernible from the ventral plate, because the circumarthrodial membrane of the future fissure of the scalp are not even indicated. Hysterosomal bag is entire, with fine transversal wrinkles. By younger larvae is sometimes visible, from the dorsal or ventral aspect, the boundary of segment *C* and *D*, and a more distinct suture between the segment *D* and *E*.

Chaetotaxy of the notogaster and of the genito-anal region of the ventral plate is indicated in Table 2. Here all setae are glabrous, whip-like, pointed at tip. Their implantation, mutual position, length and shape are seen in Fig. 1-3. No seta is vestigial. They are growing from round pores. The longest are *h1*, directed backward, obliquely upward and sideways. They have obviously a tactile function. Only a little shorter are setae *lp*, which should inform the animal about the conditions of environment on the sides and in the back. From the dorsal or ventral aspect is obvious a tendency to

Table 2. Chaetotaxy of the hysterosoma of the developmental stages of *Liaccarus coracinus*

Part of hysterosoma	Designation of seta	Larva	Proto-nymph	Deuto-nymph	Trito-nymph	Adult
Notogaster	c1 coronal	c1	c1	c1	c1	c1
	c2 coronal	c2	c2	c2	c2	c2
	c3 humeral	c3	c3	c3	c3	—
	da dorsal anterior	da	—	—	—	—
	dm dorsal medial	dm	—	—	—	—
	dp dorsal posterior	dp	—	—	—	—
	la lateral anterior	la	la	la	la	la
	lm lateral medial	lm	lm	lm	lm	lm
	lp lateral posterior	lp	lp	lp	lp	lp
	h1 terminal	h1	h1	h1	h1	h1
	h2 terminal	h2	h2	h2	h2	h2
	h3 terminal	—	h3	h3	h3	h3
	ps1 protonymphal	—	ps1	ps1	ps1	ps1
	ps2 protonymphal	—	ps2	ps2	ps2	ps2
ps3 protonymphal	—	ps3	ps3	ps3	ps3	
Genito — — anal region	ad1 adanal	—	—	ad1	ad1	ad1
	ad2 adanal	—	—	ad2	ad2	ad2
	ad3 adanal	—	—	ad3	ad3	ad3
	an1 anal	—	—	—	an1	an1
	an2 anal	—	—	—	an2	an2
	g1 genital	—	g1	g1	g1	g1
	g2 genital	—	—	g2	g2	g2
	g3 genital	—	—	g3	g3	g3
	g4 genital	—	—	—	g4	g4
	g5 genital	—	—	—	g5	g5
g6 genital	—	—	—	—	g6	
ag aggenital	—	—	ag	ag	ag	

reach by these setae also the back corners of the narrow passage in which the animal is living, as well as to reach the front corners of the passage by the solenidions φ of legs I. The remaining setae of notogaster have a similar function in examining the walls of the narrow passage and are inclined obliquely backward, not to hinder the movement forward. Dorsal setae of notogaster are developed (larvae are integridosal). Not developed is the seta which should have the implantation under the seta *la*, about at the same distance from it, as the distance between setae *da* and *la*. This seta on the segment *D* is probably *D3*, as it was marked by Grandjean (1934b). Equally the seta *h3* is not developed; consequently, larva is bideficient.

Cupules *ia*, *im*, *ip*, *ih* are developed and normally situated. They have also the usual form of funnel-shaped cups inserted into the tegument. Cupulus *ip* is laying on the ventral plate.

Ventral plate

is fusing with the notogaster. It is possible to divide it, by the apodema 3, in epimeral region and genito-anal region. Apodemes are relatively short and weak, they do not merge in the middle with those laying in the opposite direction. Acetabula have a similar structure. To the apodema are attached strong leg muscles, visible on newly hatched individuals, which were not left too long in the lactic acid, so that the muscles were not dissolved. They are diverging from the paraxial edges of the apodema and are filling the space under the epimeres, similar to thick bundles entering into the trochanters of legs. Epimeral formula is (2-1-2), the designation in Table 3. Epimeral setae are relatively short, fine, directed downward or partially backward and sideways. Their insertional pores are smaller than those of the notogastral setae. The insertion is not always regular, sometimes the setae may be inserted outside of the level of symmetry, especially forward or backward from the next pair-seta. Claparède's organ is short-cylindrical, terminally oval. Its size is indicated in Table 1.

Table 3. Chaetotaxy of the epimeral region of the developmental stages of *Liacarus coracinus*

Epimere	Larva	Protonymph	Deutonymph	Tritonymph	Adult
1	1a	1a	1a	1a	1a
	1b	1b	1b	1b	1b
	—	1c	1c	1c	1c
2	2a	2a	2a	2a	2a
3	3a	3a	3a	3a	3a
	3b	3b	3b	3b	3b
	—	—	—	3c	3c
4	—	4a	4a	4a	4a
	—	—	4b	4b	4b
	—	—	—	4c	4c

Table 4. Formulas of the leg-chaetotaxy of the developmental stages of *Liacarus coracinus*. (Without solenidions and famulus).

Leg	Larva	Protonymph	Deutonymph	Tritonymph	Adult
I	0-2-2-3-15-1	0-2-2-3-15-1	0-2-2-3-15-1	1-4-3-4-17-1	1-5-3-4-19-3
II	0-2-2-2-13-1	0-2-2-2-13-1	0-2-2-2-13-1	1-4-2-3-16-1	1-4-2-3-15-3
III	0-2-1-1-13-1	0-2-1-1-13-1	1-2-1-1-13-1	2-3-1-3-15-1	2-3-1-3-15-3
IV	—	0-0-0-0-7-1	0-2-1-1-12-1	1-2-2-3-12-1	1-2-2-3-12-3

Table 5. Leg chaetotaxy of the developmental stages of *Liacarus coracinus*. Notations of solenidions, famulus, eupathidia and true setae

Leg	Segment	Larva	Protonymph
I	Trochanter	—	—
	Femur	d, v ^o	d, v ^o
	Genu	σ, l', l ^o	σ, l', l ^o
	Tibia	φl, l', l ^o , v'	φl, l', l ^o , v'
	Tarsus	ωl, τ, p', p ^o , tc', tc ^o , ft', ft ^o , u', u ^o , s, a', a ^o , pv', pv ^o , pl', pl ^o	ωl, ω2, τ, p', p ^o , tc', tc ^o , ft', ft ^o , u', u ^o , s, a', a ^o , pv', pv ^o , pl', pl ^o
II	Trochanter	—	—
	Femur	d v ^o	d v ^o
	Genu	σ l' l ^o	σ l' l ^o
	Tibia	φ l' v'	φ l' v'
	Tarsus	ωl p' p ^o tc' tc ^o ft' ft ^o u' u ^o s a' a ^o pv' pv ^o	ωl p' p ^o tc' tc ^o ft' ft ^o u' u ^o s a' a ^o pv' pv ^o
III	Trochanter	—	—
	Femur	d v'	d v'
	Genu	σ l'	σ l'
	Tibia	φ v ^o	φ v ^o
	Tarsus	p' p ^o tc' tc ^o ft' ft ^o u' u ^o s a' a ^o pv' pv ^o	p' p ^o tc' tc ^o ft' ft ^o u' u ^o s a' a ^o pv' pv ^o
IV	Trochanter	—	—
	Femur	—	—
	Genu	—	—
	Tibia	—	—
	Tarsus	—	p' p ^o ft ^o u' u ^o pv', pv ^o

Leg solenidions of larva are arranged normally, i.e. according to the formula (1-1-1) (1-1-1) (1-1-0). They are generally long-cylindrical, blunt at tip, sabre-like, bent backward and outside. Solenidion φ on tibia I is whip-like, extended into a pointed tip, with regard to its tactile function. It is implanted on a well noticeable apophyse. Tarsal solenidion ω has no apophyse, it is growing directly from the cuticle. Genual solenidion σ has above the joint a low ridge. Famulus is short-cylindrical, blunt at tip, sabre-like and bent backwards. Its junction into the cuticle is analogous with the junction of the solenidion ω . Eupathidia are only proral setae, the remaining are true setae. Tarsal formula of larva is (15-13-13). True setae are whip-like, sharply pointed and glabrous, except the unguinal setae on tarsus I, subunguinal seta and primiventral setae on tarsus III, which are thorn-like on the bottom.

Deutonymph	Tritonymph	Adult
<p>—</p> <p>d, v[*]</p> <p>σ, l', l[*]</p> <p>φ1, φ2, l', l[*], v[*]</p> <p>ω1, ω2, ε, p', p[*], te', te[*], ft', ft[*], u', u[*], s, a', a[*], pv', pv[*], pl', pl[*]</p>	<p>l'</p> <p>d, l', l[*], v[*]</p> <p>σ, l', l[*], v[*]</p> <p>φ1, φ2, l', l[*], v[*], v[*]</p> <p>ω1, ω2, ε, p', p[*], it', it[*], te', te[*], ft', ft[*], u', u[*], s, a', a[*], pv', pv[*], pl', pl[*]</p>	<p>l'</p> <p>d, l', l[*], v[*], v[*]</p> <p>σ, l', l[*], v[*]</p> <p>φ1, φ2, l', v[*], l[*], v[*]</p> <p>ω1, ω2, ε, p', p[*], it', it[*], te', te[*], ft', ft[*], u', u[*], s, a', a[*], pv', pv[*], pl', pl[*], A', A[*]</p>
<p>—</p> <p>d, v[*]</p> <p>σ, l', l[*]</p> <p>φ, l', v[*]</p> <p>ω1, ω2, p', p[*], te', te[*], ft', ft[*], u', u[*], s, a', a[*], pv', pv[*]</p>	<p>l'</p> <p>d, l', l[*], v[*]</p> <p>σ, l', l[*]</p> <p>φ, l', l[*], v[*]</p> <p>ω1, ω2, p', p[*], it', it[*], te', te[*], ft', ft[*], u', u[*], s, a', a[*], pv', pv[*]</p>	<p>l'</p> <p>d, l', l[*], v[*]</p> <p>σ, l', l[*]</p> <p>φ, l', l[*], v[*]</p> <p>ω1, ω2, p', p[*], it', it[*], te', te[*], ft', ft[*], u', u[*], s, a', a[*], pv', pv[*]</p>
<p>l''</p> <p>d, v[*]</p> <p>σ, l'</p> <p>φ, v[*], v[*]</p> <p>p', p[*], te', te[*], ft', ft[*], u', u[*], s, a', a[*], pv', pv[*]</p>	<p>l'', v''</p> <p>d, l', v</p> <p>σ, l'</p> <p>φ, l', v[*], v[*]</p> <p>p', p[*], it', it[*], te', te[*], ft', ft[*], u', u[*], s, a', a[*], pv', pv[*]</p>	<p>l'', v'',</p> <p>d, l', v[*]</p> <p>σ, l'</p> <p>φ, l', v[*], v[*]</p> <p>p', p[*], it', it[*], te', te[*], ft', ft[*], u', u[*], s, a', a[*], pv', pv[*]</p>
<p>—</p> <p>d, v[*]</p> <p>d</p> <p>φ, v[*]</p> <p>p', p[*], te', te[*], ft', ft[*], u', u[*], s, a', a[*], pv', pv[*]</p>	<p>v''</p> <p>d, v[*],</p> <p>d, l'</p> <p>φ, v[*], v[*]</p> <p>p', p[*], te', te[*], ft', ft[*], u', u[*], s, a', a[*], pv', pv[*]</p>	<p>v''</p> <p>d, v[*]</p> <p>d, l'</p> <p>φ, l', v[*], v[*]</p> <p>p', p[*], te', te[*], ft', ft[*], u', u[*], s, a', a[*], pv', pv[*]</p>

Protonymph (Fig. 5-8)

resembles a larva. For the dimensions of the body see Table 1. 15 individuals were measured. Contrary to the larva there are occurring some changes. On the femur of the pedipalp appears an additional seta v'' , so that the formula of pedipalp chaetotaxy, except solenidion ω , is (0-2-1-3-9).

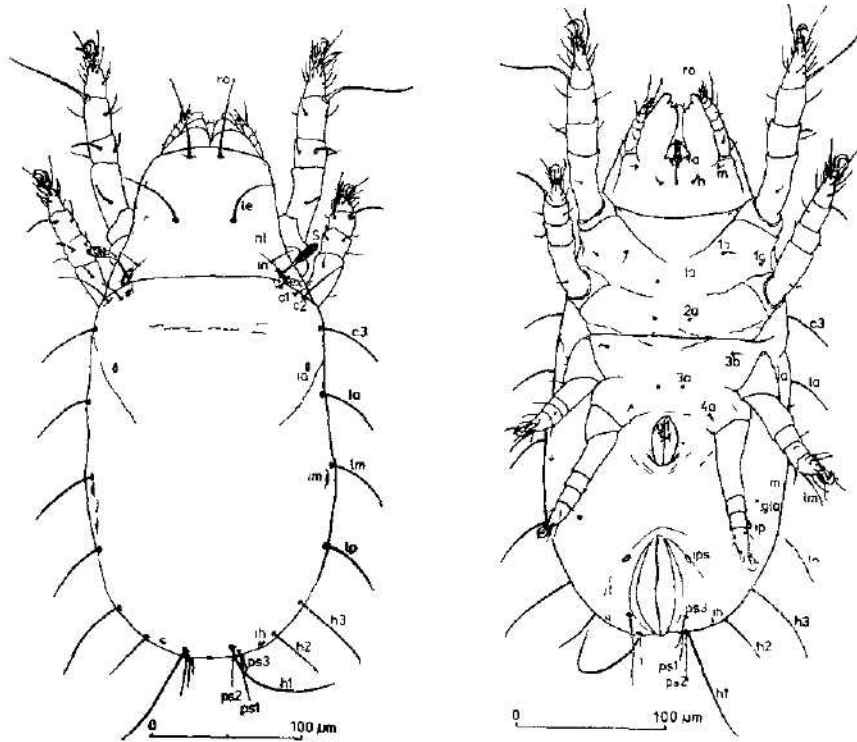


Fig. 5-6 Protonymph of *Lucares coracinus* 5 - dorsal aspect, 6 - ventral aspect.

Proterosoma is relatively shorter, occupies less than 1/3 length of the body, rostrum is not receding backward, but starts a formation of a slightly developed naso. Between the implantations of rostral setae is appearing, inside of rostral tectum, a small ovoidal almost pear-like organ of unknown function and remains also in the following immature stages. It is probably the basis of the translamellar tooth of the adult stage. Rostral setae are approaching the length of the lamellar setae, while the interlamellar setae remain short.

On the notogaster disappear the dorsal setae da , dm , dp (nymphs are dorso-deficient), but at the same time appear protonymphal setae $ps1$, $ps2$, $ps3$ and the terminal seta $h3$, consequently the protonymph is quadrideficient. Seta $h3$ took over the place and tactile function of the larval seta lp on the sides on the end of notogaster.

On the ventral plate appeared a genital opening with one pair of genital setae *g1*. Under the genital valves is transparent a pair of genital disc-suckers. Was added apodema 4 with the 4th epimera. Disappeared Claparède's organ, and near the place it occupied appeared an additional seta *1c* on the epimera 1. On the newly formed epimera 4 appeared the seta *4a*, but not in the paraxial row of setae *1a* — *2a* — *3a*, but antiaxially, between this row of setae and the row of setae *1b* — *3b*. Epimeral formula is (3-1-2-1). Cupules *ip* slid a little forward from the ventral level into the ventrolateral level, and their place near the anterior edge of the anal opening took over the cupules *ips*. In the same manner slid forward the lateral glands.

The 4th pair of the newly formed legs has the usual chaetotaxy. Solenidial formula (1-1-2) (1-1-1) (1-1-0) (0-0-0) is normal. Added was solenidion $\omega 2$ on tarsus I. Tarsal leg formula of the protonymph is (15-13-13-7). Sub-unguinal seta on tarsus III is thorn-like on the bottom, the others are glabrous.

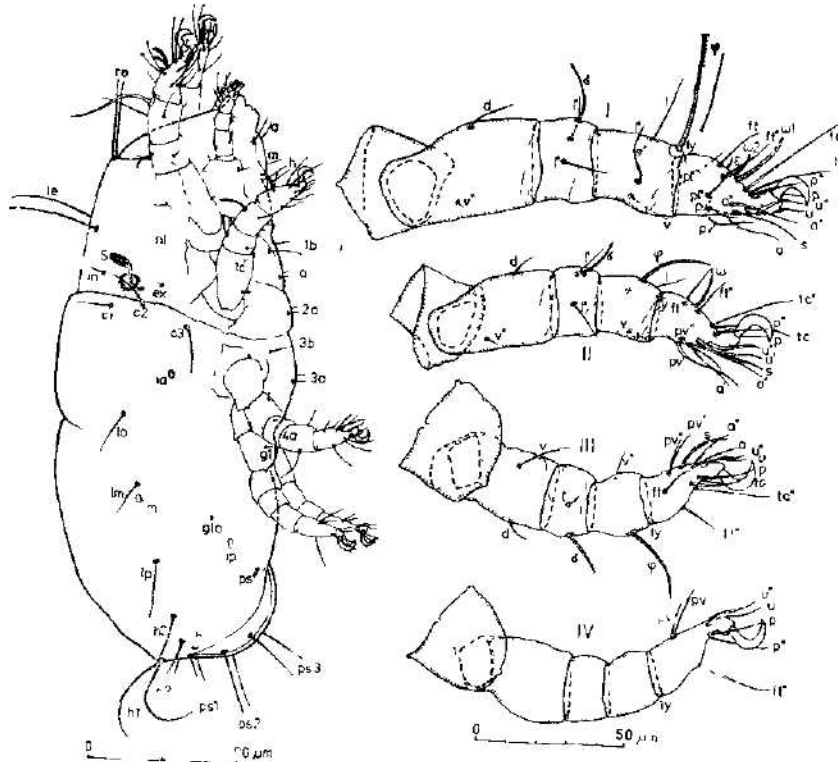


Fig. 7-8. Protonymph of *Liacarus coracinus*. 7 — lateral aspect, 8 — legs I-IV.

Deutonymph (Fig. 9-12)

The total data are a result of measurement of 15 individuals, see Table 1.

Proterosoma is relatively shorter than in the protonymph, rostrum is more noticeable. Rostral setae are as long as the lamellar setae, interlamellar setae remain short.

On the hysterosoma are not perceptible any intersegmental sutures, between segments *D* and *E* is only a saddle-like cavity of the circumference of the body.

On the ventral plate appear new adanal setae *ad1*, *ad2*, *ad3*. Beside the anterior edge of the anal opening appear new cupules *iad*, and cupules *ips* slid in the lateroventral direction. Partially slid forward also the lateral

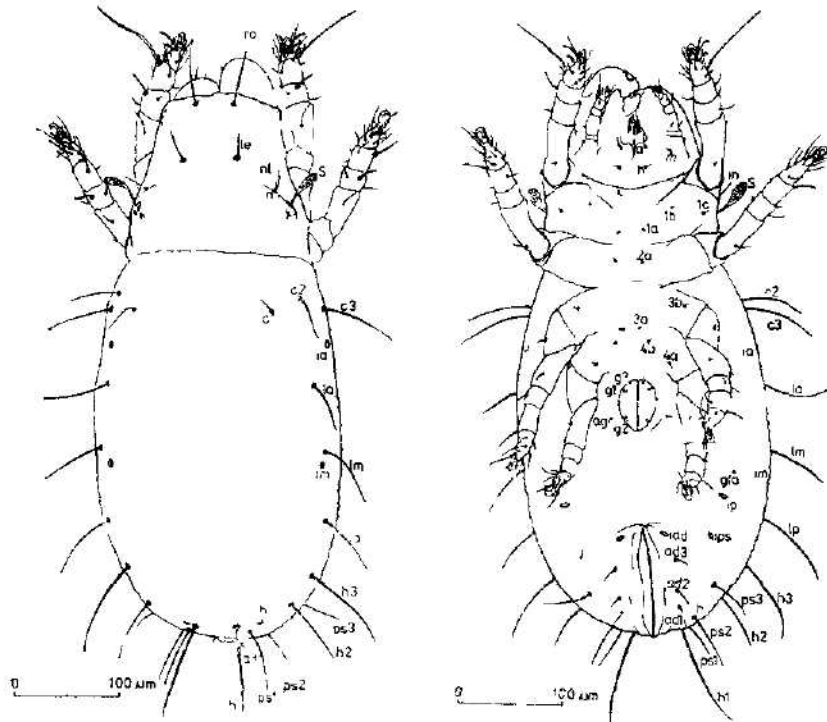


Fig. 9-10. Deutonymph of *Laecarus coracinus*. 9 - dorsal aspect, 10 - ventral aspect.

glands. Genital opening grew larger and on its valves appeared two additional pairs of genital setae *g2* and *g3*. Under the genital valves are transparent two pairs of genital disc-suckers. Beside the genital valves appeared one pair of aggenital setae *ag*, of the same structure and length as the genital setae. On the epimere 4 appeared a new seta *4b* in the row *1a* - *2a* - *3a* - *4b*. These are the shortest epimeral setae. Epimeral formula of deutonymph is (3-1-2-2).

On tibia I is formed additional solenidion $\varphi 2$, on tarsus II solenidion $\omega 2$, on trochanter III seta *l'*, on tibia III seta *v'*. On femur IV appear new setae *d*, and *v'*, on genu *d*, on tibia solenidion φ and seta *v'*. On tarsus IV emerge tectal, antelateral and subunguinal setae (see Table 6) Solenidial formula of the deutonymph is (1-2-2) (1-1-2) (1-1-0) (0-1-0), tarsal formula of legs is (15-13-13-12). Thorn-like on the bottom are primiventral setae on tarsi I and III, subunguinal on tarsi III and IV. Thorn-like on the top is dorsal seta on the femur I, the remaining setae are glabrous.

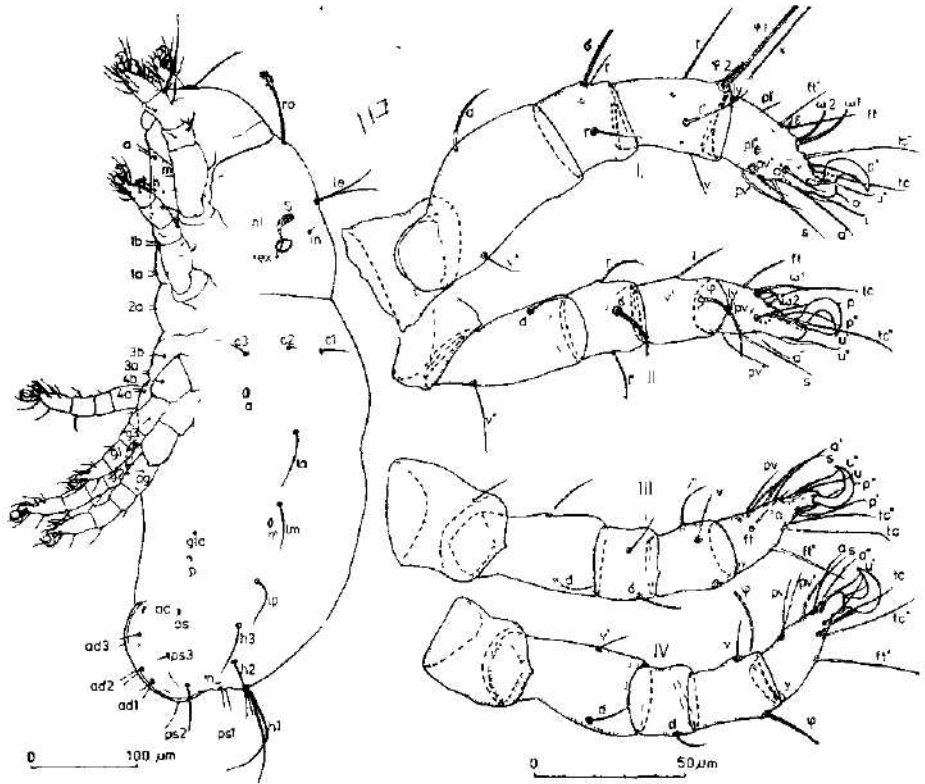


Fig. 11-12. Deutonymph of *Liacarus coracinus*. 11 - lateral aspect, 12 - legs I-IV.

Tritonymph (Fig. 13-16)

Detailed dimensions indicated in table 1 were established by measurements of 15 individuals.

Proterosoma is again relatively shorter, occupies about 1/4 of the length of the body. Rostral setae are only a little longer than lamellar setae, but the interlamellar setae became remarkably longer, reaching 2/3 length of the lamellar setae.

Hysterosoma is dorsoventrally slightly flattened, the boundaries between its segments are not clear. On the anal valves appeared new setae *an1*, *an2*. On the genital valves are added genital setae *g4*, *g5*. Under the enlarged genital opening are transparent three pairs of genital disc-suckers. The genital opening is partially sliding forward and the aggenital setae remain on the level of its posterior edge. On the epimeres 3 and 4 are formed, in the antiaxial row, setae *3c* and *4c*. In this row the setae are shorter than those in the middle row *1b* - *3b* - *4a*, which are the longest of all epimeral setae. Epimeral formula is (3-1-3-3).

On the legs I-IV originate 21 new setae. Their designations on leg segments indicates Table 5 and Table 6, the length, shape and implantation are represented in Fig. 16. On the legs I-III arise iteral setae. Their formula is

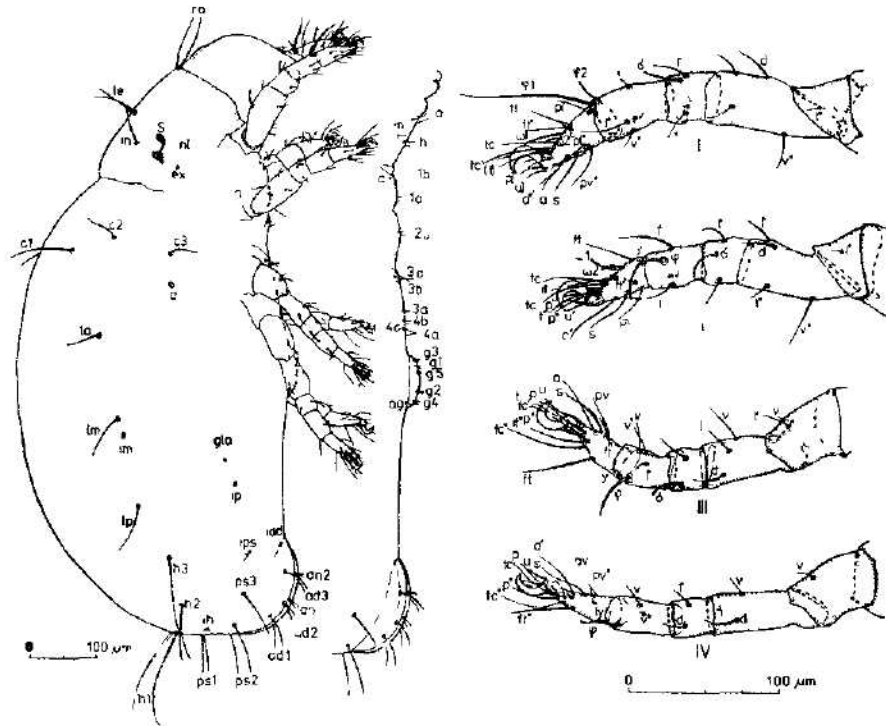


Fig. 15-16. Tritonymph of *Laacarus coracinus*. 15 - lateral aspect, 16 - legs I-IV.

partially surpass the surface of the body. In the back their wall is partially opened, which enables the sensillus to bow backward and thus be protected by the shoulder edge of the notogaster. Sensillus has a spindle form with an elongated point and, except the basis of the stalk, is on the whole surface covered with fine teeth.

Notogaster

is dorsoventrally partially flattened and has a shape of a longitudinal half of an ovoid. Its surface may be completely glabrous and shiny (seldom), but most often it is covered by shallow irregular groves. They are diverging from the dorsosejugal suture sideways and backward, and at the end of the notogaster are fusing again. Shoulder edges are developed, anterior edge of the notogaster has sometimes a slight concave bending. After shedding off the tritonymphal exuvia, the notogaster has, as the whole body, with the exception of distal parts of chelicers and rutells, a pergamen colour, but the surface of the whole body is quickly becoming dark and sclerotised. In older individuals the surface is chest-nut brown, even black-brown.

Notogastral setae are preserved as in the tritonymph, except humeral setae *c3*, which disappear in adult stage. Contrary to the immature stages, notogastral setae are very short and fine, so that by small enlargement or imperfect illumination they escape our notice, and the notogaster seems to be naked. Especially weak and short are the coronal setae *c1* and *c2*, which

even do not reach the notogastral shield. Well discernible and quite well developed are lateral setae. Their insertional pores are larger and the setae are stronger, although they are short also. A little finer are terminal setae. From the row of the protonymphal setae most noticeable are *ps1*, which together with the setae *ad1* strikingly surpass the notogaster, are always quite long and discernible. Setae *ps2* and *ps3* are shorter and only very little surpass the notogaster.

Fissure pores *ia*, *im*, *ip*, *ips* and *ih* are quite well discernible, *iad* is laying on the ventral plate. Contrary to the immature stages the lateral glands lay dorsolaterally in the middle of the notogaster. Their orifices are, as in the immature stages, round with a low ridge.

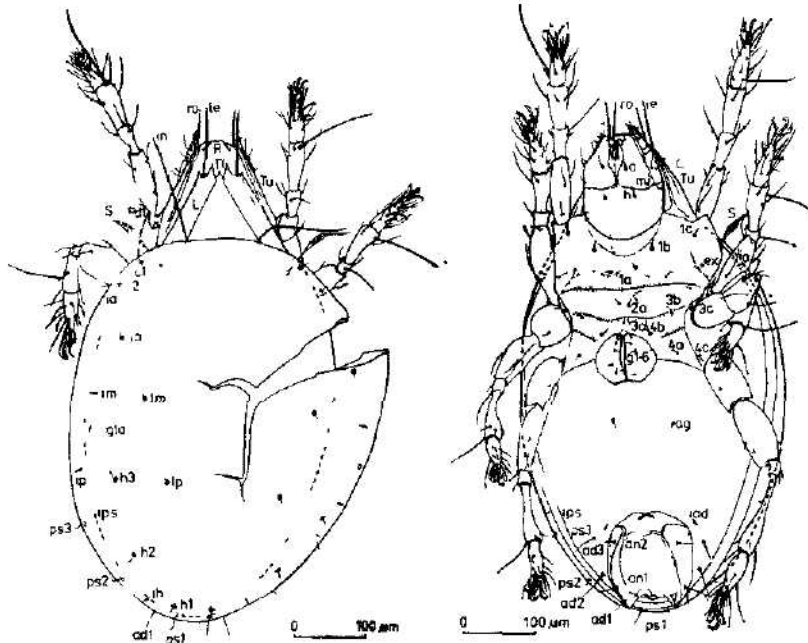


Fig. 17–18. Adult of *Leucarus coracinus*. 17 – dorsal aspect, 18 – ventral aspect.

Epimeral region

has developed a carina circumpedialis on both sides. Epimeres 1 are extended laterally as a basis of pedotectum 1. Epimeral region is, with the exception of the apodema and acetabula of legs, a little less sclerotised than notogaster and its surface is only slightly granulated (it makes an impression of thickly distributed fine pores). The formula of the epimeral setae is the same as in the tritonymph. Their implantation is usually not quite regular, some may be out of the level of symmetry, especially in the anterior – posterior direction. The pores of epimeral setae are smaller than those of notogastral setae.

Genito-anal region

has the surface identical with the epimeral region. On the genital valves are added setae *g6*. The aggenital setae are identical with genital setae. They are

short, fine, glabrous and pointed at tip. Aggenital setae are distant. They are implanted almost in the middle between genital and anal valves. Sliding forward of the genital opening occurs during the metamorphosis of the tritonymph. Chaetotaxy on anal valves and adanal segment is not changed from the tritonymph. Adanal setae are long and strong, *ad1* and sometimes also *ad2* are surpassing the ventral plate from ventral or dorsal aspect. Anal setae are only half as long. Fissure pores *iad* on the level of the anterior edge of the anal opening are directed obliquely. Praeanal clasp is ampoulaceous.

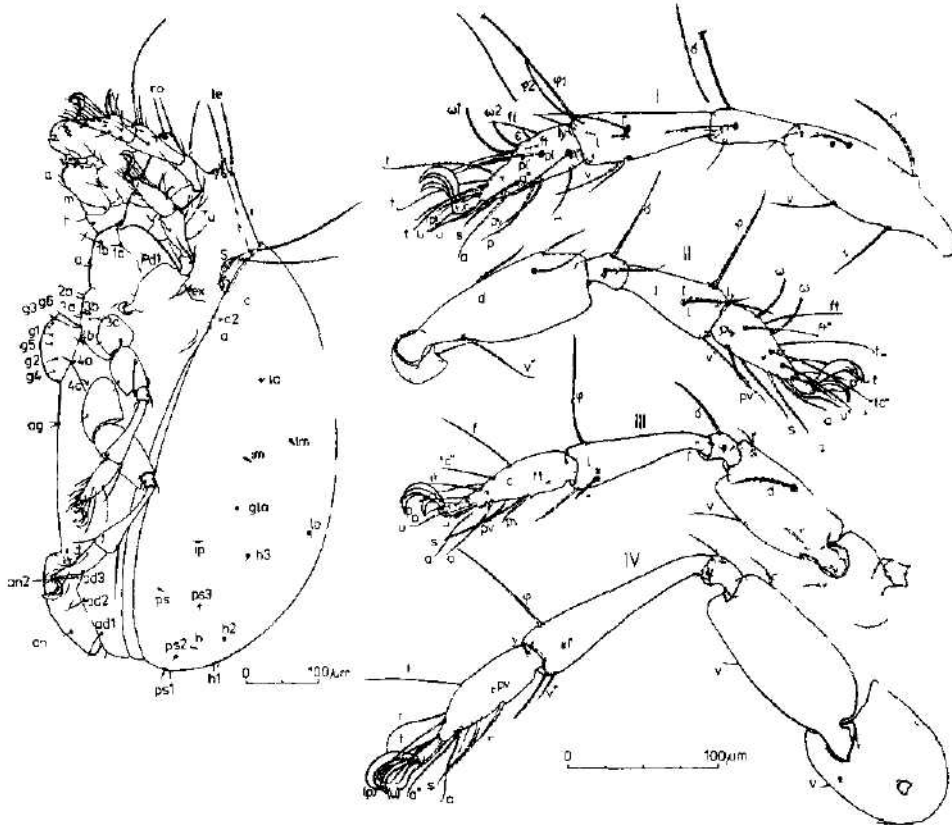


Fig. 19—20. Adult of *Liacarus coracinus* 19— lateral aspect, 20 — legs I—IV.

Legs

Leg-segments of adults are formed for a quick movement and also for a quick folding of legs on the ventral side of the body in case of danger. Ribbon- and panel-shaped growths have a protective function, especially on the trochanters and femurs of legs III and IV, and also strong sclerotisation of the whole appendices, with the surface of the cuticle covered with fine warts. Pigmentation is the same as of the ventral region.

Adults have on the trochanter I an additional seta *v'*, on tarsus I the accessory setae *A'* and *A''*, and on tibia IV seta *l'*. On all the ambulacra are formed 2 smaller side-claws (= heterotridactyl legs) All claws are glabrous.

Subunguinal seta on tarsus I becomes an eupathidium. The remaining setae, except in latter and the proral setae on tarsus I, are true setae. Thorn-like from above are tectal setae I, dorsal setae I—IV, primilateral setae on tibia and genu II, and on femur III. Thorn-like on the bottom are primiventral setae I—IV, accessory setae, antelateral setae II, subunguinal seta II—IV, ventral setae on tibiae I—IV, and on the anti-axial side ventral setae on femurs I and II. Remaining setae are weakly barbed all around. They are whip-like, pointed at tip.

Solenidial formula is the same as in deuto- and trito-nymphs, tarsal formula of legs I is (19-15-15-12).

Table 6. Ontogeny of solenidions, famulus, eupathidia, true setae and claws on the legs of the developmental stages of *Liacarus coracinus*

Leg	Segment	Larva	Protonymph
I	Trochanter		
	Femur	d, v ^o	
	Genu	σ, l', l ^o	
	Tibia	φ1, l', l', v'	
	Tarsus	ω1, ε, p', p ^o , te', te ^o , ft', ft ^o , u', u ^o , s, a', a ^o , pv', pv ^o , pl', pl ^o	ω2
Ambulacrum	1 claw		
II	Trochanter		
	Femur	d, v ^o	
	Genu	σ, l', l ^o	
	Tibia	φ, l', v'	
	Tarsus	ω1, p', p ^o , te', te ^o , ft', ft ^o , u', u ^o , s, a', a ^o , pv', pv ^o	
Ambulacrum	1 claw		
III	Trochanter		
	Femur	d, v'	
	Genu	σ, l'	
	Tibia	φ, v ^o	
	Tarsus	p', p ^o , te', te ^o , ft', ft ^o , u', u ^o , s, a', a ^o , pv', pv ^o	
Ambulacrum	1 claw		
IV	Trochanter		
	Femur		
	Genu	The leg is not developed	
	Tibia		
	Tarsus		
Ambulacrum		p', p ^o , ft ^o , u', u ^o , pv', pv ^o 1 claw	

POSTEMBRYONAL DEVELOPMENT

In the course of ontogeny no loss of body setae occurs, except dorsal setae on notogaster from protonymph, and humeral seta in the adult stage. Development of the body-chaetotaxy is represented in Table 2 and Table 3. The seta, marked by Grandjean (1934b) as *D3* has not developed at all. Seta *h3* is developing only from the protonymph. The development of the remaining body-setae has a normal course. When a seta is developed in any stage, it is preserved in higher stages, with the exception of the above mentioned setae. There is no vestigial seta. The length of the notogastral setae is relatively diminishing in higher stages in relation to the growing diameter of the hysterosoma. In the adult stage this shortening is especially noticeable and

Deutonymph	Tritonymph	Adult
φ2	I, I', I'' v. v'' it', it''	v' A', A'' 2 claws (lateral)
ω2	I' I', I'' I'' it', it''	 2 claws (lateral)
I' v'	v'' I'. I. it', it''	 2 claws (lateral)
d, v'. d φ, v' tc', tc'', s, a', a''	v'' I'. v''	I' 2 claws (lateral)

this is not in co-relation with the aggrandisement of the notogaster, but with the difference of the environment.

A possible sequence of the origin of genital setae during the ontogeny is represented in Table 7. Their numbering, indicated in this Table and in the drawings, is given in relation to the origin and placement on genital valves. I indicate them as possible, because in the deutonymph appear at the same time setae *g2* and *g3*, in the tritonymph setae *g4* and *g5*. It was impossible to determine the priority in these two cases. Genital formula is (1-3-5-6).

Table 7. Possible origin of genital setae of the developmental stages of *Liaccarus coracinus*

Order and designations of setae on the genital valve	Larva	Proto-nymph	Deuto-nymph	Trito-nymph	Adult
<i>g6</i>	—	—	—	—	<i>g6</i>
<i>g3</i>	—	—	<i>g3</i>	<i>g3</i>	<i>g3</i>
<i>g1</i>	—	<i>g1</i>	<i>g1</i>	<i>g1</i>	<i>g1</i>
<i>g5</i>	—	—	—	<i>g5</i>	<i>g5</i>
<i>g2</i>	—	—	<i>g2</i>	<i>g2</i>	<i>g2</i>
<i>g4</i>	—	—	—	<i>g4</i>	<i>g4</i>

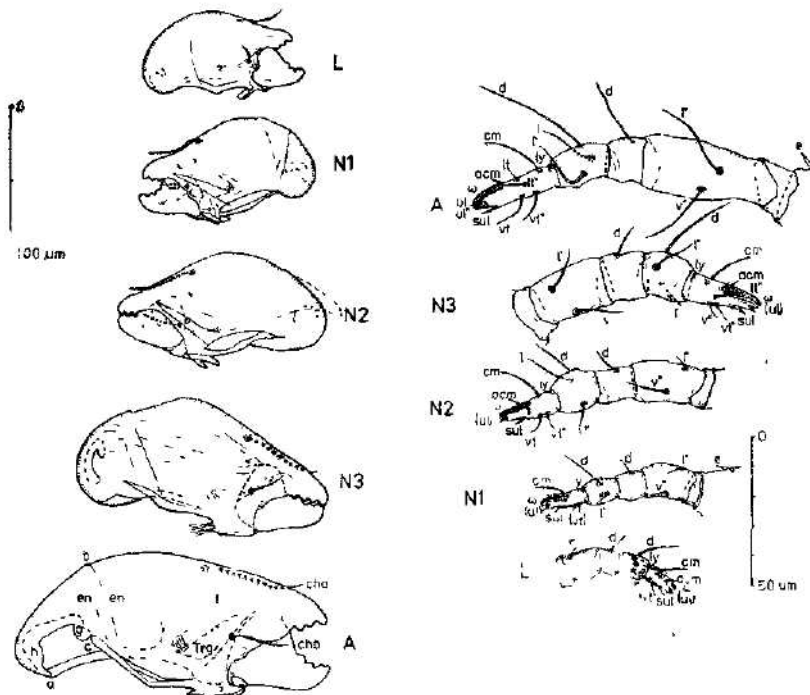


Fig. 21-22. Chelicerae and pedipalps of *Liaccarus coracinus*. L — larval, N1 — protonymphal, N2 — deutonymphal, N3 — tritonymphal, A — adult, 21 — chelicerae, 22 — pedipalps.

DISCUSSION

Morphological data concerning developmental stages of the family *Liacaridae* published: Costesèque and Taberly (1961) about *Xenillus clypeator* Robineau Desvoidy, 1839 and about *Xenillus tegeocranus* (Hermann, 1804); Arlian and Woolley (1960) about *Li acarus cidarus*, Woolley, 1968. Descriptions of the developmental stages of these species are similar to the data I established about *Li acarus coracinus*. According to these data the genera *Li acarus* and *Xenillus* have different epimeral formulae, although the same formulae are valid for many other genera systematically distant. According to the literary data about *L. cidarus* and the data I established about *L. coracinus*, there exist morphological differences between them.

Interlamellar setae in the developmental stages of *L. cidarus* are blunt, while in *L. coracinus* they are pointed at tip. Adult stage of *L. cidarus* has the rostral and lamellar setae blunt, even though they are pointed at tip in immature stages. In *L. coracinus* they are pointed at tip in all developmental stages. In the deuto- and tritonymphal stages lamellar setae of *L. cidarus* are much longer than rostral setae, while in *L. coracinus* they are approximately of the same length. Arlian and Woolley think that lost seta on the notogaster of the adult stage of *L. cidarus* is *c1*. By comparison of the insertion of notogastral setae, exobothridial setae, placement of the bothridia and cupules in all stages of *L. coracinus*, it is obvious, that the lost seta is *c3*. This behaviour of humeral seta *c3* was noted by Grandjean (1933) in *Oribatula exarata* and in the following study (1934) in other higher Oribatids. In the drawings of *L. cidarus* (Arlian and Woolley, 1969) the designation of the terminal and protonymphal setae is reversed. Identical in *L. coracinus* and *L. cidarus* is the probable increase of setae on genital valves. In the same place it is indicated for *L. cidarus* that the deutonymphal stage carries 4 adanal setae, while in following stages it is losing one of them. In *L. coracinus* 3 pairs of adanal setae are always present from deutonymphal up to the adult stage.

A complete comparison of leg-chaetotaxy is not possible, because Arlian and Woolley indicate only the number of setae on segments of leg I and do not distinguish solenidions. Supposing that the solenidions and famulus are included in the number of setae, the number of setae on segments of leg I agrees in both species of the protonymph. In other developmental stages there are differences: Larva of *L. cidarus* has 18 setae on tarsus (*L. coracinus* has 17 setae); deutonymph of *L. cidarus* has 3 setae on femur (*L. coracinus* 2 setae); tritonymph of *L. cidarus* has 5 setae both on femur and genu (*L. coracinus* 4 setae each), and 18 setae on tarsus (*L. coracinus* 20 setae). Adult stage of *L. cidarus* has 5 setae on tibia (*L. coracinus* 6 setae), 18 setae on tarsus (*L. coracinus* 22 setae).

Leg-setae of *L. coracinus* do not disappear during ontogeny, but in *L. cidarus* the adult form loses 1 seta on genu and 1 seta on tibia. The authors consider the disappearance of these setae as probably unique occurrence. Further striking occurrence is the existence of 18 setae on the larval tarsus of *L. cidarus*. The authors indicate that it carries 2 solenidions, and between them there is a shorter famulus. Existence of 2 solenidions on larval tarsus is unusual. In the tritonymph of *L. cidarus* iteral setae are probably not developed, and in the adult accessory setae, if in all developmental stages of *L. cidarus* the 18 tarsal setae remain without any change.

Grandjean (1933) wrote that oral organs are unchangeable from larva to the adult stage. Arlian and Woolley (1969) discovered remarkable differences on the infracapitulum of the immature and adult stages of *L. cidarus*. Their discovery is supporting the data established by myself regarding the infracapitulum of the developmental stages of *L. coracinus*. Immature stages have the anarthric infracapitulum with an atelebasic implantation of the rutella, whereas adults have diarthric infracapitulum with a pantelebasic implantation of the rutella. On the femur of the pedipalpe of *L. coracinus* the seta *v*" from the protonymph is added.

CONCLUSIONS

In the present work post-embryonal developmental stages of *L. coracinus* from the author's culture were described, drawn and measured.

1. In the main characteristics they are identical with other higher Oribatids.

2. Infracapitulum of the immature stages is anarthric with atelebasic implantation of the rutella, in the adults it is diarthric with pantelebasic implantation of the rutella. The larva carries only one seta on the femur of the pedipalp, higher stages carry two setae.

3. From the protonymphal stage globoid or avoid corpuscle exists inside the rostral tectum.

4. The setae of the prodorsum, except the exobothridial setae, are in all developmental stages weakly barbed and pointed at tip. Lamellar setae are twice as long as rostral setae in the larva and adult. In the protonymph up to tritonymph the length of both rostral and lamellar setae is approximately the same. Interlamellar setae are very short in the immature stages (half length of the rostral setae), in the adult they are the longest, twice as long as lamellar setae.

5. The immature stages have a barbed clavate sensillus in a cup-like bothridia inserted below the surface of the body, adult has a spindle-form, finally pointed sensillus implanted in a bothridia partially reaching above the surface of the body.

6. Notogastral formula is (11-12-11). Larva is bifidicent, nymphs are quadrifidicent, adult quinquedeficient. In the immature stages the notogastral setae are long, whip-like, in the adult stage they are very short, indiscernible. On the larva seta *h3* is missing, from the protonymph dorsal setae on notogaster disappear, but at the same time there appear protonymphal setae. In the adult seta *c3* disappears. Mutual position of the insertional pores of the notogastral setae remains unchanged during ontogeny.

7. The lateral glands have, in the immature stages, ventrolateral position, in adult, dorsolateral position. During ontogeny it is relatively diminishing and sliding forward.

8. The epimeral formula is (2-1-2) (3-1-2-1) (3-1-2-2) (3-1-3-3) (3-1-3-3). The implantation of the epimeral setae may be irregular. The shortest setae are in the paraxial row, the longest in the middle row.

9. The genital formula is (1-3-5-6). During the ontogeny the genital opening is sliding forward.

10. The aggenital formula is (0-1-1-1). The aggenital setae are following the genital opening in sliding forward.

11. The ambulacrum of the immature stages is monodactylous, in the adult stage it is heterotridactylous. The solenidions are distributed accord-

ing to the normal formulas. Eupathidia are in the immature stages only the proral setae on tarsus I, in the adult also the subunguinal seta on the same tarsus. The formula of true setae on the tarsus of legs in larva is (15-13-13), in protonymph (15-13-13-7), in deutonymph (15-13-13-12), in tritonymph (17-15-15-12), and in the adult (19-15-15-12). No one leg-seta disappears during the ontogeny when it has once appeared.

12. The exuviae are very fine in the hysterosomal region. The type of breaking is circumgastral — incomplete.

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CONTRIBUTION TO THE CLASSIFICATION OF MICROSPORIDIA

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Abstract: The Phylum Microsporidia is divided into two classes: Metchnikovellidea and Microsporididea. The first contains the genera *Mechnikovella*, *Amphicantha*, *Chytridiopsis* and *Hessea*. The second is divided into 6 families in 2 orders and contains 34 genera. Fam. Pleistophoridae contains the genera *Perezia*, *Tuzetia*, *Glugea*, *Pleistophora* and *Weiseria*. The fam. Thelohaniidae the genera *Telomyza*, *Gurleya*, *Stempellia*, *Duboscqia*, *Trichoduboscqia*, *Pegmatheca*, *Thelohania*, *Inodosporus*, *Cryptosporina*, *Spiroglugea*, *Toxoglugea* and *Vavraia* n.g. The fam. Amblyosporidae contains the genera *Amblyospora*, *Parathelohania*, *Chapmanium* and *Hyalinocysta*. The fam. Culicosporidae n. fam. the genera *Culicospora* n. g., *Hazardia* n. g., *Culicosporella* n. g., *Cougourdella* and *Pyrotheca*. The family Nosematidae contains the genera *Variimorpha*, *Nosema*, *Issia* n. g., *Octospora*, *Caudospora* and *Golbergia* n. g. and the family Mrázekidae contain the genera *Mrázekia* and *Jirovecia* n. g. Major characteristics used in the system are: number of nuclei in spores, synchrony of nuclear divisions, structures of polar filament and polaroplast, sporogonial dimorphism and general spore shape. Type species are assigned.

With the intensive use of electron microscopy in the study of Protozoa older schemes of their taxonomy needed to undergo a revision and reconstruction. This is the case also with the Microsporidia, intracellular parasitic Protozoa with spores containing a single polar filament. This is extruded, everted, in the host body and through its interior channel the germ passes into the host tissues. A group of workers (Tuzet et al., 1971, Sprague, 1970, Ormières and Sprague, 1973) tried to overbridge the gaps appearing in the old system used by Kudo (1924) or Weiser (1971) and proposed new taxonomic conceptions. A recent series of papers by Hazard and associates (Hazard and Anthony, 1974, Hazard and Fukuda, 1974 or Hazard and Oldacre, 1975) interrupted the period of retirement in this activity caused by expectation of the newly proposed taxonomical scheme by Sprague (Sprague and Vávra, 1976). They brought a large amount of new data on ultrastructures of Microsporidia together with proposals of new taxons. This development leads to an inevitable need of a new general concept of the taxonomy of Microsporidia. This effort is far from a final solution. Many data on ultrastructures are based only on limited experience with a group of pathogens and hosts and on limited experience of the development of some ultrastructures such as membranes in sporogony, during the whole duration of the infection or after different infective dosage in different hosts. We wish to propose in this paper a general system of higher taxons of Microsporidia with short definitions as a basis for a discussion at the Int. Congress of Protozoology in 1977. In a further series we will analyse the variability of morphological features inside each family and genus and try to redistribute the species on basis of type materials in different collections.

Kudo (1924) — the same as Sprague (1976) — when preparing his monograph used *bona fide* the definitions of species and genera formulated by previous authors. At that time the number of species known in the different genera was quite limited and their variability was accepted without discussion. For people who needed merely the determination for working purposes and for a differentiation of a limited number of species the definitions were fair without details of formulations. It is typical that the new taxonomic units are usually based in their descriptions on the first studied case — which may be far from the most typical one or may have only a fragment of information on other species which were differentiated later. Today we have for our revision three types of materials:

a) Old verbal descriptions and illustrations which are considering only the symptoms which were valuated at that time. The type materials of the old authors were lost in the meantime.

b) New revisions with some new ideas but based on old descriptions and formulations which considered only some symptoms.

c) New descriptions and proposals based on ultrastructures and newly collected material and difficult to compare with old descriptions. Conditions in old localities (water pollution, eutrophization) are so changed that even requirements of the Rules of Nomenclature do not provide a secure way to establish neotypes.

We will base our considerations on several years of work with Microsporidia, connecting the old authors with the new generation. We have at our disposal a large collection of slides with more than 200 identified species and types and many more materials to be described. We have personal experience with the ecological and experimental appearance of microsporidian infections. Therefore we expect to be able to understand the variability, anomaly in morphology, teratology of infections under abnormal conditions and errors in identification of stages which change the spore sizes.

In normal hosts under ordinary conditions the spores are rather uniform in shape and size and every diversion may be a species — specific symptom. The genus *Stempellia* is characterized by formation of three different sizes of spores.

The spore size is in details rather distinctly influenced by the density or refractivity of the medium. Differences as large as 0.3 to 0.5 μm are rather common. Some variability of spores occurs in cross infections of different hosts. An example of it is *Pleistophora culicis* (Weiser and Coluzzi, 1972). Measurements of spores in watermount are influenced in many descriptions by inclusion of young spores or sporoblasts in the measured series. A further source of variation is the different deformation of spores due to drying on smears or in section preparations. The differences reflect the elasticity and permeability of the spore wall. It is therefore rather difficult to use differences in size in fragments of a micron in differentiation of new species.

The spore shape of fresh spores is rather persistent under identical conditions and so is the ordinary deformation in sections after fixation. Some groups (Amblyosporidae) are characterized by two different spore types in larval and adult hosts.

The morphology and ultrastructure is rather important for the clas-

sification of Microsporidia. Of the surface structure on spores the persistent ones appear during the stage of the pansporoblast and sporoblast in form of crests or ridges or of a surface fleece (Weiser and Žižka, 1975) which all are directly connected with the spore wall. Transient phenomena such as mucose sheaths on their surface are remains of their original plasmodium. They are visualised in India ink and sometime they are not yet formed in fresh preparations, other time they are already dissolved after long lasting watering. Transient phenomena are not good for characterization of genera, but help in definitions of species. In principle each microsporidian has the conditions for production of mucose sheaths as sporoblasts are formed inside the plasmodial wall. It depends of the enzymatic dissolution during spore formation if some substances are retained or dissolved. The dissolution includes in some cases the pansporoblastic membrane and spores are fixed together by protoplasmic remains only or are entirely free in the periparasitic vacuole. In other cases the plasmodial wall form the pansporoblastic membrane and some Microsporidia have this wall reinforced by further deposits. There are not enough data concerning the persistency of this phenomenon and therefore, contrary to Tuzet et al., 1971, we wish not yet to use it as a diagnostic characteristics.

Some persistent structures on the spore surface are good for characterization in the generic level: caudal appendages of *Caudospora* or *Jirovecia* which are formed as a part of the spore membrane early during the sporoblastic stage. So are sutures or membranous structures in *Weiseria*. Other cases are more questionable: the fleece of curled filaments on the exospore of *Pleistophora debaisieuzi* or the array of structures on *Nosema pulvis*, the inflatable long hyaline protrusions in *Inodosporus* or the non-cellular sheath in *Tuzetia*.

Of the internal structures of microsporidian spores, the most important characteristics is the number of nuclei, evaluated or in ultrathin section, or in an adequate staining technics (Weiser, 1976). The last mentioned technics allows the observation of large series of spores at the same time and is able to indicate variability in the number of nuclei in teratospores. The method shows that in most genera the size and shape of the nuclei inside the spores is uniform, in some of them large diplokaryons, in others dot-like minute clumps. Some genera have long elongated nuclei, others have a less compact, irregular nucleus, with diffuse borders.

Another important characteristics of the spore is the structure of the polaroplast. In some species it is honeycomb-like, in most it is lamellar, in further species it forms a deep helicoidal system of vacuoles (Fig. 1, I.). Other distinctive characters are on the polar filament. In some spore types it has a rigid manubrium (*Mrazekia*), in others it has two distinct parts: the broader, basal, part and a narrow apical end. This we indicate as anisofilar spores. Most spores bear a long uniform polar filament, all its way the same diameter (isofilar). The number of coils is useful only to some extent, from case to case. Where the sporogony was studied, it was shown that the number of coils in the sporoblast and young spore is greater than in mature spores — so in *P. debaisieuzi* (Weiser and Žižka, 1975). The composition of the spore wall is also variable in different genera. Variations are especially in its electron-transparent chitinous layer, the endospore and the outer proteinic layer, the exospore. In most terrestrial genera it is uniform all round the

spore. In some aquatic genera it has a reduced thickness in the apical pole, sometimes also in the posterior. In other genera it has a thickening or a bulbous protrusion on its posterior end (Fig. 1, G.). The exospore is thickened in species with a thin apical endospore. (H.)

Besides the morphology of their spores, the higher taxa of Microsporidia are characterized by their sporogony. The schizogony is known from hosts where experimental infection is possible. It appears in two subsequent cycles. The first, starting from an extruded germ (planont), is represented by round, spherical or ovoidal stages with a variable but low number of nuclei. On dry smears stained with Giemsa these first schizonts have dense round nuclei and an intensively stained cytoplasm. They divide into uninucleate merozoites and this cycle is repeated several times. After the first or some further merogony, the merozoites show changed nuclei: a large nucleolus appears in the centre of the nucleus, chromatin grains are deposited on its wall. This is well visible on wet-fixed smears stained with Heidenhain's stain. In dry, Giemsa stained smears, these nuclei are large and filled with granular chromatin. The cytoplasm is faintly stained and vacuolated. These stages grow to ribbon-like series where the nuclei are arranged longitudinaly in one row. During the next nuclear division the second nucleus is pushed laterally and the nuclei alternate in a zig-zag arrangement. This division actually produces twin nuclei in the obligate coffee-bean form and a subsequent cytokinesis produces constrictions and separation of a chain of diplokaryon bearing stages. In some microsporidia the ribbonlike series of diplokarya are rather persistent and well visible: *Nosema pyraustae*, *N. mesnili*, *N. apis*, *Glugea anomala*, *Pleistophora chaobori*, *Mrazekia* div. sp., etc. In others they are short lasting and not recorded at all. The diplokaryon stages are the final stage of the second schizogony.

The next series of stages in the development of the Microsporidia is well visible in some genera (*Parathelohania*, *Amblyospora*), less so in other groups. We anticipate a cryptic occurrence of these forms in the later groups. The series has definitely to do with the rearrangement of the genetic substance and we designate it as the gamogonial cycle. Some ultrastructural evidence was brought by Loubes et al., 1976. It is characterized by cells with hypertrophic nuclei which fill almost the whole stage. Chromosomes are formed and undergo a mitotic division of the classical type. The final stages of this autogamy are young sporonts. In some Microsporidia we find this series as the first in young cysts. The previous schizogony is not known at all. This is the case of Amblyosporidae in larval Diptera. Their schizogony is hidden in infected cells and proceeds only with a few stages. The main multiplication of the stages begins with the gamogony.

Development of the stages in sporogony form again a basis for the taxonomy of Microsporidia. During the sporogony the primary sporont grows and divides its nuclei forming a plasmodium. Nuclear divisions during this stage are mitotic. The plasmodium divides into prosperoblasts, sporoblasts and these mature to spores. During sporogony the sporoblasts release digestive fluids which digest periparasitic vacuoles around the pansporoblasts or single spores, with a membrane on the interface. Three regulative systems are guiding the sporogony: the synchrony of nuclear divisions, the regulation of cyto- and karyokinesis and the regulation of spore size. The different genera undergo in sporogony one to many divisions. The only division in some

genera is identical with the last division in other genera, where several divisions occur. Only the first five divisions produce even numbers of nuclei (2, 4, 8, 16 and 32). Further divisions bring less regular spore counts in large groups. In different genera, the mechanism of divisions stops after one, two, three etc. divisions so that sporogony results in two, 4, 8, 16 or 32 spores. The sporoblasts are separated from a 4, 8, 16 or 32-nuclear plasmodium. In most cases this system is repeated without disturbance. In abnormal hosts or under abnormal conditions of temperature, salinity of water etc., the share of stages dividing once less or once more may grow to 30—40%, but not as a rule. The synchronous genera have their groups of spores first closed up in the membrane of the plasmodium. This sometime remains as a persistent membrane of the pansporoblast. In other cases they are connected with remains of the cytoplasm or the single spores dissolve the pansporoblastic membrane and are free in the tissues.

The synchronous genera produce an irregular number of nuclei in large plasmodial masses or are the plasmodia fragmented before formation of the pansporoblasts and fragments are produced with irregular numbers of nuclei (5, 7, 10, 20 etc.). The sporulation in the large masses occurs or as a synchronous development of all nuclei, and their pertinent plasmodic masses and sporoblasts are all of the same age in the whole mass. Or migrate nuclei to the surface of the plasmodia, protrude in finger-like protrusions and form sporoblasts. After they separate from the remain of the plasmodium, new nuclei migrate to the surface and another series of sporoblasts is shed off. The size of a plasmodium is given by its nutrition in the host cells, the number of produced spores changes from 30 to 200 and more. In the genus *Stempellia* there are late plasmodia which do not grow further from their third to fifth nuclear division. This division stops in some plasmodia after formation of four, in others of eight and further of 16 spores. Due to the fact that the original mass of the plasmodium does not grow further, the pansporoblasts with four sporoblasts form large spores, those with 8 sporoblasts form medium sized and those with 16 spores minor spores. In other cases, in *Culicosporidae*, there are plasmodia with 4, 8 or 16 nuclei, but they grow adequately and the resulting spores are of the same size.

Steps and morphology of stages in spore formation and maturation are analogous in all *Microsporidia* and do not bear characteristics, so far, useful for identification of higher taxa.

On basis of the discussed symptoms we are proposing the following scheme of taxonomy of the *Microsporidia* together with a short diagnosis of each taxon:

Phylum: *Microsporidia* Stempell, 1909

Protista with spores of unicellular origin, in undivided membrane, containing a single germ discharged via tubular polar filament. A polaroplast fills the anterior, a posterosome the posterior pole of the spore. The amoeboid germ is uninuclear or binuclear. Obligatory intracellular parasites.

Class 1: *Metchnikovellidea* n. cl

Microsporidia with rudimentary polar filament, polar opening laterally, spores spherical to lenticular, sporoplasm uninuclear or binuclear. Pansporoblast persistent, thickwalled.

Order 1: Metchnikovellida Vivier, 1975

Polar filament functional, shorter than spore length. Spores spherical, closed in persistent thickwalled pansporoblasts.

Family: Metchnikovellidae Caullery and Mesnil, 1914

Polar filament smooth, with terminal plate instead of coil. Nucleus crescent-shaped.

Genus: *Metchnikovella* Caullery and Mesnil, 1897

Spherical spores in oval pansporoblasts with a thickened pole. Proposed type: *Metchnikovella spionis* Caullery and Mesnil, 1897. Ultrastructures based on *M. hovassei* Vivier, 1965. The genus may include *Amphiamblys* Caullery and Mesnil, 1914, if ultrastructures are identical.

Genus: *Amphiacantha* Caullery and Mesnil, 1914

Spherical spores in spindle-shaped pansporoblasts tapering on poles in long thin spines. Type by monotypy: *Amphiacantha longa* Caullery and Mesnil, 1914.

Order 2: Chytridiopsida n. o.

Polar filament C-shaped, with warty surface. Spores spherical, uninuclear, in thinwalled and thickwalled pansporoblasts.

Family: Chytridiopsidae n. fam.

With the characters of the order.

Genus: *Chytridiopsis* Schneider, 1884

Spores spherical, fixed oval, short polar filament with foamy, warty surface, uninuclear germ. Spores in groups of 16 to 30 in thinwalled and thickwalled pansporoblasts of spherical shape, after fixation bell-shaped. Type: *Chytridiopsis socius* Schneider, 1884. Persistency of the differences justifying the genera *Steinhausia* Sprague et al., 1972 and *Burkea* Sprague (Sprague in press) have to be demonstrated.

Order 3: Hesseida Ormières and Sprague, 1973

Spores subspherical to lenticular, short polar filament with a few coils, smooth. Binuclear (and uninuclear) sporogony. In groups in thickwalled pansporoblasts.

Family: Hesseidae Ormières and Sprague, 1973

With the characters of the order.

Genus: *Hessca* Ormières and Sprague, 1973

Spores subspherical, polar filament smooth, without surface structures or terminal thickening. Stages in sporogony binuclear. In groups of 16 to 32 in thickwalled pansporoblasts, with warty surface. Type by monotypy: *Hessca squamosa* Ormières and Sprague, 1973.

Class 2.: Microsporididea Corliss and Levine, 1963

Microsporidia with long, tubular polar filament, polar opening apically, spores spherical, oval or tubular, sporoplasm uninuclear or binuclear. Pansporoblast thinwalled, persistent or nonpersistent.

Order 1.: Pleistophorida Stempell, 1906

Sporogony and spores uninuclear.

Family Pleistophoridae Stempell, 1909 (Fig. 2.)

Spores uninuclear, monomorphic. Polar filament isofilar. Nuclear divisions in sporogony asynchronous, resulting in variable numbers of plasmodial nuclei and sporoblasts.

Genus: *Perezia* Léger and Duboscq, 1909 emend Ormières et al., 1977

Diplokarya in late-schizogony persistent till early sporogony. Prosperoblasts, sporoblasts and spores uninuclear, single, without outer secretory „membrane”, in periparasitic vacuoles. Type: *Perezia lankesteriae* Léger and Duboscq, 1909 (Include the genus *Encephalitozoon* Levaditi et al. 1923).

Genus: *Tuzetia* Maurand et al., 1971

Spores single, closed in a secretory “membrane” each, in periparasitic vacuoles. Type by monotypy: *Tuzetia infirma* Maurand et al., 1971.

Genus: *Glugea* Thélohan, 1891

Uninuclear sporonts produce in 1 to 4 divisions groups of two to 16 uninuclear sporoblast and spores concentrated in digested periparasitic vacuoles in host cells. Later large multinuclear plasmodia break into irregular parts with different number of nuclei. Rigid pansporoblast membrane not formed, groups of spores stick together with plasmatic remains. With host macrophages they form xenoparasitic complexes closed up in thickwalled cysts. Inside the cyst wall the xenoma cells multinuclear, nuclei fragmenting but functional. Type by monotypy: *Glugea anomala* Gurley, 1893.

Genus: *Pleistophora* Gurley, 1893

Uninuclear sporonts divide asynchronously and produce plasmodia of different size with a different number of nuclei. Plasmodia sometimes break into irregular fragments before sporulation, other time the whole mass changes into spores. Pansporoblast membrane subpersistent, sporoblasts hold together in the digested vacuoles in tissues. Type by monotypy: *Pleistophora typicalis* Gurley, 1893.

Genus: *Weiseria* Doby and Saguez, 1964

Uninuclear sporonts divide asynchronously and produce plasmodia of different size with a different number of nuclei. Subpersistent pansporoblasts with 16 to 25 spores. Spores oval, with a system of sutures protruding from

the spore wall and forming a posterior collar. Type by monotypy: *Weiseria laurenti* Doby and Saguez, 1964.

Family: Thelohaniidæ Hazard and Oldacre, 1975 (Fig. 3.)

Spores uninuclear and monomorphic or dimorphic (micro- and macrospores). Sporogony with synchronous divisions resulting in 2, 4, 8, 16 or 32 nuclei, sporoblasts and spores. The number of nuclei in the pansporoblast before formation of sporoblasts indicates the critical number. Polar filament of uniform thickness the whole length (isofilar). Without an aberrant cycle of development in adult insects.

Genus: *Telomyxa* Léger and Hesse, 1910, emend. Codreanu, 1961

Uninuclear sporonts divide once producing two uninuclear spores fixed together in a persistent pansporoblasts. The space of the pansporoblast is filled with rigid secretions, with mucus or is empty. Type by monotypy: *Telomyxa glugeiformis* Léger and Hesse, 1910.

Genus: *Gurleya* Doflein, 1898

Uninuclear sporonts divide twice forming four nuclei of the plasmodium and finally four sporoblasts and spores sticking together with remains of the cytoplasm in a pansporoblastic membrane. Its space is empty or filled with rigid secretions, or with mucose substances. Type by monotypy: *Gurleya tetraspora* Doflein, 1898.

Genus. *Stempellia* Léger and Hesse, 1910

Uninuclear sporonts divide two-, three- or four times and produce plasmodia with 4, 8 or 16 nuclei. Pansporoblasts contain 4, 8 or 16 spores, in other cases 8, 16 or 32 spores. The spores in more numerous groups are minute, microspores, those in less numerous larger, makrospores, compared with the average spores which are most common. Pansporoblast membrane persistent or subpersistent. Spores thinwalled, polar filament isofilar, polaroplast lamellar. Type by monotypy: *Stempellia mutabilis* Léger and Hesse, 1910.

Genus: *Duboscqia* Pérez, 1908

Uninuclear sporonts divide 4 times and produce 16-nuclear plasmodia, sporoblasts and spores in persistent or subpersistent pansporoblasts Type by monotypy: *Duboscqia legeri* Pérez, 1908.

Genus: *Trichoduboscqia* Léger, 1926

Uninuclear sporonts divide 4 times and produce 16-nuclear plasmodia, sporoblasts and spores in a persistent pansporoblastic membrane with four needle-like appendages on its surface. Type by monotypy: *Trichoduboscqia epeori* Léger, 1926.

Genus: *Vavraia* n. g.

Uninuclear sporonts divide 5 times and produce plasmodia with 32 nuclei and pansporoblasts with persistent or subpersistent membrane and 32

spores. Proposed type: *Vavraia culicis* (Weiser, 1946) comb. n. for *Plistophora culicis*).

Genus: *Thelohania* Henneguy, 1892

Uninuclear sporonts divide 3 times and produce octonuclear plasmodia and pansporoblasts with eight sporoblasts and spores. Pansporoblasts in persistent or subpersistent membrane, spores sticking together with proteinic remains which are sometimes transformed into mucose masses. One type of sporogony in larval and adult hosts, directly infectious spores. Polar filament isofilar. Type: *Thelohania giardi* Henneguy, 1892.

Genus: *Pegmatheca* Hazard and Oldacre, 1975

Uninucleate sporoblasts give rise to 4 to 16 octonuclear plasmodia connected together by thin strands of cytoplasm during the formation of sporoblasts and octosporous pansporoblasts with spores. Spores with thin endospore on both poles. Type by monotypy: *Pegmatheca simulii* Hazard and Oldacre, 1975.

Genus: *Inodosporus* Overstreet and Weidner, 1974

Sporogony ending in octosporous pansporoblasts. Each spore with three or more hyaline, acicular appendages inflated when free in water. Type by original designation: *Inodosporus spraguei* Overstreet and Weidner, 1974.

Genus: *Cryptosporina* Hazard and Oldacre, 1975

Sporogony ending in octosporous pansporoblasts with persistent membrane. Its interior is filled with ambercolored secretions cementing the whole mass in a hard pack. Polar filament short. Type by monotypy: *Cryptosporina brachyfila* Hazard and Oldacre, 1975.

Genus: *Spiroglugea* (Léger and Hesse, 1922)

Octonuclear plasmodia produce in a subpersistent membrane eight arched, tubular spores, tightly compressed in spherical to oval pansporoblasts. Free spores thinwalled, vibrio-like. Type: *Spiroglugea octospora* (Léger and Hesse, 1922).

Genus: *Toxoglugea* (Léger and Hesse, 1922)

Octonuclear plasmodia produce in a subpersistent membrane eight crescent shaped, tubulous spores in spherical pansporoblasts. Type by monotypy: *Toxoglugea vibrio* (Léger and Hesse, 1922).

Family: Amblyosporidae n. fam. (Fig. 4.)

Microsporidia with octosporous pansporoblasts in larval hosts, with two different developmental sequences, with thinwalled spores in irregular groups in adult hosts. Polar filament of thickwalled spores anisofilar, of thinwalled spores isofilar and very long.

Genus: *Amblyospora* Hazard and Oldacre, 1975

Microsporidia with two developmental sequences, a thickwalled and octosporous in male larvae and a thinwalled in adult females, with single spores. Thickwalled spores with thin endospore on the apical end and with a laterally thickened exospore. Polar filament anisofilar. Thinwalled long elliptical spores in adult females with very long, isofilar polar filament. Egg transmitted, development sexdependent. Type by original designation: *Amblyospora californica* (Kellen and Lipa, 1960).

Genus: *Parathelohania* Codreanu, 1966

Microsporidia with two developmental sequences, a thickwalled and octosporous in male larvae and a thinwalled in adult females, with single spores. Thickwalled spores with thin endospore on the apical end and a thickening to bulbous protrusion on the posterior end. Exospore thin. Polar filament anisofilar. Thinwalled spores kidneyshaped, binuclear, with isofilar polar filament. Egg transmitted, development sex-dependent. Type by monotypy: *Parathelohania legeri* (Hesse, 1904).

Genus: *Chapmanium* Hazard and Oldacre, 1975

Only larval infection known. Octosporous pansporoblasts elongate navicular, persistent membrane. Spores pyriform, thinwalled, with anisofilar polar filament. Type by original designation: *Chapmanium cirritus* Hazard and Oldacre, 1975.

Genus: *Hyalinocysta* Hazard and Oldacre, 1975

Only larval infections known. Octosporous pansporoblasts oval, pyriform spores thinwalled, with anisofilar polar filament, closed in a mucose mass. Polar filament half its length thickened. Type by monotypy: *Hyalinocysta chapmani* Hazard and Oldacre, 1975.

Family: Culicosporidae n. fam. (Fig. 4.)

Microsporidia producing in sporogony pansporoblasts with 4, 8 or 16 spores which are of uniform size (no microspores and macrospores). Spores long pyriform, with a typical polaroplast filling the whole anterior half of the spore and divided into large chambers divided by septa of helicoidal arrangement. One or two sporogonial sequences, uninuclear or binuclear spores.

Genus: *Culicospora* n. g.

Long pyriform spores with large helicoidal polaroplast and one elongate lateral nucleus produced in groups of four, eight or sixteen on fingerlike protrusions of the plasmodium. One sporogonial sequence known, all spores of the same size. Not infectious by feeding. Type: *Culicospora magna* (Kudo, 1920) (former *Stempellia magna*).

Genus: *Hazardia* n. g.

Long pyriform spores of two types: thinwalled with the large helicoidal polaroplast, uninuclear, and thickwalled (due to an irregular exospore), with

a lamellar polaroplast and two nuclei. Both are formed in a sporogony where plasmodia with irregular numbers of nuclei are budding into fingerlike protrusions and liberate sporoblasts without a pansporoblastic membrane. All spores about the same size. Infectious by feeding. Type: *Hazardia milleri* (Hazard and Fukuda, 1974) (former *Stempellia milleri*).

Genus: *Culicosporella* n. g.

Long pyriform spores known in one type yet, thinwalled, with a large helicoidal polaroplast, binuclear. Mature spores comma-shaped to straight. Not infectious by feeding. Type: *Culicosporella lunata* (Hazard and Savage, 1970) (former *Stempellia lunata*).

Genus: *Cougourdella* Hesse, 1935

Long pyriform spores with pestle-like posterior pole, thinwalled, with a large helicoidal polaroplast with chambers filled with granular substance, short polar filament, uninuclear, produced from plasmodia with 4, 8 or 16 nuclei. Type by original designation: *Cougourdella magna* Hesse, 1935.

Genus: *Pyrotheca* Hesse, 1935

Comma-shaped elongate spores, tapering apically in a pointed end. Polaroplast long and helicoidal. Sporogony with plasmodia with 4 nuclei and spores in a bundle. Type by original designation: *Pyrotheca incurvata* Hesse, 1935.

Order 2.: Nosematidida Labbé, 1899 (Fig. 5.)

Sporogony and spores diplokaryotic.

Family: Nosematidae Labbé, 1899

Spores and sporogonial stages with diplokarya or two nuclei, polar filament isofilar, pansporoblastic membrane persistent or subpersistent.

Genus: *Variimorpha* Pilley, 1976

Two sporogonial sequences with dimorphic spores. One with binuclear spores formed by one division of the binuclear sporont. Other with uninuclear spores in pansporoblasts of eight, formed by three subsequent divisions of the sporont. Type by monotypy: *Variimorpha necatrix* (Kramer, 1965).

Genus: *Nosema* Naegeli, 1857

Spores monomorphic, one sporogonial sequence. Binuclear spores formed from sporoblasts after one sporogonial division of the sporont. Pansporoblastic membrane non-persistent, spores free. Type by monotypy: *Nosema bombycis* Naegeli, 1857.

Genus: *Issia* n. g.

Spores monomorphic, one sporogonial sequence, binuclear. Two spores formed after one division of the sporont, pansporoblast persistent, spores fixed together. Type: *Issia trichopterae* (Weiser, 1946) (former *Pérezia trichopterae*)

Genus: *Octospora* Flu, 1911

Spores monomorphic, one sporogonial sequence, all binuclear, cylindrical, sometime lightly arched. In sporogony three divisions resulting in octosporous pansporoblasts with subpersistent membrane. Some species with big number of spores. Polar filament isofilar. Type by monotypy: *Octospora muscaedomesticae* Flu, 1911.

Genus: *Caudospora* Weiser, 1946

Four or more asynchronous divisions in sporogony, plasmodia with irregular numbers of diplokarya, 30—50, subpersistent membranes. Spores oval, binuclear, with a posterior caudal appendage formed during the prosporoblastic stage. Lateral ledge-like thickenings on exospore. Type by monotypy: *Caudospora simulii* Weiser, 1946.

Genus: *Golbergia* n. g.

Asynchronous divisions in sporogony, spores binuclear, font-like flattened on one side and on the anterior pole. Posterior end with a nail-like protrusion, ridged exospore. Type: *Golbergia spinosa* (Golberg, 1971) (former *Weiseria spinosa*).

Family: Mrazekidae Léger and Hesse, 1922

Sporogony with different number of divisions, stages with persistent diplokarya. Spores long cylindrical, binuclear, nuclei elongate. Polar filament with a rigid, well visible manubrium crossing the length of the spore.

Genus: *Mrazekia* Léger and Hesse, 1916

Cylindrical spores without posterior caudal appendage. Type by subsequent designation: *Mrazekia argoisi* Léger and Hesse, 1916.

Genus: *Jirovecia* n. g.

Cylindrical spores with a posterior caudal appendage. Type: *Jirovecia caudata* (Léger and Hesse, 1916) (former *Mrazekia caudata*).

The indicated definitions of the types are emendated according to the requirements of actual differentiation on the basis of new informations from studies of ultrastructures, experience with more known species, from experimental infections and cross transmissions. The actual taxonomical differentiation is very rich in multispore aquatic species and very poor in terrestrial *Nosema*'s. The proposed higher taxonomic groups overlap in some genera: The genera of Amblyosporidae have mononuclear as well as binuclear sporogonial sequences the same as Nosematidae have mononuclear spores in the genus *Variimorpha*. In some groups such as the Metchnikovellidea or the family Culicosporidae further studies of ultrastructures and studies of transmission of the infections will bring additional information which will justify or re-organize the proposed division. Lack of positive experimental transmissions in aquatic species of the *Parathelohania*, *Amblyospora* and closely related genera makes the decision on justification of generic or specific differences impossible. Some genera are not included in the proposed scheme because they are not yet supported by adequate supply of information to

make the decision possible, so *Pseudopleistophora* Sprague, *Heterosporis* Schubert, *Amphicantha* Caullery and Mesnil, *Spraguea* Weissenberg, *Unicaryon* Canning, Lai and Lie, *Nosemoides* Vinckier, *Ameson* Sprague, *Agmasoma* or *Pilosporella* Hazard and Oldacre or *Ichthyosporidium* Caullery and Mesnil. In many cases mentioned there is basic information on ultrastructures available but there are old similar microsporidia from which they have to be differentiated and where the type material is lost and information on ultrastructures not available.

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The figures will be found at the end of this issue.

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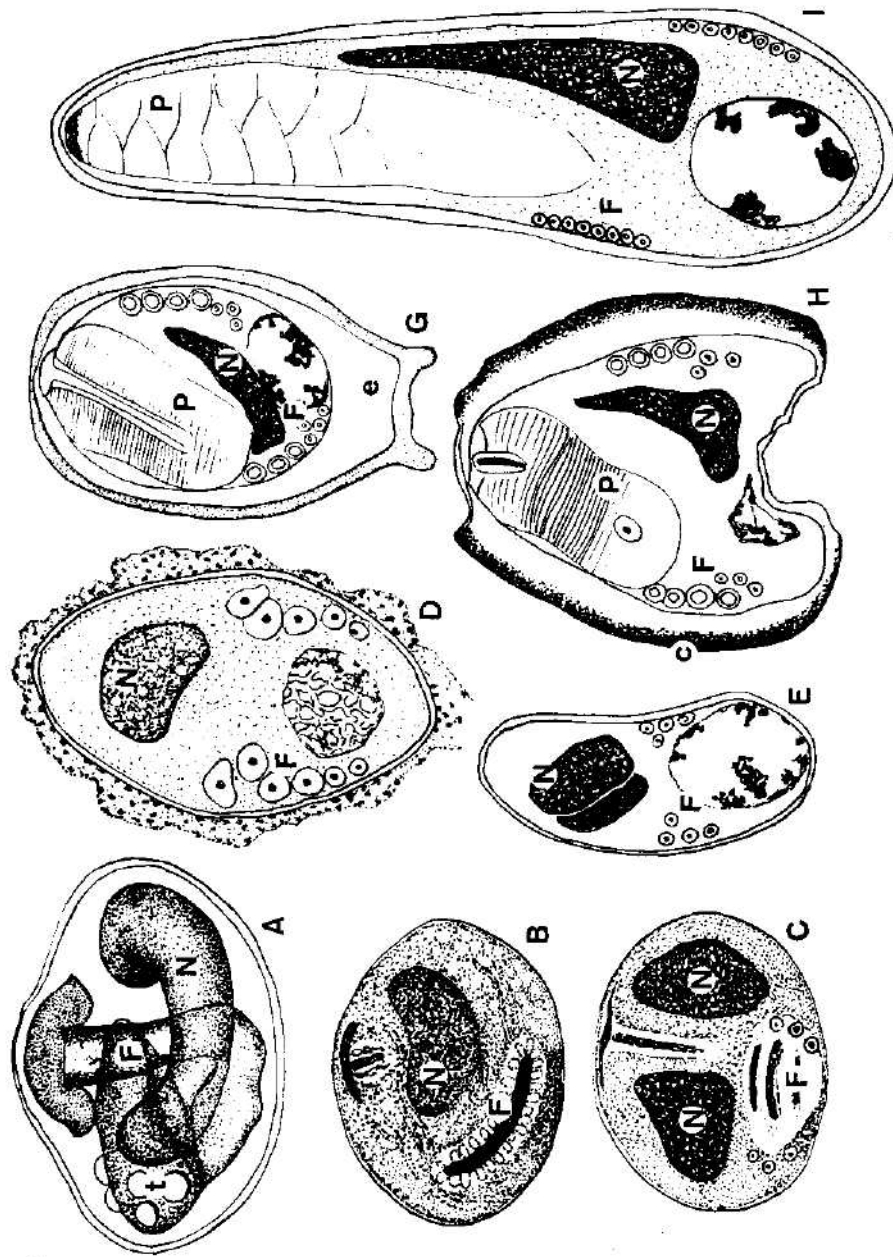


Fig. 1. Some types of ultrastructures of microsporidian spores. Drawings after electron micrographs of different authors. A. *Metchnikovella* with a crescent-shaped nucleus (N) and a rudimentary polar filament (F) with the terminal plate (t). B. *Chytridiopsis*. Spore with oval nucleus (N), polar filament with warty surface (F). C. *Hessea*. The binuclear (N) spore with smooth, long polar filament coiled (F) in the posterior part of the spore. D. *Tuzetia*. The thin-walled spore is uninnucleated (N), its polar filament (F) with some signs of a distal narrow part (anisofilar). The surrounding secretory "membrane" has no organization of a pansporoblast wall. E. *Parathelohanica*, the thin-walled spore type from adult hosts: Nucleus oval (N), polar filament (F) isofilar. G. *Parathelohanica*, the thick-walled spore type from larval hosts: Nucleus flat (N), polar filament anisofilar (F), polaroplast lamellar (P). The posterior pole with thickened endospore (e) and corrugated exospore after fixation. H. *Amphysozoa*, the thick-walled spore type. Nucleus flat (N), polaroplast lamellar (P). Very long, narrow spore, thin-walled, isofilar (F), spheroidal thin wall lateral thickened wall with O₂-positive opisporeal cover (e). I. *Hazardia*. Very long, narrow spore, thin-walled, isofilar (F), spheroidal nucleus (N) and a helicoideal polaroplast (P).

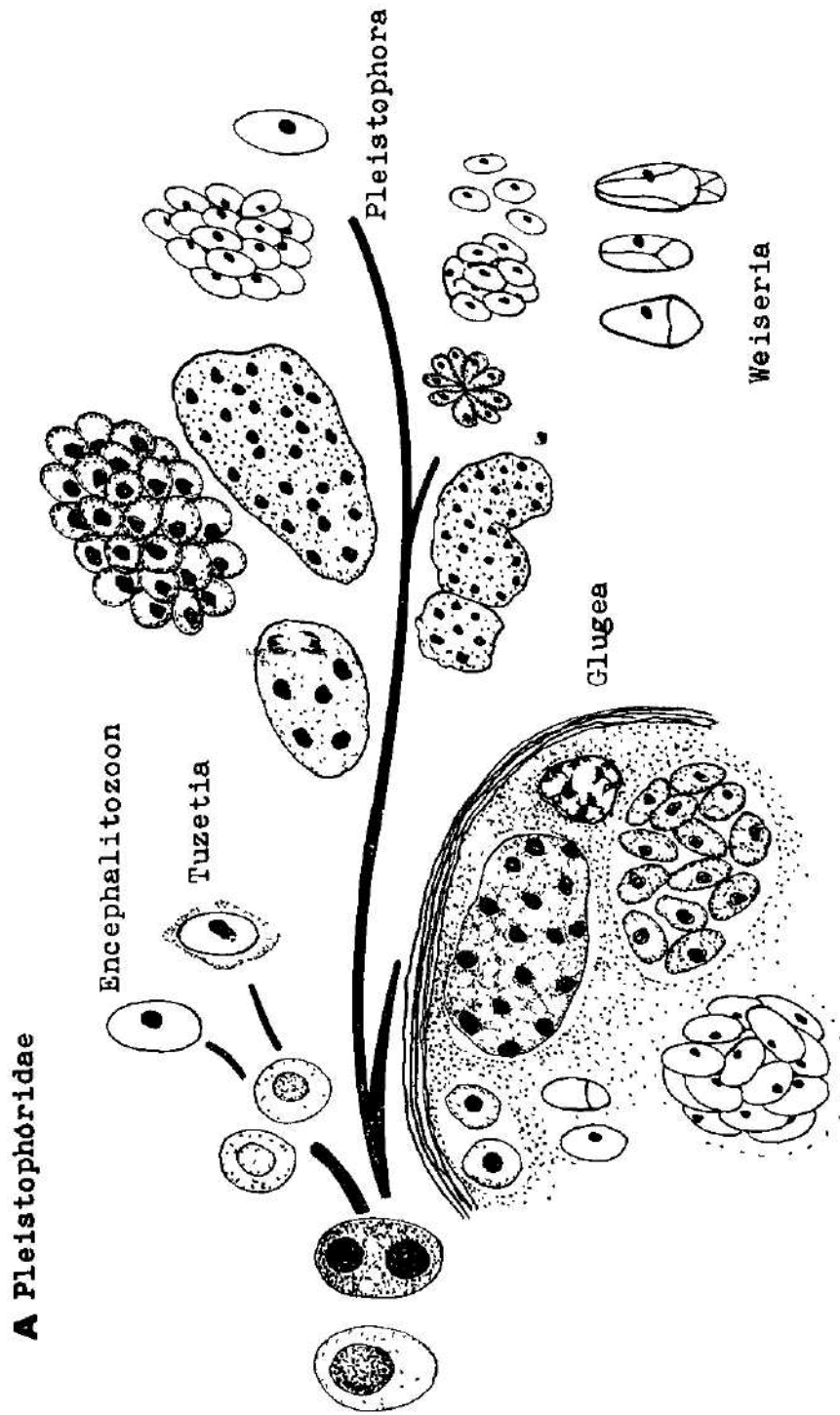


Fig. 2. Scheme of the genera of the fam. Pleistophoridae.

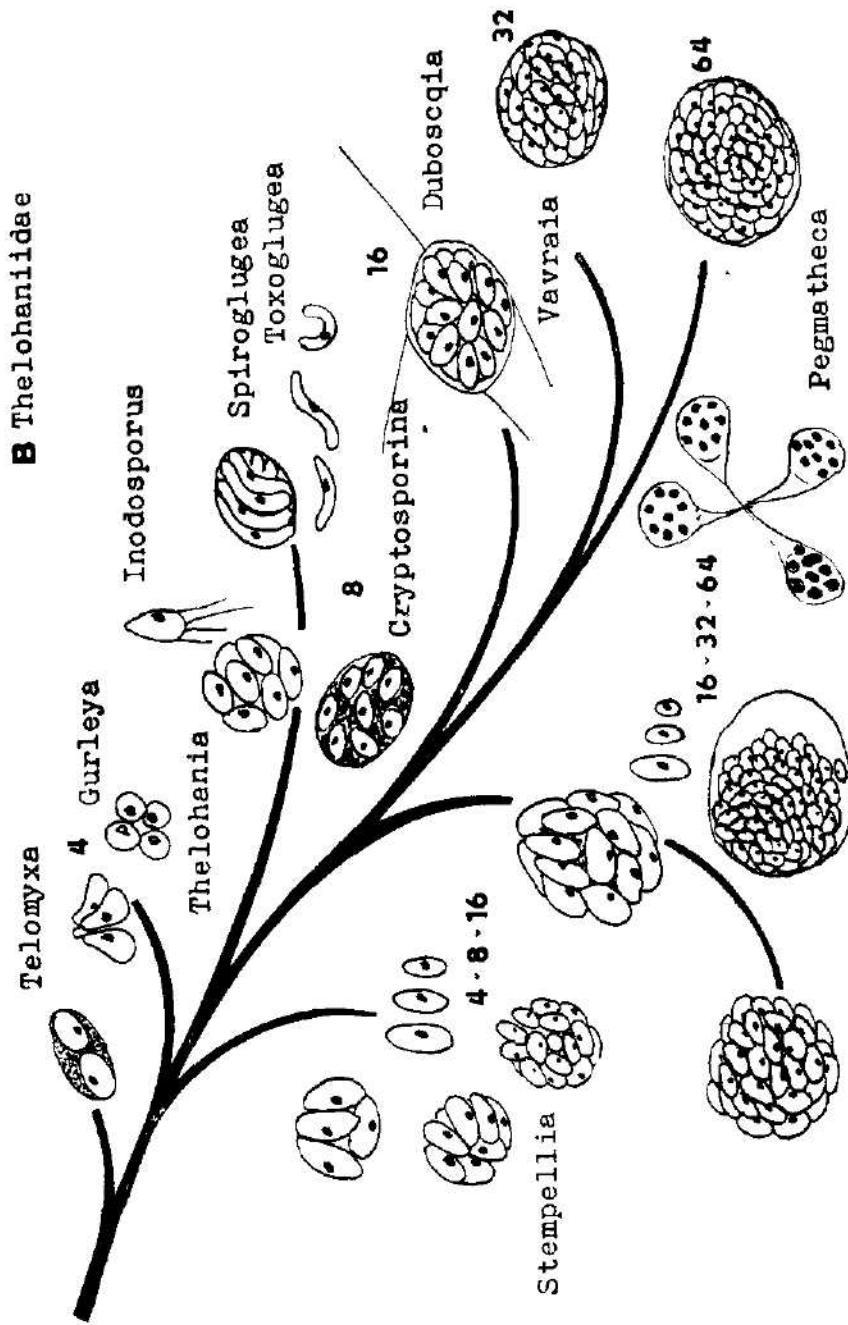


Fig. 3. Scheme of the genera of the fam. Thelohanidae.

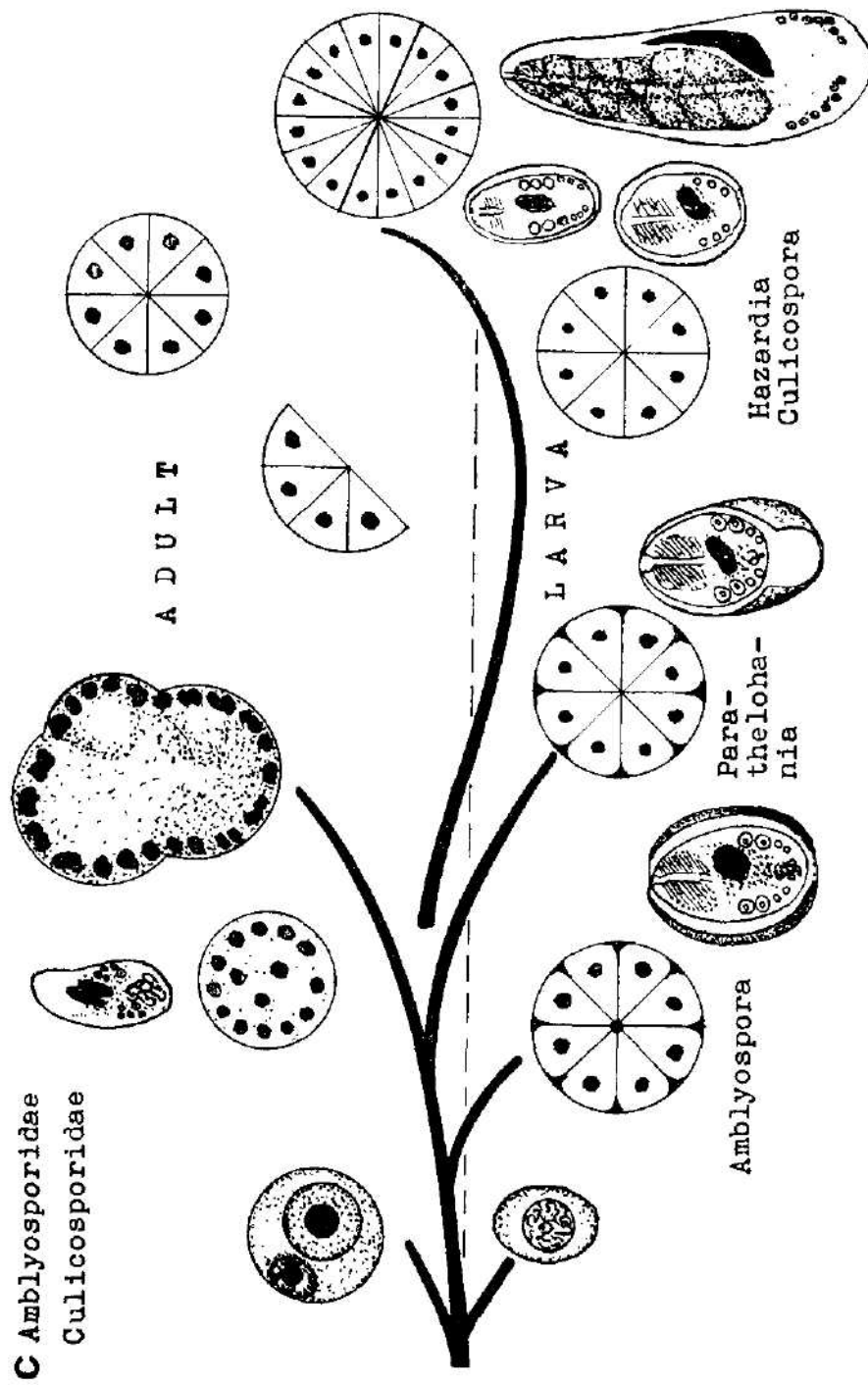


Fig. 4. Scheme of the genera of the fam. Amblyosporidae and Culicosporidae.

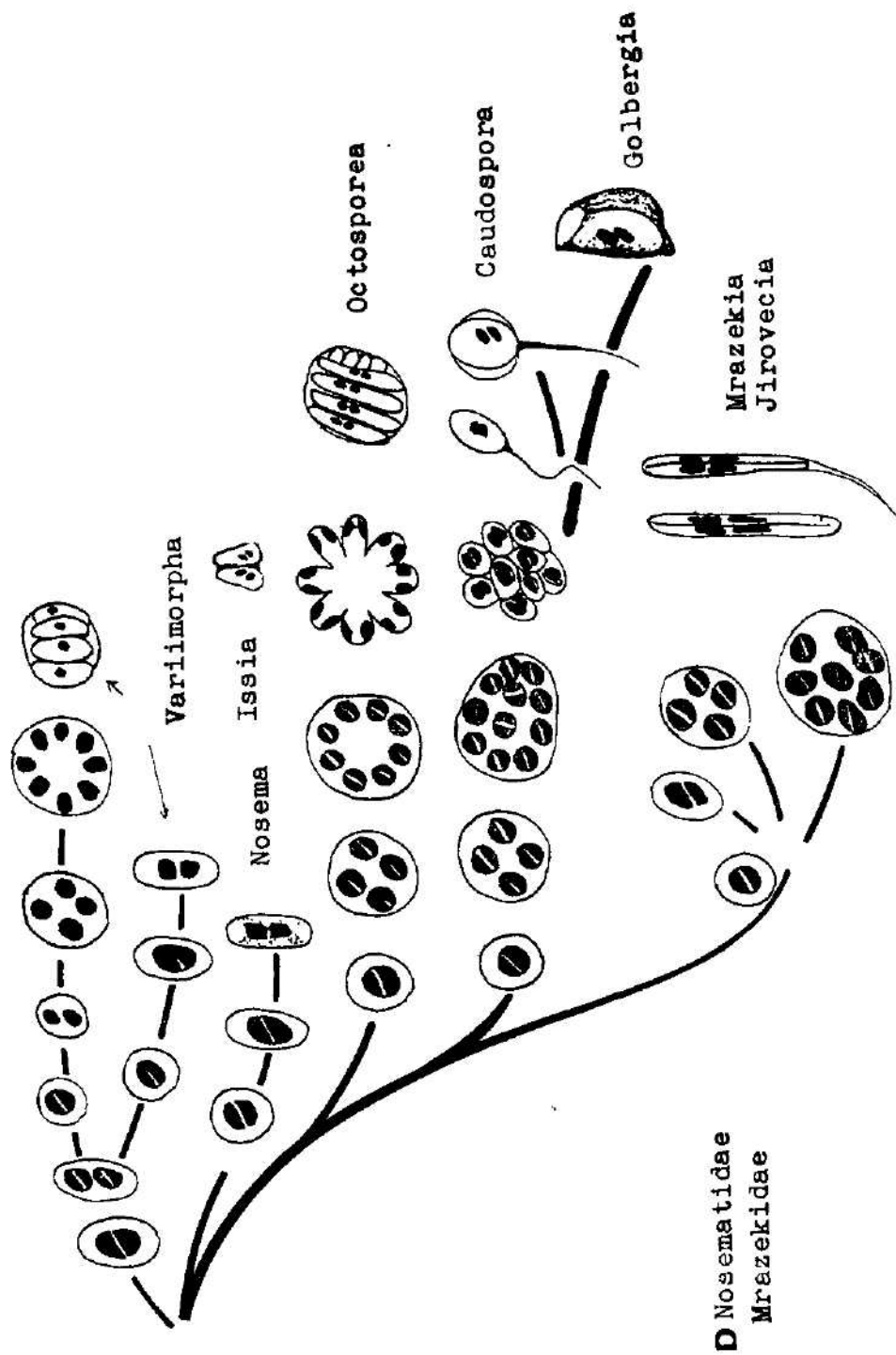


Fig. 5. Scheme of the genera of the fam. Nosematidae and Mrazekidae.

Kratochvíl J.: Die Faktoren, die die Schwankungen der Westgrenze des Verbreitungsareals von *Apodemus agrarius* bedingen.

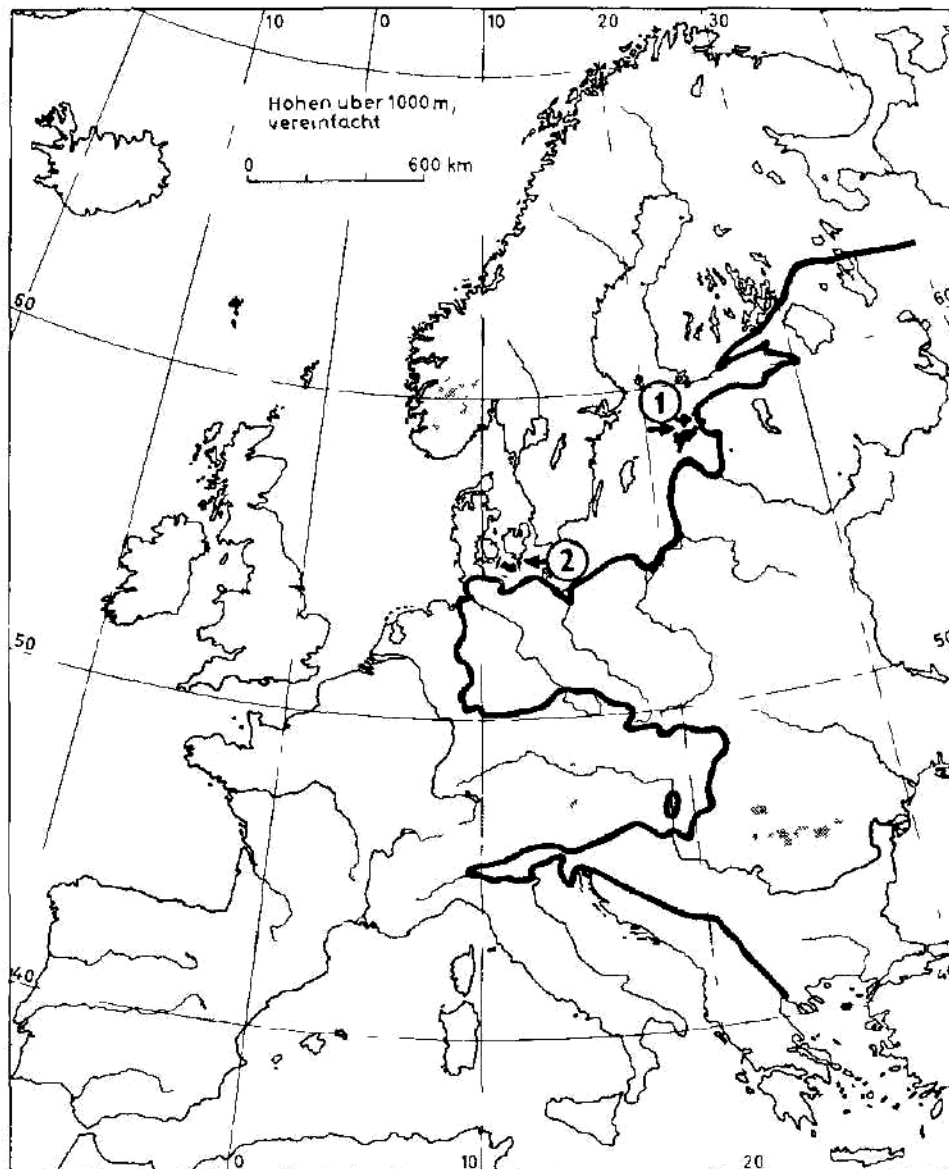


Abb. 1. Grenzen des westlichen Verbreitungsareals der Art *Apodemus agrarius* in Europa. Zusammengestellt nach Siivonen (1968; Karte Nr. 40), Kuznecov (1965, Karte Nr. 87), Niethammer (1976, Abb. 1), Gerner (1976; Abb. 1), Kratochvíl (1976; Abb. 2a), Schmidt & Topal (1976, Abb. 1, 2), Petrov (1976; Abb. 2) und Kahmann (1971; Abb. 1). Erklärungen: 1 = die dänischen und 2 = die grossen Inseln in der Bucht von Riga, wo *A. a.* in der Fauna vertreten ist.

Kratochvíl J Die Faktoren, die die Schwankungen der Westgrenze des Verbreitungsareals von *Apodemus agrarius* bedingen

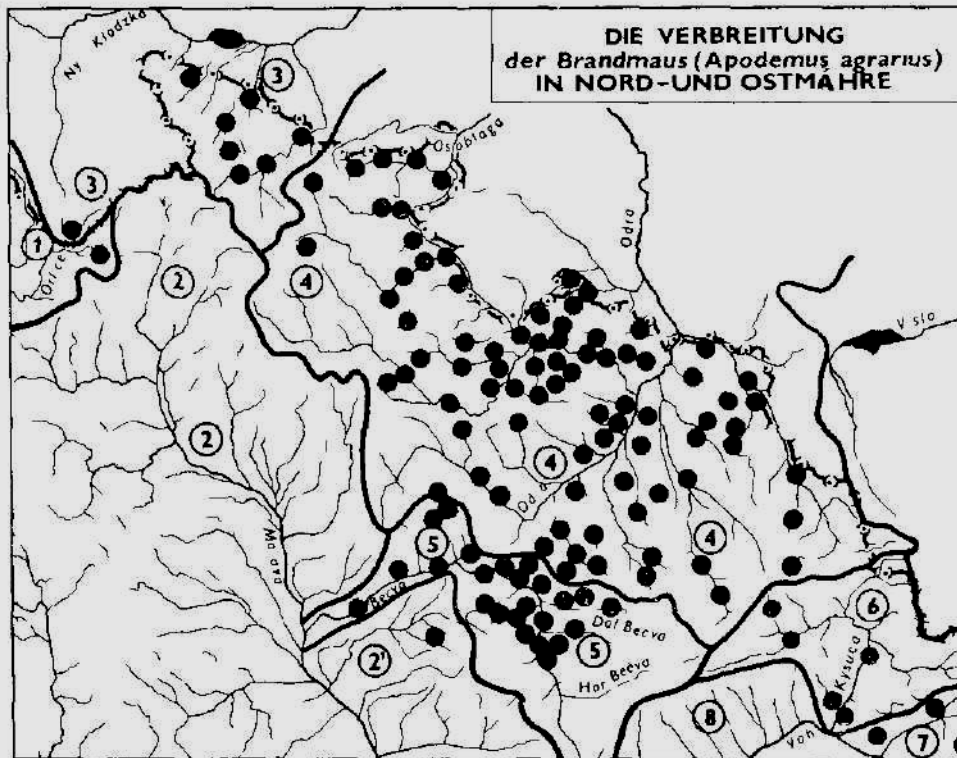


Abb 2 *Apodemus agrarius* besiedelte vom polnischen Tiefland aus stromaufwärts folgende Flussgebiete Nord- und Ostmährens: das Flussgebiet der Nisa Kladska (Nysa Klodska, Nr 3) und der Odra (Nr 4). Nach Überschreitung der Wasserscheide besiedelte diese Art stromabwärts das Bečva Flussgebiet (Nr 5), drang in die Quellzone des Flussgebiets der Orlica (Nr 1) und der Zuflüsse des Mittellaufs der Morava (Nr 2) vor, in der Slowakei besiedelte sie in ähnlicher Weise das Flussgebiet der Kysuca (Nr 8) und Várinka (Nr 7). Über ein Vorkommen *A. a.* im oberen Flussgebiet der Morava (Nr 2) und mittleren Flussgebiet des Váh (Nr 8) liegen vorläufig keine Belege vor.