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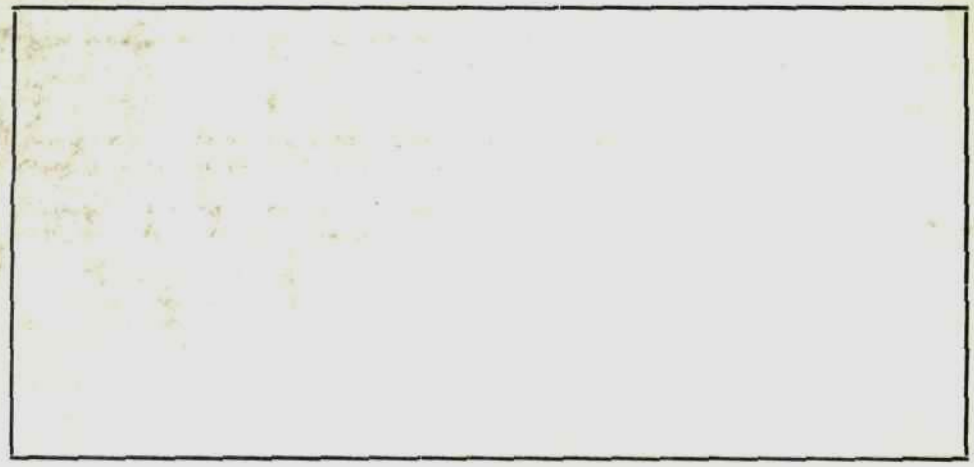

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REVISION OF THE MEIGEN'S TYPES OF RHAMPHOMYIA (DIPTERA, EMPIDIDAE) IN THE PARIS MUSEUM

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A b s t r a c t. The material of the genus *Rhamphomyia* in Meigen's collection in Paris was revised. Lectotypes of nine species are designated and five holotypes are identified. *Rhamphomyia dentipes* Zetterstedt, 1842, is a new synonym of *R. pilifer* Meigen, 1838, and *R. nitidicollis* Frey, 1913, is a new synonym of *R. obscuripennis* Meigen, 1830.

J. W Meigen (1804, 1822, 1830, 1838) described 24 species of *Rhamphomyia*. Those species described in 1804 in the genus *Emphis* he transferred to *Rhamphomyia* in 1822. Lectotypes of nine of them are designated here and five holotypes are identified. Of the ten remaining species the lectotype of *R. sulcata* (Meigen, 1804) was not designated because there was no appropriate specimen in the collection, *R. bilineata* (Meigen, 1804) remained unrecognized species because the only specimen present was very damaged and did not fit the original description. *R. ferruginea* Meigen, 1822 was found to belong to the genus *Empis* and the holotype of *R. caesia* (Meigen, 1804) has already been identified (Barták, 1982). Six species were not found in the Paris Museum, viz *R. schistacea* Meigen, 1822, *R. geniculata* Meigen, 1822, *R. latipennis* Meigen, 1822, *R. anthracina* Meigen, 1822, *R. carbonaria* Meigen, 1822, and *R. rufipes* (Meigen, 1804). According to Dr. Ruth Contreras-Lichtenberg (pers. comm.) they are not present in Vienna Museum either. The species *Empis rufipes* Meigen, 1804 is not treated below because it seems to me that this name was used in *Rhamphomyia* by mistake

It is surprising that only Collin (1926, 1961) has revised Meigen's types of *Rhamphomyia*, but his redescriptions concern the British species only. Recently, Syrovátka and Chvála (1986) have revised Meigen's types of *Empis* s. str. The present paper is based on a complete study of Meigen's collection of *Rhamphomyia* in the Paris Museum. The collection is not preserved in Meigen's original arrangement as it was rearranged lately by Séguy (Dr. Matile — pers. comm.). The species are arranged alphabetically.

Rhamphomyia alipes Meigen, 1822
Rhamphomyia alipes Meigen, 1822, Syst. Beschr., 3: 45

Described from two males, one "aus hiessiger Gegend" (= Aachen), the other "aus Fabricius Sammlung". There is one pinned male in the collection labelled "Meigen" and "Rhamphomyia alipes ♂", with only the right leg missing. I believe it to be the syntypic male. I designate it hereby as a lectotype of *Rhamphomyia alipes* Meigen, 1822 and I labelled it accordingly. It is a male of *Rhamphomyia (Pararhamphomyia) atra* Meigen, 1822.

Rhamphomyia anomalipennis Meigen, 1822
Rhamphomyia anomalipennis **Meigen, 1822, Syst. Beschr., 3: 55**

Described from a single female holotype (" . . nur einmal das Weibchen . "). There is a single well preserved female in the collection labelled "Meigen" and "Rhamphomyia anomalipennis ♂" (a mistake in sex determination probably made by Séguy). It is obviously the holotype specimen and it was labelled accordingly. *Rhamphomyia (Megacyttarus) anomalipennis* Meigen, 1822, was redescribed by Collin (1961: 348) and Barták (1982: 435).

Rhamphomyia anthracina Meigen, 1822
Rhamphomyia anthracina **Meigen, 1822, Syst. Beschr., 3: 54**

Described from an unknown number of specimens from Austria ("coll. Megerle"). The species is absent in Paris Museum and it is not present in Vienna Museum either. Redescription of *Rhamphomyia* (s. str.) *anthracina* Meigen, 1822 sensu auct. is given in Barták (1981: 369).

Rhamphomyia atra Meigen, 1822
Rhamphomyia atra **Meigen, 1822, Syst. Beschr., 3: 45**

Described from an unknown number of specimens of both sexes without any data of their origin. There are one female of *R. atra* and one pinned male without antennae labelled "Meigen" and "Rhamphomyia atra ♂" I believe the male to be syntypic. It is designated hereby as a lectotype of *Rhamphomyia atra* Meigen, 1822 and it was labelled accordingly. *Rhamphomyia (Pararhamphomyia) atra* Meigen, 1822 was redescribed by Collin (1961: 381), Frey (1956: 469), and Barták (1982: 419).

Rhamphomyia bilineata (Meigen, 1804)
Empis bilineata **Meigen, 1804, Klass., 1: 230**

Described from a single male without data of its origin. The species was lately transferred into *Rhamphomyia* (Meigen, 1822: 56). There is one female in the collection labelled "Meigen" and "bilineata ♀". The specimen is badly damaged (head and legs missing) but certainly it represents a female of *Rhamphomyia (Megacyttarus) poissoni* Trehen, 1966 (= *R. tephraea* auct. not Meigen, 1822). Uufortunately, the original description does not fit this female ("der Hinterleib braun, aschgrau schillernd", ... "die Schienbeine der Mittel und Hinterfüfse rostgelb") because the abdomen is silvery grey in *R. poissoni* and legs uniformly black or brown, and moreover, the holotype should be a male of greater size ("3 linien"). Thus, *Empis bilineata* Meigen, 1804 remains an unrecognized species.

Rhamphomyia caesia Meigen, 1822
Rhamphomyia caesia **Meigen, 1822, Syst. Beschr., 3: 56**

Described from a single female. The holotype is deposited in Vienna Museum and it was revised by Barták (1982: 421). In the Paris collection there is one male of *Rhamphomyia geniculata* Meigen, 1830 under the name "caesia" labelled "113240" and "caesia ♂". The species *Rhamphomyia (Pararhamphomyia) caesia* Meigen, 1822 was redescribed by Barták (1982: 421).

Rhamphomyia carbonaria Meigen, 1822
Rhamphomyia carbonaria Meigen, 1822, Syst. Beschr., 3: 59

Described from an unknown number of specimens from Hoffmannsegg's collection. The species is not preserved in Paris nor Vienna Museums. ***Rhamphomyia carbonaria*** Meigen, 1822 thus remains an unrecognized species.

Rhamphomyia cinerascens (Meigen, 1804)
Empis cinerascens Meigen, 1804, Klass., 1: 230

Described from an unknown number of specimens without any data of their origin. Transferred from *Empis* to *Rhamphomyia* by Meigen (1822: 48) and, in the paper from 1822 Meigen stated that he had two females only. There are one male and one conspecific female in the collection. I believe the female to be syntypic and I designate it hereby as a lectotype of *Rhamphomyia* (s. str.) *cinerascens* (Meigen, 1804). It was also labelled accordingly. *Rhamphomyia* (s. str.) *cinerascens* was redescribed by Barták (1982: 399).

Rhamphomyia erythrophthalma Meigen, 1830
Rhamphomyia erythrophthalma Meigen, 1830, Syst. Beschr., 6: 340

Described from an unknown number of males without locality data. There is a single male in the collection labelled "Meigen" and "erythrophthalma ♂" and a third label with an illegible notice. This pinned male with left haltere missing and left hind tibia stuck to a pin is obviously syntypic. It is designated hereby as a lectotype of *Rhaphomyia (Amydroneura) erythrophthalma* Meigen, 1830 and it was labelled accordingly. *Rhamphomyia erythrophthalma* was redescribed by Collin (1961: 435) and Barták (1982: 440).

Rhamphomyia ferruginea Meigen, 1822
Rhamphomyia ferruginea Meigen, 1822, Syst. Beschr., 3: 60

Described from a single male holotype. There is one male specimen in the collection (obviously holotype) belonging to the genus *Empis*.

Rhamphomyia geniculata Meigen, 1830
Rhamphomyia geniculata Meigen, 1830, Syst. Beschr., 6: 340

Described from an unknown number of specimens of both sexes. The species is not preserved in Paris nor Vienna. *Rhamphomyia (Pararhamphomyia) geniculata* Meigen, 1830 sensu auct. was redescribed by Collin (1961: 365), Frey (1956: 480) and Barták (1982: 424).

Rhamphomyia infuscata Meigen, 1822
Rhamphomyia infuscata Meigen, 1822, Syst. Beschr., 3: 53

Described from a single male holotype. There is one male in the collection with left tarsus missing labelled "Meigen" and "Rhamphomyia infuscata" which is obviously the holotype. It is a male of *Rhamphomyia (Holoclera) variabilis* (Fallén, 1816).

Rhamphomyia latipennis Meigen, 1822
Rhamphomyia latipennis Meigen, 1822, Syst. Beschr., 3: 44

Described from two males, one from Aachen (from "hier"), the other as from

Mr. Megerle. The types are not preserved in Paris or Vienna. The species thus remains an unrecognized species.

Rhamphomyia longipes (Meigen, 1804)
Empis longipes **Meigen, 1804, Klass., 1: 231**

Described from an unknown number of specimens of both sexes, without locality data. Transferred to *Rhamphomyia* by Meigen (1822: 55) without additional distributional data. There are two males and one conspecific female in the collection which are obviously syntypic. One male with antennae, right fore and middle tibiae and left hind tibia and tarsus missing, labelled "Meigen" and "Rhamphomyia longipes", was selected as a lectotype and it was labelled accordingly. *Rhamphomyia (Aclonempis) longipes* (Meigen, 1804) was redescribed by Frey (1956: 447), Collin (1961: 381) and Bartàk (1982: 456).

Rhamphomyia obscuripennis Meigen, 1830
Rhamphomyia obscuripennis **Meigen, 1830, Syst. Beschr., 6: 340**
Rhamphomyia nitidicollis **Frey, 1913, Acta Soc. Fauna Fl. Fenn., 37: 26, syn. n.**

Apparently described from a single male without locality data. However, there is a single female in the Paris collection under "obscuripennis". The original description fits this specimen well and, thus, Meigen obviously made a mistake in the sex determination (wings described as "bräunlich" are brownish in female, in male they are rather greyish). This female is fairly well preserved except that the fore left leg is missing, labelled "Meigen" and "obscuripennis ♀ Lüttig". I have labelled it as a holotype of *Rhamphomyia (Pararhamphomyia) obscuripennis* Meigen, 1830. The same species was later described by Frey as *R. nitidicollis*, which becomes a junior synonym of *R. obscuripennis*. The species was also redescribed as *R. nitidicollis* by Bartàk (1982: 429).

Rhamphomyia pilifer Meigen, 1838
Rhamphomyia pilifer **Meigen, 1838, Syst. Beschr., 7: 89**
Rhamphomyia dentipes **Zetterstedt, 1842, Dipt. Scand., 1: 397, syn. n.**

Described from an unknown number of specimens of both sexes. There is a single female under the above name in Paris with right antenna and a part of abdomen missing, labelled "Meigen" and "Rhamphomyia pilifer ♀" which I consider to be syntypic. It was designated as a lectotype of *Rhamphomyia pilifer* Meigen, 1838 and it was labelled accordingly. The same species was described lately (1842) as *R. dentipes* which thus becomes a junior synonym of *R. pilifer*. *Rhamphomyia (Pararhamphomyia) pilifer* Meigen, 1838 was redescribed as *R. dentipes* by Collin (1961: 358) and Bartàk (1982: 423).

Rhamphomyia plumipes (Meigen, 1804)
Empis plumipes **Meigen, 1804, Klass., 1: 230**

Described from an unknown number of specimens of both sexes, without locality specification. Transferred to *Rhamphomyia* by Meigen (1822: 47) without additional locality data. There are three males of *R. stigmosa* Macquart under the above name in the collection and one female of *R. plumipes*. Following Collin (1961: 415) and the continuity principle in nomenclature, I select-

ed the female specimen as a lectotype. It is a rather damaged specimen with mesonotal pubescence missing as well as the left middle leg, right haltere and a part of abdomen, labelled "Meigen" and "Rhamphomyia plumipes ♀". It is hereby designated as a lectotype of *Rhamphomyia plumipes* (Meigen, 1804) and it was labelled accordingly. *Rhamphomyia* (s.str.) *plumipes* (Meigen, 1804) was redescribed by Collin (1961: 413) and Bartàk (1982: 410).

Rhamphomyia rugicollis Meigen, 1822
Rhamphomyia rugicollis **Meigen, 1822, Syst. Beschr., 3: 46**

Described from an unknown number of specimens without any specification of sex. originating from Aachen ("aus hiessiger Gegend"). There are one male of *R. sulcata* (Meigen) and one female of *R. montana* Oldenberg in Paris. I suppose both above specimens are syntypes and the male with right hind tibia and halteres missing, labelled "Meigen" and "Rhamphomyia rugicollis ♂", was selected as a lectotype and labelled accordingly. *Rhamphomyia rugicollis* Meigen, 1822 is a junior synonym of *Rhamphomyia* (s.str.) *sulcata* (Meigen, 1804).

Rhamphomyia schistacea Meigen, 1822
Rhamphomyia schistacea **Meigen, 1822, Syst. Beschr., 3: 57**

Described from one male from Hoffmannsegg's collection and one female from Aachen. The species is absent both in Paris and Vienna. *Rhamphomyia schistacea Meigen,* 1822 remains an unrecognized species.

Rhamphomyia sulcata (Meigen, 1804)
Empis sulcata **Meigen, 1804, Klass., 1: 229**

Described from an unknown number of specimens of both sexes without locality specifications. There is one male under the above name in Paris with very light wings, probably *R. cinerascens* (Meigen), and another female, probably *R. sulcata* (Meigen) sensu auct. I hesitated to state lectotype from this part of type series because the male is not convenient from the view of continuity of nomenclature and the female was not distinguishable with certainty from *R. sulcatina* Collin. *Rhamphomyia* (s.str.) *sulcata* (Meigen, 1804) sensu auct. was redescribed by Collin (1961: 383) and Bartàk (1982: 412).

Rhamphomyia tarsata Meigen, 1822
Rhamphomyia tarsata **Meigen, 1822, Syst. Beschr., 3: 45**

Described from a single male from Aachen. There is one male under the above name in the collection fairly well preserved, with right antenna, left hind tibia and right hind leg missing, labelled "1114" and "Rhamphomyia tarsata ♂". I consider it to be a holotype and it was labelled accordingly. *Rhamphomyia (Pararhamphomyia) tarsata* Meigen, 1822 was redescribed by Collin (1961: 380) and Bartàk (1982: 431).

Rhamphomyia tephraea Meigen, 1822
Rhamphomyia tephraea **Meigen, 1822, Syst. Beschr., 3: 47**

Described from a single female without locality specification. There is one very damaged female in the collection with mesonotal hairs missing as well as antennae and both hind tibiae, labelled "Meigen" and "Rhamphomyia teph-

raea ♀". This specimen is belived to be a holotype and it was labelled accordingly. I suppose it is *Rhamphomyia* (s.str.) *laevipes* (Fallén, 1816).

Rhamphomyia umbripennis Meigen, 1822
Rhamphomyia umbripennis Meigen, 1822, Syst. Beschr., 3: 54

Described from an unknown number of specimens of both sexes without locality data. In the Paris Museum there are two males of *Rhamphomyia nigripennis* (Fabricius) and one damaged female and one male of *R. umbripennis* Meigen sensu auct. All these specimens are obviously syntypic. The latter male of *R. umbripennis* was selected as a lectotype. It is a fairly well preserved specimen with left middle leg missing as well as left haltere and hind tibiae on both sides, labelled "Meigen" and "umbripennis ♂". It is hereby designated as a lectotype of *Rhamphomyia (Holoclera) umbripennis* Meigen, 1822, and it was labelled accordingly. This species was redescribed by Barták (1982: 450).

APPENDIX

Notes on other *Rhamphomyia* in Meigen's collection in Paris.
— 1♂ of *R. variabilis* (Fallén, 1816) under "culicina"
— 1♂ and 1♀ of *R. flava* (Fallén, 1816) under "flava"
— 1♀ of *R. stigmosa* Macquart, 1827 under "laevipes"
— 1♀ of *R. marginata* (Fabricius, 1787) under "marginata"
— 1♂ of *R. crassirostris* (Fallén, 1816) under "nigripes"
— 1♂ of *R. variabilis* (Fallén, 1816) and 1♂ of *R. sciarina* **(Fallén, 1816)** under "sciarina"
— 1♂ of *R. variabilis* (Fallén, 1816) under "tenuirostris"

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I am very much indebted to Dr. Loic Matile (Paris) for enabling me to study the Meigen's collection in Paris and to Dr. Ruth Contreras — Lichtenberg (Vienna) for checking Meigen's types in the Vienna Museum. I thank also Dr. Milan Chvála (Prague) for many suggestions given me during this type revision.

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PRENATAL DEVELOPMENT OF THE EYE OF THE ASIAN MUSK SHREW, SUNCUS MURINUS (MAMMALIA, INSECTIVORA)

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A b s t r a c t. The development of the eye primordia of *Suncus murinus* embryos was studied. Lens vesicles appeared toward the end of day 14 and they as well as the optic cup completed development between days 17.5 and 19. Sensory layer differentiation of the optic cup began at that time but was incomplete at birth. The nictitating membrane originated about day 21 and rearranged by day 23, perhaps to accomodate a cartilage stiffening plate reported for adults. The pigmented epithelium differentiated between day 16 and 17.5. The lens vascularized by day 19. In some cases the hyaloid artery persisted until 13 days after birth. With minor exceptions, the eye at term resembled that of the adult organ. Eye development in *Suncus murinus* is compared with that of other mammalian species including the human eye. In addition, a pathological phenomenon in the form of a retinal cyst was found in some individuals involved in this study. This observation, however, revealed no definite anatomical basis for the poor eyesight attributed by others to representatives of the family Soricidae.

INTRODUCTION

It is a common belief, on the basis of limited behavioral observations, that shrews have a reduced sight capacity (R o o d, 1958; V l a s á k, 1970; V e r r i e r, 1935; R o c h o n - D u v i g n e a u d, 1943; Grassé, 1955) or are capable of only light/dark visual distinction (S h a r m a, 1958; B r a n i š, 1988).

The olfactory, tactile and auditory senses of shrews are well developed (G o u l d et al., 1964; B u r d a, 1979; Šibkov, 1979; B u r d a and B a u e r o v á, 1985; S i g m u n d and S e d l á č e k, 1985; S e d l á č e k, 1986) It has been suggested that the eyes of shrews function poorly, however, this has not been supported by anatomical or physiological evidence. No case of optic degeneration or developmental arrest was reported in some eight species of adult shrews previously studied (S c h w a r t z, 1935, G r ü n and S c h w a m m b e r g e r, 1980; B r a n i š, 1981, 1985a, 1986). Neither recent studies on the eye (B r a n i š, 1985b; S i g m u n d et al., 1985) nor behavioral experiments (S i e g m u n d and S i g m u n d, 1983; R i s s m a n et al. in press) could confirm any reduction in eye morphology or eye function.

Observations of *Suncus murinus* during 22 years of a captive breeding program suggest that animals of all ages navigate with agility in a variety of enclosures. The young experience rapid postnatal development and acquisition of musculo-sensory coordination (D r y d e n, 1968; D r y d e n and R o s s, 1971; S t i n e and D r y d e n, 1977). Tactile sensation and audition are established and the eyelids open during the first 10 days of life, but satisfactory tests of their visual acuity have not been conducted. The anatomy of the eye has only been partially described for adults (S h a r m a, 1958) and a detailed

Table 1. Appearance and thickness (mean ± SEM, μm) of neuroptic features in *Suncus murinus* embryos and fetuses of indicated age (days)
+ = presence and − = absence of a structure, NM = damaged and not measurable

Structure	14	15.4	15	17.5	19	21	23	25	28
Retinal neural layer	−	47 ± 2	37 ± 3	59 ± 4	75 ± 7	−	−	−	−
Outer neuroblastic layer	−	−	−	−	−	59 ± 6	−	−	−
Inner neuroblastic layer	−	−	−	−	−	28 ± 2	−	−	−
Outer nuclear layer	−	−	−	−	−	−	72 ± 2	80 ± 1	86 ± 1
Inner plexiform layer	−	−	−	−	−	−	18 ± 1	15 ± 2	16 ± 2
Ganglion cell body layer	−	−	−	−	−	−	10 ± 1	11 ± 1	10 ± 1
Nerve fiber layer	−	11 ± 1	10 ± 1	11 ± 2	16 ± 2	10 ± 1	9 ± 1	8 ± 1	6 ± .5
Optic nerve	−	−	−	−	25 ± 1	56 ± 1	57 ± 1	NM	74 ± 2
Pigmented epithelium	−	−	−	6 ± .5	9 ± 1	9 ± 1	8 ± 1	7 ± .5	7 ± .5
Visual cells nuclei	−	−	−	−	−	−	+	+	+
External limiting membrane	−	−	−	−	−	−	+	+	+
Internal limiting membrane	−	−	−	−	−	−	+	+	+
Nictitating membrane	−	−	−	−	−	−	+	+	+
Outer plexiform layer	−	−	−	−	−	−	−	−	+
Inner nuclear layer	−	−	−	−	−	−	−	−	−

account of the embryonic eye development of the soricid eye is lacking (with the exception of *Sorex araneus*; Braniš, 1985b, 1986). Thus acquisition of eyesight early in life or the basis of its possible subsequent reduction remains an open question.

Accordingly, we report here the prenatal development of the ocular apparatus in a series of *Suncus murinus* embryos and fetuses to document its morphologic composition prior to birth and to compare it with that of other species whose eye ontogeny is known and postnatal vision is testable. Eyes of early postnatal shrews were also examined to facilitate the comparison of these structures with those of other species of wild soricids of unknown age.

MATERIALS AND METHODS

Embryos studied were from the colony described by Dryden (1975). Embryonic age ranged from 14 days (crown rump length, CRL = 3.2 mm) to 28 days (CRL = 21.6 mm) of the 28—30 day gestation period (Dryden, 1969). All tissues were fixed in alcohol-formol-acetic acid, dehydrated in ethanol and prepared according to standard histologic procedures for paraffin and paraffin-paralodion embedding. Entire heads of animals through 21 days, but only blocks containing the eyes of older embryos and fetuses were sectioned (one transversely, one longitudinally). Serial sections were cut at 6—10 μm and stained with Harris haematoxylin and eosin. Measurements were made with a calibrated ocular micrometer and the mean dimensions (10 measurements per one structure) ± standard error of the mean were recorded in Table 1.

Ages of the 17 embryos utilized in this study were: 14 days (2); 14.5 days (1); 15 days (1); 17.5 days (3); 19 days (1); 21 days (2); 23 days (2); 25 days (2) and 28 days (3). Five postnatal shrews were also examined: 2 days (2) and 13 days (3).

RESULTS

14 days (CRL = 3.2 mm):

The first indication of the eye primordia was the presence of bilateral, expanded optic vesicles broadly continuous with the diocele.

14.5 days (CRL = 3.75 mm):

The head ectoderm overlying the invaginating rim of the optic cup has thickened to form a lens placode. A slight invagination just below the center of the placode indicated the origin of the fovea lentis (lens pit), heralding secondary optic cup formation. The cells of the neural retina were densely packed and contained round nuclei. Histologic differentiation in this layer had not begun but many mitotic figures characterized the periphery of the optic cup. The pigmented epithelium was composed of low columnar epithelium devoid of granules.

15 days (CRL = 3.9 mm):

This stage of development was characterized by an overal enlarged optic cup and constricted lens pit margin (Figs. 1, 2).* The deep lens pit communicated with the amniotic cavity by the lenticular aperture. The neural tube was subdivided into a nucleated zone ($37.0 \pm 3.0\ \mu m$ thick) and an acellular, translucent zone ($19.0 \pm 1.0\ \mu m$ thick) lining the nucleated layer toward the lens vesicle. The low columnar cells of the presumptive pigmented epithelium did not contain pigment granules at this time. Neither a hyaloid artery nor annular vessel rudiments were found in the optic cup, however, some erythrocytes were found in this area.

17.5 days (CRL = 6.3 mm):

The eyelid primordia began to develop as lateral head outgrowths at the periphery of the optic cup (Fig. 3)*. Secondary eyelid structures could not be identified. The margins of the lens vesicles have fused but the vesicles remain attached to the head ectoderm by a strand of newly formed lens epithelium. Each lens vesicle was comprised of three regions (Fig 4): 1) the lens epithelium; 2) the proliferative zone; 3) primary lens fibres. The nucleated (neuroblastic) layer and the acellular (marginal or fibrous) layers are $59.0 \pm 6.0\ \mu m$ and $11.0 \pm 2.0\ \mu m$ thick, respectively. Pigment granules began to accumulate in the pigmented epithelium adjacent to the optic disc but diminished anteriorly toward the periphery of the optic cup. The mean thickness of the pigmented epithelium is $6.0 \pm 0.5\ \mu m$.

The hyaloid artery entered the optic cup via the optic fissure. Main branches were found in the area between the primary vitreous and the marginal zone. The annular vessel primordium entered the optic cup between the cup rim and the edge of the lens vesicle. Neither the hyaloid artery nor the annular vessel could be found attached to the fibrous tunic of the lens. The choroid plexus was also identified external to the pigmented epithelium and the optic nerve began to grow toward the diencephalon.

Two cases of a pathological phenomenon in the form of the retinal cyst were identified at this age.

19 days (CRL = 8.6 mm):

The eyelids have become more prominent and more vascularized but have not fused. The conjunctiva formed and was composed of a layer of low columnar cells. The lens epithelium remained unseparated from overlying head ectoderm (corneal primordium). Lens fibers were prominent and the proliferative zone more centrally located (Fig. 5). The tunica lentis had formed and the hyaloid

*Figs. 1—8 will be found at the end of this issue.

artery and annular vessels have begun to form the tunica vasculosa lentis. The optic cup is nearly devoid of an optocoele by day 19 and the sensory layer of the retina was still composed of a neuroblastic layer whose thickness had increased to $75.0 \pm 7.0\ \mu m$. The pigmented portion of the future pars caeca retinae, in the vicinity of the lens body was thickened (Fig. 5) in preparation for corpus ciliare and iris formation. The future pigmented epithelium is $9.0 \pm 1.0\ \mu m$ thick.

The formation of the choroid vascular net marked the beginning of choroid development. Mesenchyme surrounding the choroid net multilaminar and eventually contributed to the choroid and sclera, while that sandwiched between the lens and head ectoderm presages the cornea.

The optic nerve ($25.0 \pm 1.0\ \mu m$ in diameter) reached the diencephalon floor and was surrounded by the precursor of the retractor bulbi muscle. The medial, lateral, superior and inferior recti muscles could be identified but not the superior and inferior obliques. The trochlear, oculomotor, and abducens nerves could not be identified. A retinal cyst occurres in the right eye of this embryo.

21 days (CRL = 10.0 mm):

The eyelids were not fused and no accessory structures were present. The cavity of the lens vesicle was reduced to a thin, crescent shaped space and the lens epithelium remained attached to the corneal primordium. The sensory retina was composed of four distinct layers: 1) a developing external limiting membrane; 2) a light staining nuclear layer ($28.0 \pm 2.0\ \mu m$ thick); 3) a dark staining nuclear layer ($59.0 \pm 6.0\ \mu m$ thick); and 4) a fibrous layer ($10.0 \pm 1.0\ \mu m$ thick). The pigmented layer resembled that of the day 19 embryo. This was the youngest embryo in which the choroid fissure could no longer be found. The optic nerve was $56.0 \pm 1.0\ \mu m$ in diameter.

23 days (CRL = 14.0 mm):

The eyelids have fused and a few epithelial buds have developed along with the orbicularis ocule muscle. The cavity of the lens vesicle was reduced to a narrow, crescentric slit bounded anteriorly by a single layer of cuboid epithelium (Fig. 6). The choroid and sclera, though indistinguishable from each other, were represented by a loose aggregate of mesenchyme and fibers. The sensory retina contained seven distinct layers. These included: 1) the underdveloped layer of photoreceptor cells 2) the external limiting membrane. 3) a layer of darkly stained nuclei as well as a layer of lighter stained nuclei ($72.0 \pm 2.0\ \mu m$). 4) an inner plexiform layer ($18.0 \pm 1.0\ \mu m$ thick), 5) a ganglion cell body layer ($10.0 \pm 1.0\ \mu m$), 6) the fibrous layer ($9.0 \pm 1.0\ \mu m$) and 7) the internal limiting membrane. The optic nerves were $57.0 \pm 1.0\ \mu m$ thick. The pigmented epithelium contained a large amount of pigment and was $8.0 \pm \pm 1.0\ \mu m$ thick. The pigmented pars iridica retinae and the unpigmented pars ciliaris retinae were identified at the anterio-lateral portion of the lens and appeared to be growing medially. The cartilage support noted in the adult nictitating membrane began to develop (Fig. 6).

25 days (CRL = 18.1 mm):

Significant modifications of the eye since day 23 were the development of more epithelial buds along the eyelid periphery and a reduction of the lens vesicles. The anterior chambres of the eye began to resemble their adult counterparts. The layer of mesenchyme destined to become the choroid and sclera had not

undergone any further differentiation and resembled that found in the 23 day embryo. The pigmented epithelium was $7.0 \pm 0.5\ \mu m$ thick, the outer dense nuclear layer $80.0 \pm 1.0\ \mu m$ thick, the inner plexiform layer $15.0 \pm 2.0\ \mu m$ thick, the ganglion cell body layer $11.0 \pm 1.0\ \mu m$ thick and the fibrous layer $8.0 \pm 1.0\ \mu m$ thick.

Table 2. External features (from Dryden, 1966) and optical characters of *Suncus murinus* embryos and fetuses

Age	External features	Optical features
14–18 days	No digits	Optic vesicle Optic cup with lens pit Choroid fissure Lens vesicle
21–22 days	Stubby digits without claws No vibrissae Pina barely indicated	Closed choroid fissure Nerve fibers in optic stalk Lens cavity obliterated Eyelids forming
23–24	Elongated digits with rudimentary claws Prominent vibrissal hillocks Pinae formed	Eyelids fused Epithelial buds starting Retina stratified
28 days	Digits well formed with obvious claws Vibrissae emerged Pinae protrude as rims	Outer plexiform layer forming Lens still incomplete Cornea underdeveloped Iris and ciliary body differentiate

28 days (CRL = 21.6 mm):

The eyelids show increased vascularization and epithelial bud formation (Fig. 7). The lens retained a crescentric cavity which was not lost until day 2 post partum. The lens epithelium was markedly separated from the cornea and formed the anterior chamber of the eye. The cornea contained three distinct layers: 1) an underdeveloped corneal epithelium, 2) a connective tissue lamina, and 3) a very poorly developed endothelium.

Photoreceptor cells had developed near the porus opticus and those nuclei adjacent to the external limiting membrane were arranged into several rows of darkly staining nuclei — the future outer nuclear layer ($36.0 \pm 1.0\ \mu m$ thick). Development of the external plexiform layer began at the porus opticus and continued peripherally. The inner plexiform layer was well developed and $10.0 \pm 1.0\ \mu m$ thick. The ganglion cell body layer was capped by a fibrous layer ($6.0 \pm 0.5\ \mu m$ thick) and the internal limiting membrane. The optic nerve was $74.0 \pm 2.0\ \mu m$ thick.

A retinal cyst occured in one eye of one of the three fetuses studied.

Subsequent to the 28 day of development there was some indication of pigmentation of the pars ciliaris retinae, which was in contact with the lens periphery at day 28. Von Szilli's cavity (marginal or ring sinus) was identified between the pars ciliaris and pars iridica retinae. Choroid and scleral thickness varies and in some places the choroid (still without pigment) cannot be distin-

guished from the sclera. The inner nuclear layer can be resolved 13 days after birth but its continued morphogenesis requires greater clarification.

DISCUSSION

Prenatal eye development in *Suncus murinus*, in general, resembled eye development in other mammals, especially nonprimate altricious species (Braekevelt and Hollenberg, 1970; Pei and Rhodin, 1970; Jackson, 1976). Optic vesicles in *Suncus murinus* are born by relatively short stalks but are otherwise unremarkable. The first indication of the eye primordia, the expanded optic vesicles. were identified comparatively later (day 14) than in other mammalian species studied. The optic vesicle appeared in mice (Pei and Rhodin. 1970; Theiler, 1972) and hamsters (Jackson, 1976) on day 9 of development; in rats on day 11 (Braekevelt and Hollenberg, 1970) and in *Sorex araneus* between day 10 and 12 of embryonic development (Braniš, 1986). The fourteen-day *Suncus* optic primordium resembled that of the human at age 3.5 weeks (O'Rahilly, 1983). Table 3 compares the timing of events in the development of the *Suncus* eye with other mammalian species including man.

The three lens zones of the human at week 6 can be found in *Suncus murinus* at day 17.5. In both species cells of the proliferative zone extended into the distal lens. Primary lens fibers in humans are formed by week 7 and completely obliterate the lens cavity (Barber, 1955; O'Rahilly, 1983), whereas in the musk shrew, cavity obliteration is not accomplished until two days post partum (only a thin slit exists on day 28). In the common shrew, primary lens fibres begin to form by days thirteen to fifteen and obliterate the lens cavity between day 17 and 18 (Braniš, 1986). In mice, the lens cavity is closed by day 13—14 (Pei and Rhodin. 1970).

Human eyelids appear about week 7 (Barber, 1955; O'Rahilly, 1983), fuse by week 9 and reopen in utero (Nelsen, 1953). *Suncus* eyelid primordia appeared between days 15 and 17.5 and fused by day 23 only to reopen 7—10 days after birth (Dryden, 1968). Similarly in the common shrew, eyelids form about day 16, close on day 20 of embryonic development and reopen approximately 17—20 days post partum (Braniš, 1986). House mouse eyelids, however, originate by day 14 and fuse within three days, to reopen some 12—14 days post partum (Theiler, 1972). The nictitating membrane of *Suncus murinus* developed 2—4 days after that of the mouse but unlike the mouse was initially devoid of cartilage. Cartilage subsequently developed in the adult (Sharma, 1958).

The sensory layer of the *Suncus murinus* eye at day 17.5 resembled that of the 26 mm human, the difference being that there was no transient layer of Chiewitz (a characteristic of the human, Barber, 1955) recorded in the shrew. According to Mann (1928) the presence of the Chiewitz layer can be missed in small animals due to relatively rapid prenatal development of retinal structures. In all mammalian species studied to date the neuroblastic layers differentiate peripheral to the optic cup equator. This occurs in humans by the end of the second month (Barber, 1955) but not until relatively later in *Suncus* (25—29 days) and approximately days 2—5 post partum in the common shrew (Braniš, 1986). Nuclei of the rods and cones can be distinguished from the other nuclei of the human sensory retina by the end of the third month (Barber, 1955). In the 23 day Suncus fetus, nuclei of the visual cells

and the inner nuclear layer appear unseparated by a physical barrier but were partially distinguishable by their staining characteristics. The cells of the inner nuclear layer stained much lighter than those of the outer nuclear layer. Ten layers of the retina are established in the human (Barber, 1955) and are photoreceptive (Arey, 1974) between 5—10 months in the human. In *Suncus murinus*, however, anatomical completion of the retina is delayed until after birth. This phenomenon is not unusual and is a characteristic feature of many other altricious mammalian species, such as: rats (Braekevelt and Hollenberg, 1970); mice (Caley et al., 1972); cats (Moore et al., 1976; Vogel, 1978); rabbits (Noel, 1958); common shrew (Braniš, 1958b). Pigmentation of the pigmented epithelium in the human is complete by the fifth week of development (Barber, 1955); days 16—18 in the common shrew (Braniš, 1986), but not until day 23 in *Suncus*.

The iris rudiment developed in the musk shrew between days twentyfive and 28, thus paralleling that of the human at 12 weeks and the common sherw at 2—4 days post partum (Braniš, 1986). In both *Suncus* at day 21 and humans at 3 months (Barber, 1955) the optic cup margin reached the periphery of the lens and continued to extend around the anterior surface of it such that a portion of the bilaminar cup overgrew the lens. The external columnar layer of cells connected posteriorly with the pigmented epithelium. This internal layer represented the pars iridica retinae, which became pigmented near term in *Suncus* but about mid term in humans. In humans (CRL = = 65—70 mm) and musk shrews (day 26—28) a marginal sinus (von Szilli's ring) appeared at the extreme tip of the growing cup. The sinus disappeared from the human eye during the seventh month (Barber, 1955) and some time between day 28 of gestation and 2 days post partum in *Suncus*.

In many of the mammalian species studied corneal development begins before the eyelids fuse, but the cornea of *Suncus murinus* apparently does not differentiate corneal stroma, layered epithelium, Bowman's membrane or Descement's membrane by day 28. Similarly, in *Sorex araneus* the main period for corneal development takes place several days post partum (Braniš, 1986).

In *Suncus* the hyaloid artery at day 17.5 was not attached to the tunica fibrosa lentis. Upon entering the eye it repeatedly branched radially between the primary viterous and the internal limiting membrane, unlike that of the human which sends a main branch to the posterior lens with only lateral sprouts. Annular vessels of the 13 mm human resembled those of musk shrews about day 17.5. Similarly, the choroid plexus of *Suncus murinus* at day 17.5 resembled that of the 18 mm human (Barber, 1955). The choroid and sclera of *Suncus murinus* seem to develop simultaneously, though apparently not until 2 days after birth unlike the human whose sclera develops anterio-posteriorly completing development by the seventh month (Barber, 1955). These events were comparable to choroid and sclera development in the common shrew. In the latter species both structures were indistinguishable before the eight day post partum when choroid pigmentation occured (Braniš, 1985b).

Presumeably, due to staining procedure, many characteristics of the musk shrews vitreous body were not identified, however, the primary vitreous body was found between day 15 and 17.5. The secondary vitreous was undetected by day 28.

In addition to those sequential differences noted, 8 of the 17 (47 %) embryos and fetuses studied presented interesting retinal anomalies consisting of localy

Table 3. Approximate times of appearance of optical features in embryos and fetuses of *Suncus murinus* compared with those of humans (Arey, 1974), house mice (Theiler, 1972) and common shrews (Braniš, 1986)

Feature	Human (weeks)	Mouse (days)	*Sorex* (days)	*Suncus* (days)
Optic vesicle	3.5	9.5	10—12	14
Optic cup, lens pit	4	10	NA	14.5
Choroid fissure	5	10—10.5	NA	15—17
Free lens vesicle	5	11—11.5	13—15	15—17
Vitreous body	5	13	13—15	15—17
Optic cup with pigmented epithelium and nerv. layer	6	11.5	13—15	15—17
Lens vesicle thickens	6	12	16	15—17
Choroid fissure closed	7	12	NA	17—21
Nerve fibers in stalk	7	12	16	17—21
Lens cavity lost	7	13	17—18	17—21
Eyelids form	7	13	16	17—21
Iris and ciliary body	10	17—18	4 PP	23
Eyelids fused	10	16—17	19—20	21—23
Layered retina	12	17	4—6 PP	23—28
Retinal layers complete	28	10 PP	13 PP	PP (NA)
Eyelids reopen	28—32	12—14 PP	17—19 PP	7—10 PP

NA — information not available, PP — post partum

separated retinal cysts protruding into the vitreous chamber. These retinal cysts varied in size and occured in one or both eyes of an individual, persisting to term (Fig. 8). The incidence of retinal infolding in these animals is inexplicable but may be a consequence of lack of outbreeding. The colony has been closed to significant genetic influx for 20 years.

Behavioral studies (Rood, 1958; Grünwald, 1969) suggest that shrews have a reduced sight capacity and orient non-visually (Gould et al., 1964; Burda, 1979). Paradoxically, all published accounts of adult soricid eyes document well developed retina and a recent, comprehensive analysis of the eyes of 8 species of European shrews revealed all species had a normally developed optical apparatus (Braniš, 1981; 1985a; 1985b; 1986; Sigmund, 1985; Sigmund et al., 1985). The ability to respond to photoperiod has recently been reported for *Suncus murinus* by Rissman et al., (in press). The apparent delayed development of receptors established in the present study for the musk shrew correspond with the timing and developmental sequence of events of retinal structures in other (non-primate, altricious) small mammals including the related soricid — the common shrew.

Appart from the aformentioned pathological phenomenon — the retinal cyst — this study reveals no major developmental arrest of the prenatal *Suncus* eye. We conclude that any reduced (or limited) sight capacity could be caused similarly as in other microophtalmic animals not by the developmental arrest or by degeneration of structures but by the size of the visual organ. The eye of *Suncus murinus* as well as that of other soricids does not posses highly specialized structures and regions as an area or fovea centralis. Consequently, due to the low number of retinal cells, it probably cannot functionally compare

with the large well developed eyes and high resolution of diurnal primates and ungulates or carnivores.

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ECOLOGY OF RHITHROFAUNA IN THE TORRENTIAL WATERS OF GARHWAL HIMALAYA, INDIA: FECUNDITY AND SEX RATIO OF GLYPTOTHORAX PECTINOPTERUS (PISCES)

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A b s t r a c t. The paper deals with the spawning biology of *Glyptothorax pectinopterus* which spawns in the flooded river Nayar during July-August. The fecundity ranges from 1710 to 8050 and is more closely related to the fish weight and ovary weight than the fish length and ovary length. The number of males and females differ significantly with their mean ration of 1 : 1.79.

INTRODUCTION

The breeding biology of Indian carps has received great attention, whereas the freshwater catfishes remain comparatively neglected, which drew author's attention for the present study. Some important contributions to the breeding biology of Indian carps have been made by K h a n (1942, 1945), H o r a (1945), G a n a p a t i et al. (1951), N a t r a j a n and J h i n g r a n (1963), Q a y y u m and Q a s i m (1964), P a r m e s h w a r a n et al. (1972), D e s a i (1973), S o b h a n a and N a i r (1977), T h a k r e and B a p a t (1981), S i n g h et al. (1985) and D o b r i y a l and S i n g h (1987). However, the information on the freshwater catfishes is available in the reports of S a i g a l and M o t w a n i (1961), S a i g a l (1964), D a n n (1977) and D o b r i y a l (1983).

MATERIAL AND METHODS

Glyptothorax pectinopterus (McClelland), a hillstream siluroid catfish, was collected during January through December, 1980 from the river Nayar at Banghat (650 masl). The fish were brought to the laboratory in fresch condition and their morphometric data were recorded. For maturity stages, ova samples were taken after the ovaries were hardened in 5 % formalin solution. Ova diameters were measured by means of an ocular micrometer. For determining maturity stages, the I C E S scale (W o o d, 1930) was modified by combining the two immature stages into one. The frequency of spawning, spawning season, and size at first maturity were studied by tabulation of the percentage occurrence of fish in various maturity stages monthwise and sizewise and also by the ova diameter frequency polygons. For determining the size at first maturity, fish in IV, V and VI stage were considered mature. The gonado-somatic index was also calculated for each fish. Fish of advance maturity were collected during prespawning and spawning period, and fecundity was studied by gravimetric method. Total fecundity was calculated by the formula:

$$F = \frac{S \times OW}{100}$$

where F = fecundity, S = average number of eggs obtained from three different samples of 100 mg each, OW = total weight of ovary in mg. Various relationships

$$\log Y = \log a + b \log X$$

where Y = dependent variable, i.e., fecundity; X = independent variables, i.e., fish total length, fish weight, ovary length, ovary weight; r = Correlation coefficient,

Table 1. *Classification of maturity stages of Glyptothorax pectinopterus* (McClelland) and comparision with the I.C.E.S. scale (Wood, 1930)

Maturity stages	*Ova diameter* Ocular micrometer division (*1 omd = 0.018 mm*)	Peak	ICES stages
Ist. Immature	8—20 omd	12 omd	I—II
IInd. Maturing I	12—48 omd	44 omd	III
IIIrd. *Maturing II*	12—68 omd	48, 60 omd	IV
*IV*th. Mature	12—80 omd	70 omd	V
Vth. Spawning	12—120 omd	80, 100 omd	VI
VIth. Spent	12—100 omd	12 *omd*	*VII*

a and b are the *constants*. The *analysis* of variance (F) was made use for testing the linearity of regression.

RESULTS

Glyptothorax pectinopterus, locally called "Nowu", is an important catfish of the hillstreams of Garhwal Himalaya, India. For maturity analysis, the fishes were classified into different stages of maturity on the basis of the microscopic study of the ova diameters (Table 1).

A. Maturity and spawning

(I) Development of ova to maturity: Ova diameter frequency *polygons* of different maturity stages are presented in Fig. 1. The curves represent average frequencies from samples of specimens *representing* the same stage of maturity. Ova less than 8 ocular micrometer division (1 omd = = *0.018 mm*) were *not* taken into account in the present study.

Stage 1 of maturity was represented by the size group of 8—20 *omd*, with a peak at 12 omd. In stage II, the first batch of ova got separated from the general egg stock with a mode at 45 omd and at a maximum size of 48 omd. Two distinct batches of the ova first appeared in the III stage of *maturity*, the first at 48 omd, and second at 60 omd. In the progressive IV stage of maturity both the batches became *continuous* in one, showing peak value at 68 omd. The two batches of ova again reappeared at the V stage of maturity. It shows that the rapid growth of ova has taken place after it had attained a size of 80 omd. The fish spawned for a limited *period* (*July* — August) with two batches of eggs, continuous to each other. This type of spawning is called protracted spawning.

(II) Frequency of spawning: The frequency distribution of the ova diameter measurements from a mature ovary (stage V) showed two groups of ova represented by the modes 'a' and 'b' at a size of 80 and 98 omd respectively. The two groups of ova were well continuous to each other and spawned one after the other, within a limited period. It showed that the fish *G. pectinopterus* spawned only once a year.

(III) Gonado-somatic-index (GSI): This index was calculated for each individual of male and female fish and monthly average values were

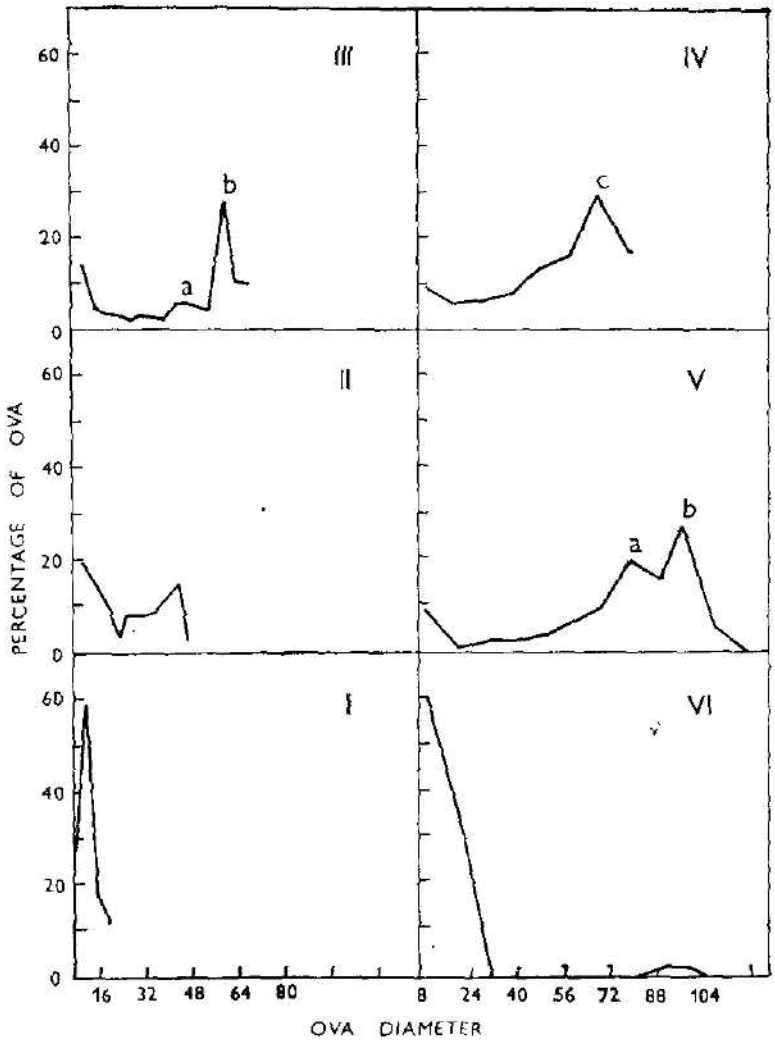

Fig. 1. Ova diameter frequency polygons of ovaries of G. pectinopterus.

calculated separately. In females and males (Fig. 2) maximum GSI values were noticed in June and July respectively, afterwards a gradual decrease was seen

up to December and January. The data supported one, short, limited durational spawning of the fish.

(IV) Size at first maturity: Percentage occurrence of mature fish for both the sexes is graphically represented in Fig. 3. In 100—106 mm length group all the females were immature and the percentage of mature females

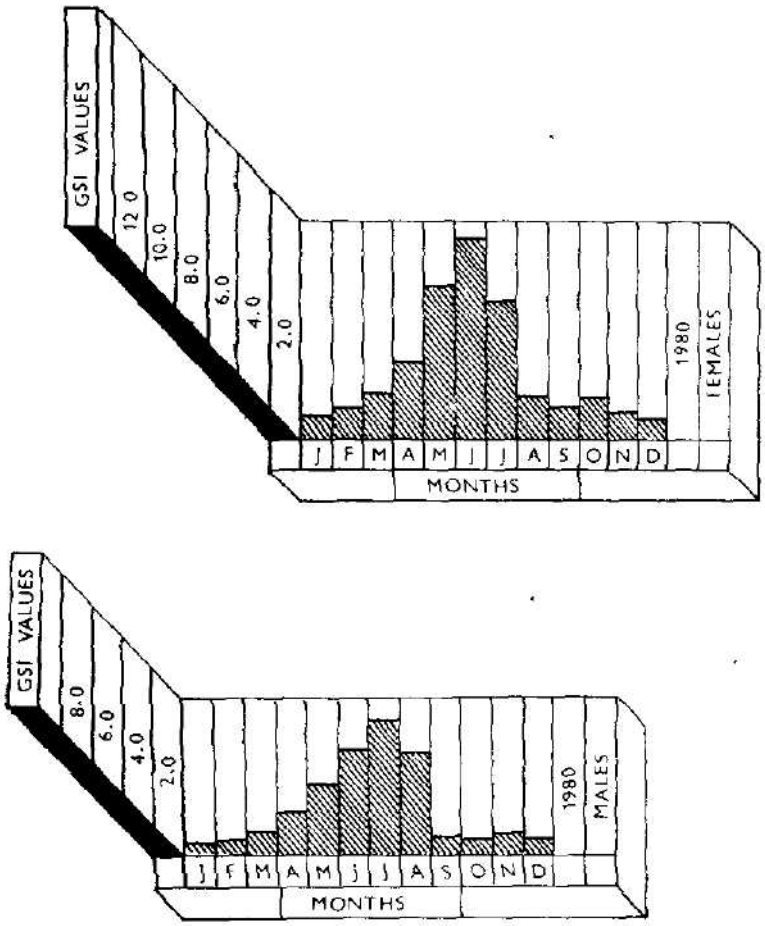

Fig. 2. Gonado-somatic index of *G. pectinopterus.*

increased with length upto 136—142 mm when all the individuals examined were found to be mature. At a size of 110—120 mm, only 1/3 mature males could be obtained. The hundred percentage maturity in males was obtained after the fish had attained a size range of 150—160 mm. The 50 % level in maturity, which has been taken to represent the mean length at which maturity was obtained, were 125 mm for males and 121 mm for females.

(V) Spawning season: The percentage occurence of various stages of maturity is graphically represented in Fig. 4. Fish of advanced maturity (Stage V) were observed in the month of June. The first appearance of spent fish was

observed in July, which continude till the month of August, showing the spawning season from July to August. The maximum number of fish of the first stage of maturity was observed in the month of September which also supported the above observations.

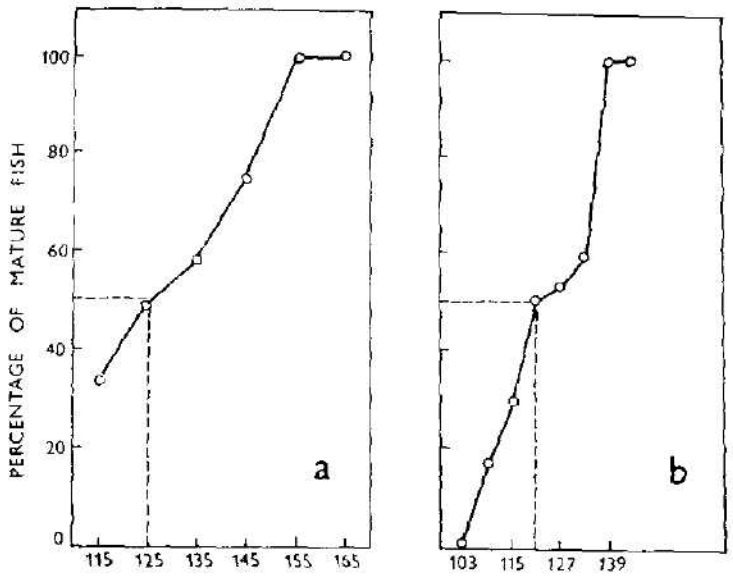

Fig. 3. Mid points of size groups of *G. pectinopterus*, a — males, b — females.

B. Fecundity and Sex ratio

(I) Fecundity : Data on the fecundity of G. *pectinopterus* has been arranged in the Table 2. The total length of fish ranged from 12.1 to 16.0 cm and the

Table 2. *Relationship* between the fish length, fish weight, ovary weight and fecundity in *G. pectinopterus*

Size group (mm)	No. of fish examined	Mean of fish (g)	Mean wt. of ovary (g)	Percentage wt. of ovary	Range in fecundity	Mean fecundity
121—124	15	15.80	1.844	11.67	1600—2200	1866
125—128	12	17.75	2.010	11.32	2100—2360	2230
129—132	13	20.00	2.326	11.63	2030—3200	2677
133—136	15	22.90	2.781	12.14	1800—3400	2555
137—140	13	25.50	2.596	10.18	2100—3000	2600
141—144	14	27.00	2.991	11.07	2460—3600	2953
145—148	14	29.87	4.016	13.44	3100—4450	3841
149—152	13	32.66	4.703	14.39	4640—6035	5449
153—156	16	35.50	6.350	17.88	6000—7120	6560
157—160	09	39.00	7.856	20.14	6030—8050	6903

fecundity ranged from 1710 to 8050 by gravimetric method. Relationships between fecundity and other body parameters were observed to be as:

(a) *Fecundity and fish length*

$\log F = -7.0285 + 4.9253\ FL$ ($r = 0.9495$)

where F = fecundity, FL = fish length. The analysis of variance proved the linearity of regression (observed F = 55.1226, *significant at 1 % level*).

(b) Fecundity and fish weight

$\log F = 1.3157 + 1.576\ FW$ ($r = 0.9806$)

where F = fecundity and FW = fish weight. The result of analysis of variance proved the linearity of regression (F = 151.4255).

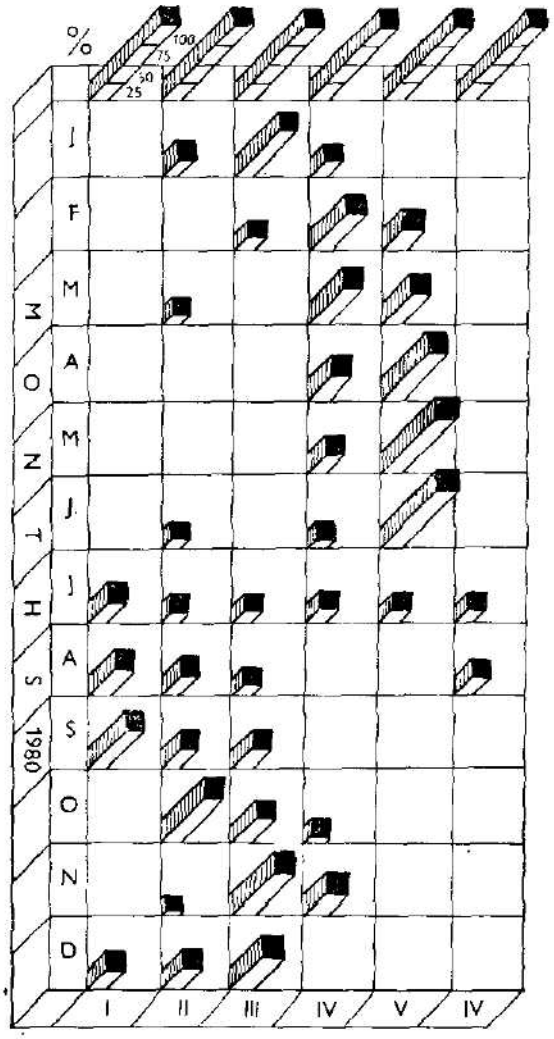

Fig. 4. Percentage distribution of *different maturity* stages of *G. pectinopterus*.

Table 3. Sex composition in *G. pectinopterus* during different months (1980)

Months	Total No. of specimens	Male		Females		Ratio	Expected number		Chi square value	Remarks
		No. of specimens	%	No. of specimens	%	Males : Females	Males	Females		
January	08	03	37.50	05	62.50	1 : 1.66	4	4	0.50	NS
February	09	03	33.33	06	66.67	1 : 2	4.5	4.5	1.00	NS
March	16	06	37.50	10	62.50	1 : 1.66	8	8	1.00	NS
April	07	04	57.14	03	42.86	1.33 : 1	3.5	3.5	0.14	NS
May	11	03	27.27	08	72.73	1 : 2.66	5.5	5.5	2.27	NS
June	41	14	33.30	27	66.70	1 : 1.92	20.5	20.5	4.12	*
July	34	09	24.00	25	76.00	1 : 2.77	17	17	7.52	*
August	23	07	30.43	16	69.57	1 : 2.28	11.5	11.5	3.52	NS
September	10	06	60.00	04	40.00	1.5 : 1	5	5	0.81	NS
October	25	09	36.00	16	64.00	1 : 1.77	12.5	12.5	1.96	NS
November	22	06	27.27	16	72.74	1 : 2.66	11	11	4.54	*
December	15	09	60.00	06	40.00	1.5 : 1	7.5	7.5	0.60	NS
Total	221	79	35.74	142	64.26	1 : 1.79	110.5	110.5	17.95	*

NS = nonsignificant; * = significant at 5 % level

(c) Fecundity and ovary length

log F = 0.834 + 2.8005 OL ($r = 0.96086$)

where OL = ovary length. The analysis of variance proved the linearity of regression ($F = 72.1957$).

(d) Fecundity and ovary weight

log F = 3.0071 + 0.98921 OW ($r = 0.99417$)

where OW = ovary weight .The analysis of variance proved the linearity of regression ($F = 510.64$).

(II) Sex Ratio: The sex composition in *G. pectinopterus* during different months is shown in the Table 3. A total of 221 specimens were examined, out of which 79 (35.74 %) were males and 142 (64.26 %) were females. The number of males and females differ significantly ($x^2 = 17.95$, 11 d.f., at 5 % level) with their mean ratio 1 : 1.79.

DISCUSSION

The study of spawning biology is useful in various applied aspects of fishery. Fishes exhibit various types of spawning tendencies which can be studied from the development of intraovarian eggs. Clark (1934), and Hickling and Rutenberg (1936) were among the pioneers to study the spawning behaviours based on the size distribution of intraovarian eggs in different fishes. According to the present study *G. pectinopterus* spawned for a limited period (July — August) with two batches of ova, continuous to each other. The gonado-somatic index has been employed by various workers to indicate the maturity and periodicity of spawning. The maximum GSI values obtained for female and male *G. pectinopterus* were noticed in June and July respectively. The determination of minimum size at maturity by the tabulation of percentage occurrence of mature fish during spawning season has been made by several workers (Sobhana and Nair, 1974; Thakre and Bapat, 1981; Dobriyal and Singh, 1987). 50 % level in the maturity, which has been taken to represent the mean length at which maturity was obtained, were 125 mm and 121 mm for male and female *G. pectinopterus* respectively.

Studies on the ecology of spawning niches of fish have been made by Khan (1945), Hora (1945), Ganapati and Alikunhi (1950), David (1953), and Dobriyal and Singh (1987). Nikolsky (1963) has proposed a classification of ecological groups of fishes, based particularly on the spawning sites. *G. pectinopterus* spawns in the flooded Nayar with a temperature range of 21—26 °C, pH 7.5—7.8, dissolved oxygen range of 9.5—9.8 ppm and high velocity of water (1—2 m/sec.). In the hillstream fishes any single environmental factor does not seem to act as the stimulus for natural spawning; rather it is a specific combination or interaction of several factors which acts as the stimulus for spawning (Singh, et al., 1985).

The fecundity of fish is the number of mature eggs in the female prior to spawning. Relationship between fecundity and other body parameters have been reported by Desai (1973), Joshi and Khanna (1980), Pathani (1981), Singh et al. (1982) and Dobriyal and Singh (1987). During present investigation, four linear relationships of fecundity with the body measurements of *G. pectinopterus* were observed. Though the fecundity increased with an increase in all the body parameters, yet it was more closely related to the fish weight ($r = 0.9806$) and ovary weight ($r = 0.9941$) than the fish length ($r = 0.9495$) and the ovary length ($r = 0.9608$). The average relative fecundity

for G. *pectinopterus* was observed to be 139.18. Joshi and Khanna (1980) calculated an average relative fecundity of 271 for *Labeo gonius*, while Dobriyal and Singh (1987) found it to be 275.04 for *Barilius bendelisis*.

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THE GROWTH OF THE GRAYLING, THYMALLUS THYMALLUS, (OSTEICHTHYES : THYMALLIDAE) IN THE MORÁVKA VALLEY RESERVOIR

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Abstract. The data base for this study was provided by 103 specimens of the grayling *Thymallus thymallus* (L.) caught in the Morávka reservoir between 1982 and 1984. This sample furnished the material for my calculation of back length and weight. In the fish caught, all in all, 7 age classes were distinguished ranging in length from 175 to 400 mm. The $l_t : l_c$ relationship determined is 1.156. The value of Bank s star is 31.9. Fulton s condition index decreases with age, the average value being 1.38.

INTRODUCTION

Ichthyological research in the area of what today is the Morávka river reservoir was conducted back in the early 1950s by members of the Department of Systematic Zoology, Faculty of Sciences, Charles University, Prague. As no data have so far been published on fish growth in the contemporary Morávka reservoir, the report presented here sums up the results of my dissertation thesis which studied the length and weight parameters of growth in fish species typical for this area.

Characteristics of the Morávka valley reservoir

The Morávka reservoir was constructed on the river of the same name between 1960 and 1966. The size of the drainage area is 63.3 square km, the annual average rate of rainfalls is 1 400 mm. The surrounding area is well forested and despite a small settlement in the locality there are no major sources of pollution. The Morávka reservoir supplies potable water to Frýdek–Místek, Těšín, Třinec, Havířov and Těrlicko. It also improves the water course of the Lučina stream feeding the Žermanice reservoir. The dam spans the narrowest section of the Morávka Valley between the foot of the Kyčera Hill (834 m) on the right bank and the foot of the Malý Travný Hill (1,009 m) on the left bank. The dam is formed by piled-up earth and is fitted with an asphalt shield (length – 396 m, height 39 m). The crest of the dam is situated at the elevation of 518,8 m.

The inundation area measures 79.5 ha, its length is 2.8 km, width 200 m. The total capacity of the reservoir is 11 299 million cubic metres, its reserve capacity – 4,33388 mil cubic metres. The average annual rate of flow is 1.76 m^3/sec. The reservoir has two tributaries. The chief (and more powerful) tributary is the Morávka, the second tributary is the Slavíč (on the right side). The left bank of the reservoir is formed by a steep slope abounding in spruce and beech forest vegetation (*Ženatý, Maníček, Zubek, 1984*).

The right bank is a gentle slope overgrown with grass, except for the left bank of the Slavíč river and the right bank close to the mouth of the Morávka river. Brown-trout spawning occurs every year in both tributaries. The grayling, however, only spawns in the Morávka tributary. From 1982 to 1985 the following fish species were identified in the reservoir: the brown trout, *Salmo trutta* m. *fario* (Linnaeus, 1758), the rainbow trout, *Salmo gairdneri* (Richardson 1836), the brook trout, *Savelinus fontinalis* (Mitchill, 1815), the grayling, *Thymallus thymallus* (Linnaeus, 1758), the perch, *Perca fluviatilis* (Linnaeus, 1758), the gudgeon, *Gobio gobio* (Linnaeus, 1758), the minnow, *Phoxinus phoxinus* (Linnaeus, 1758), the chub, *Leuciscus cephalus* (Linnaeus, 1758).

On 1 January 1978 the "Povodí Odry water management enterprise assumed control over the use and management of the Morávka reservoir and acting in this capacity has replaced in function the former management authority, viz., the Czech Angler s Union.

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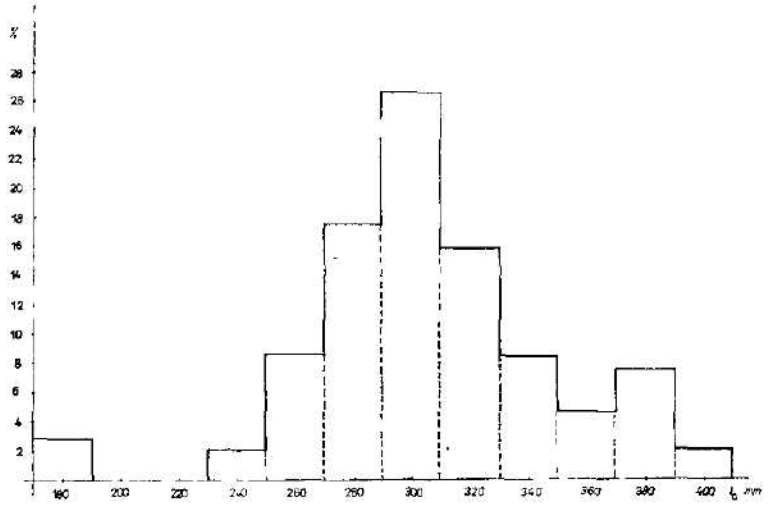
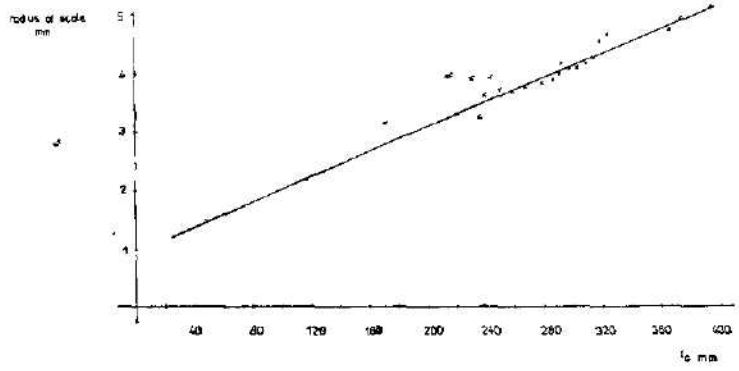
MATERIAL AND METHODS

The data for this study were collected between 1982 and 1984. The scales for my study of fish growth were obtained from 103 specimens of the grayling. About 50 % of the material was acquired during the spring season through electrofishing in the spawners of the main tributary (i. e. in the Morávka river), up to the distance of about 1,000 m from the edge of the impoundage of the reservoir. Further material was obtained by the use of gill nets (the size of matches 3 × × 3 cm, height 3 m, length 20 m). For reasons of speedy and more efficient manipulation, the



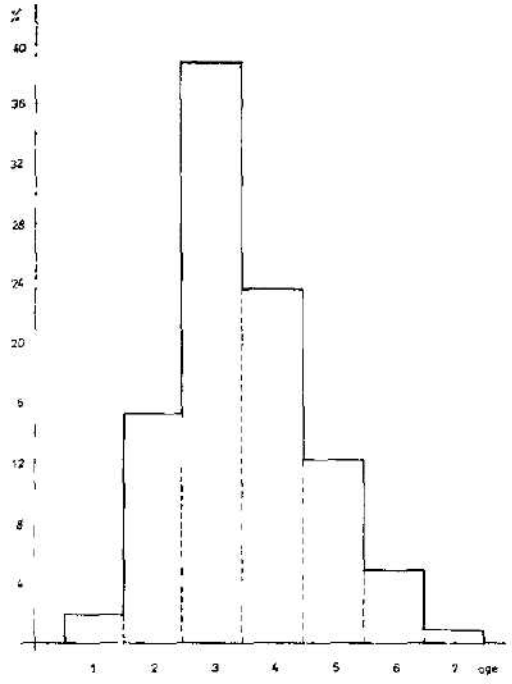
Graph 1. The number of graylings in different length groups in relation to the total number of fish expressed percentually.

gill nets were used only during the day. I checked the nets in 30 min intervals. After weighing and sampling was completed, the catch was released back to water. 3—5 scales were extracted from each specimen on the left side below the lateral line above the base of the ventral fin. The structure of the scales was studied with the "Meoflex RI 21 P" device (magnification — 21 ×). Only scales with the most distinct annulus were analyzed. The *ventrodiagonal radius of scale* was used for measurements. In the calculation of back length growth the Rosa Lee method was applied.



Graph 2. The relation of the ventrodiagonal radius of scales and length of graylings body from the reservoir Morávka.

Using the linear regression principle, I calculated the constants of the relationship between the body and the radius of scale and correction value. The length of each fish was calculated by means of the Lea board using the corresponding correction. The constants of the equation of the length-weight relationship were likewise calculated from the linear regression. Introducing the regressive calculated length to this equation, I then calculated the weight values of fish obtained for the respective length of body. From the dimensions thus determined I then calculated Fulton s coefficient K and l_t/l_c relation.



Graph 3. The age composition of graylings expressed in percent of the total number of collected fish.

RESULTS

The growth of the grayling in Czechoslovak waters was studied by Balon (1953), Hochman (1964), Sedlár (1970), Naiksatam (1974), Bastl, Holčík, Kirka (1975), Peňáz (1975). The number of fish in different length groups in relation to the total number of graylings is expressed percentually in Graph 1. The

Table 1. The average regressive reckoned of the length of graylings in single years of life
l_1—l_7 — the length of the body (mm)

	l_1	l_2	l_3	l_4	l_5	l_6	l_7
	108	215	285	319	339	368	394
min.	76	158	217	255	373	355	—
max.	153	253	336	367	363	400	—

Table 2. The average length growth of grayling in Czechoslovak waters $l_1 - l_7$ — the length of body in single years of life

Locality — author	l_1	l_2	l_3	l_4	l_5	l_6	l_7
Poprad							
Nieslanik (1963)	64	111	216	244	287	—	—
Revúca							
Balon (1953)	73	166	239	285	315	—	—
Hron							
Jedral (1965)	75	150	200	241	268	—	—
Vrica							
Kirka (1962)	88	160	236	279	—	—	—
Belá							
Nieslanik (1963)	89	161	211	228	279	—	—
Moravice							
Hochman (1957)	90	180	236	279	—	—	—
Nitra							
Sedlár (1970)	94	162	209	254	298	—	—
Hornád	99	174	218	—	—	—	—
Hornád							
Jedral (1965)	99	174	218	—	—	—	—
Vltava							
Naiksatam (1974)	111	156	192	220	—	—	—
Turiec							
Nieslanik (1963)	113	172	217	260	335	343	—
Svratka							
Lusk (1975)	116	205	254	285	300	303	—
Reserv. Svratka							
Lusk (1975)	122	227	291	329	353	269	384
Div. Orlice							
Hochman (1964)	127	201	254	289	241	—	—
Reserv. Dobšná							
Balon (1962)	147	224	269	294	311	—	—

relationship between ventrodiagonal radius and body length is expressed as

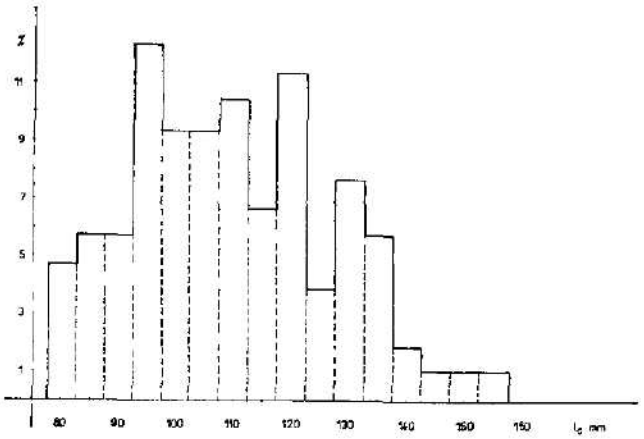
$$y = 19.65294 + 0.23155 \times l \text{ (see Graph 2)}$$

The length of body at the start of the scale formation calculated from this equation was regressive. Using Monastyrsky's logarithmic method I have received similar results. According to Peňáz's (1975) study of the postembryonal development of the grayling, scales are formed at the length of the body 29.6 mm. For the back length calculation of growth I therefore used a 30 mm correction. Table 1 presents

Table 3. The average weight growth of graylings in the reservoir Morávka during single years of life with given mm. and max. reckoned values

	g_1	g_2	g_3	g_4	g_5	g_6	g_7
	24.0	149.0	312.0	423.0	495.0	611.0	733.0
mm.	9.7	35.3	154.0	235.0	438.0	471 0	—
max.	52.4	257.0	448.0	614.0	641.0	768.0	—

the results of back length calculation with minimum and maximum values. The table reveals discrepancies in the length of growth. Absolute annual lenght increases diplay a generally downward trend with the increasing age of the fish. The average value of all years is 48 mm. For the frequency distribution of the calculated body lengths to the first annulus see Graph 4. The graph shows that most graylings (53 %) reached the 95—120 mm range in body length to the first annulus. On the basis of body lengths (the end of the scale covering) and total length I then ascertained the $l_t : l_c$ relation as 1.156.

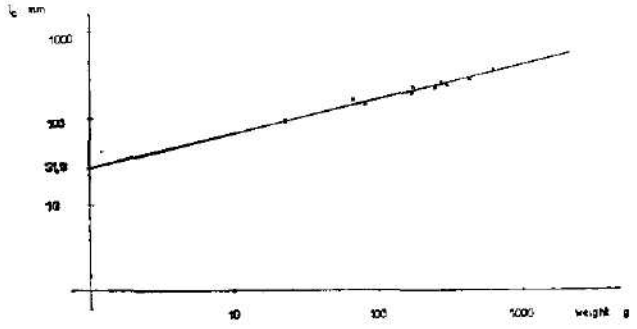


Graph 4. Frequency distribution of the calculated body lengths to the first annulus expressed in percent of the total number of collected graylings.

The length-weight relationship of the grayling can be expressed as follows:

$$\log w = -3.95220 + 2.62719 \log l \text{ (see Graph 5)}$$

Table 3 traces weight growth in individual years of life and specifies the minimum and maximum values recorded in the process of growth. The value of Bank's start is 31.9 mm. Table 3 reveals considerable discrepancies in weight growth. On the



Graph 5. The relationship of the length and weight of graylings from the reservoir Morávka in the logarithmic scale.

basis of the calculated back length and weight values I have calculated Fulton's condition index. The average value of Fulton's condition index for all years of life is K = 1.38.

DISCUSSION

During the scale analysis of the grayling I assumed linear growth in the diagonal scale radius in relation to body length as described by Sedlár (1970) and Naiksatam (1974). The negative length of fish expressed by the linear regression in terms of the measured values can be explained by the nonregular distribution of the fish caught and by the absence of the grayling in the first age class (Graph 3). In congruence with Sedlár (1970), I, too, have found considerable differences in the size of scales in grayling specimens of the same length. My use of the 30 mm correction value is based on Peňáz's study (cf. Peňáz 1975). Lusk (1975) used the 12 mm correction, Sedlár (1970) the 30 mm correction. On the basis of the length growth of the grayling in other reservoirs (see Table 2) growth in the valley of the Morávka reservoir can be estimated as distinctly better than average. The $l_t : l_c$ relationship is $l_t : l_c = 1.156$. The value recorded by Lusk (1975) for the grayling of the Svratka river equals 1.182. The weight of the grayling in the Morávka valley reservoir can hence be estimated as standard, in contrast to length growth.

SUMMARY

1. In the Morávka reservoir the relationship between body length and ventrodiagonal radius of scale is almost linear.
2. The average length growth in the Morávka reservoir is as follows:

l_1	l_2	l_3	l_4	l_5	l_6	l_7
l_1	l_2	l_3	l_4	l_5	l_6	l_7
108	215	285	319	339	368	394

3. The relationship between total length and body length to the end of the scale cover is 1.156.
4. The relationship between body length and weight is characterized by the equation $w = 0{,}008958 \cdot l^{2.62719}$
5. The average weight growth of the grayling in the Morávka reservoir is as follows:

g_1	g_2	g_3	g_4	g_5	g_6	g_7
24	149	312	423	495	611	733

6. The value of Bank's start is 31.9 mm.
7. Fulton's condition index decreases with increasing age. The average value is K = 1.38.

Acknowledgements

The study of growth was undertaken as part of my dissertation thesis presented at the Department of Systematic Zoology, Faculty of Sciences, Charles University, Prague. The basic problem-area was suggested by Dr. O. Oliva PhD, who also read the manuscript and contributed with a valuable critical commentary. The work was supported by the "Povodí Odry" Hydrological institute. My thanks are also due to Mr. Ludvík Kunc of the Ostrava Zoo.

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BRAIN SIZE IN BIRDS: 1. TINAMIFORMES THROUGH CICONIIFORMES

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Abstract. Brain size in 182 bird species and its relation to body size in 7 families of birds are estimated. The following avian orders are considered: Tinamiformes, Rheiformes, Struthioniformes, Casuariiformes, Dinornithiformes Podicipediformes, Sphenisciformes, Procellariiformes, Pelecaniformes, Anseriformes, Phoenicopteriformes and Ciconiiformes.

Brain size is a frequently studied phenomenon in vertebrates (Jerison 1973), but the coverage of individual vertebrate groups by these studies is rather uneven, the most attention being given to mammals (Portmann 1972, Jerison 1973). Birds (class Aves) belong in this respects to the least studied groups of vertebrates.

According to Tiedemann (1810), brain size in birds was mentioned for the first time by Browne (1646) who stated (incorrectly; see Mlíkovský 1985a) that in the European Blackbird, *Turdus merula*, the brain constitutes 1.41 % of its body mass. The first more detailed studies of brain-body size relationship in birds were carried out much later by Jaeger (1870) and Snell (1892). Snell (1892) was also the first to relate brain mass and body mass by an equation (see Data analysis). This application of mathematics stimulated many later workers to investigate brain-body mass relationships in various groups of vertebrates, especially mammals.

Lists of brain and body masses in birds were first published by Welcker and Brandt (1903), Hrdlička (1905) and the French neurologist Louis Lapicque and his associates (Lapicque and Girard 1905, 1906, Lapicque 1907a, b, 1908, 1909, Girard 1908, Waterlot 1912). Since then only scattered papers on brain size in birds have appeared, including especially those by Portmann and Sutter (1940), Portmann and Vischer (1943) and Portmann (1947) in Switzerland; Crile and Quiring (1940) and Graber and Graber (1962, 1965) in the U.S.A.; Skvorcova (1952, 1954, 1956, 1961) and Nikitenko (1959, 1963, 1966) in Soviet Union; and Senglaub (1957, 1963) in East Germany. The first allometric plot of brain mass versus body mass appears to be due to Brody (1945: 592). The more recent studies are due to Martin (1981, Fig. 2) and Mlíkovský (1982b, 1985a, c).

The intention of the present paper is to summarize our knowledge of the brain size in birds. Due to place limitations, evolutionary interpretation of the data at the between-family level is scheduled for a future paper. Note that use of conventional encephalization indices as commonly applied in encephalization studies is impossible here, because the slope of the brain-body mass regression varies between bird families (Mlíkovský 1985a). Such a variation is not allowed in these indices for statistical reasons (cf. Jerison 1973).

I thank Dr. Rudolf Piechocki (Halle/Saale), Dr. Gottfried Mauersberger and Dr. Burkhardt Stephan (Berlin, GDR) and Dr. Jan Hanzák and Dr. Ivan Horáň (Praha) for allowing me to study specimens under their care. To Dr. R. Piechocki I owe my debts for his advice how to measure the volumes of cava cranii.

MATERIAL

All of the skulls measured in this study were from the collections of the Department of Zoology of the National Museum in Praha, Czechoslovakia, the Institute of Zoology of the Martin Luther University in Halle (Saale), East Germany, and the Museum of Natural History of the Humboldt University in Berlin, East Germany. A complete list of measurements is given by Mlíkovský (1985a).

Measurements were made on 1675 skulls from 615 extant species belonging to 87 different families of birds. These measurements were supplemented by data published by other workers. Most of these authors used brain mass as a measure of brain size. In comparison with measurements applied by myself, this method is known to be much less accurate (see Dubrovina 1979), especially because the avian brain is 75–80% water (Sutter 1943, Requate 1959, Graber and Graber 1965) and its mass and volume can easily change during preparation (Senglaub 1963). Measurements which were apparently incorrect for this reason and which significantly deviated from my measurements were excluded from this study. Particularly, the data by Lapicque and Girard (1905) for *Sterna hirundo* and *Pica pica*, Girard (1908) for *Sterna hirundo*, Welcker and Brandt (1903) for *Tyto alba* and *Apus apus*, Portmann and Vischer (1943) for *Rallus aquaticus*, Portmann (1947) for *Leptoptilos crumeniferos* and *Serinus canaria* and all of the data by Nikitenko (1959, 1963, 1966) were excluded.

After eliminating apparently faulty data, all of the measurements were combined. The aggregate data contains estimates of brain size in 4344 brains in 766 extant species belonging to 116 families of birds. Of them, the data on 182 species belonging to 26 families are presented in this paper. In addition, the data on brain size in 5 fossil species are presented.

Body mass was used here as a measure of body size. Unfortunately, it proved impossible to obtain body mass data for all of the species for which brain size has been determined. Data for both parameters are available for 662 extant species belonging to 71 families, of which those for 159 species belonging to 23 families are presented here.

METHODS

Measurement of brain size

I have used volume of the cava cranii as a measure of brain size (the morphological terminology of Baumel et al. 1979 is used throughout this paper). Volume has been determined using small, different sized shot particles (up to 0.5 mm in diameter). The first step was to plug all openings in the cranium, excepting the foramen magnum with plasticine. Then the cavum cranii was filled with shot up to the plane of the foramen magnum, while shaking the skull to be certain that all spaces were filled. The shot was poured into a volumetric flask and the volume determined directly. The average measuring error was 2–3% and never exceeded 10%.

Because the brain in birds completely fills the cavum cranii (with the negligible exceptions of the sinus cavernosus occipitalis and sinus foraminis magni), the volume of the cavum cranii must closely approximate the volume of the brain. Moreover, since brain density is about 1.03 g.cm^{-3} (Schudnagis 1975), brain mass and brain volume have approximately equal values. All measurements were restricted to those of fully ossified, healthy adult skulls.

Body size estimation

Because body mass is rather variable in birds (see Baldwin and Kendeigh 1938 and Clark 1979 for reviews), it is difficult to determine a single "correct" or "typical" body mass for individual species. To minimize the potential bias of wrong body mass estimates I used whenever possible standard values from ornithological tables and monographs (by region or taxon). In absence of these data, as many body mass measurements as possible were compiled for each species. (Due to place limitations it is not possible to cite the source here.) Only adult, healthy birds were considered, the sexes were combined. In markedly sexual size dimorphic birds, the "typical" body mass for a species was obtained by weighting the "typical" body mass of the two sexes. Despite these efforts, variations in body mass data will remain the main bias for the calculations presented below, although their effect at the family level (which is in focus of this paper) appears negligible. The bias clearly increases toward lower taxonomic levels.

Data analysis

Brain size may be expressed as a function of body size by the allometric equation $E = b\ S^a$, where E is brain size (volume or mass, cm^3 or g), S is body mass (g), a is allometric exponent or slope and b is intercept. This equation is linear after logarithmic transformation. The coefficients

Table 1 **Brain size and encephalization in the "Ratitae"** n = number of measured brains or cava cranii, S = body mass (g), E = brain mass (g), I_{rel} = relative brain mass (%), Q_r = coefficient of relative encephalization, Author = who measured brains or cava cranii The figure in parentheses after the family name gives number of extant species of that family (after Wolters 1975–1982)

Taxon	n	S	E	I_{rel}	Q_r	Author
Tinamidae (46)						
Crypturellus soui	1		1.9			7
Crypturellus obsoletus	2		3 3			7
Rheidae (2)						
Rhea americana	2	20000	22 5	0 11		7
Rhea pennata	3		19 2			7
Struthionidae (1)						
Struthio camelus	10	80000	41 9	0 052		2–4,6,7
Dromiceidae (1)						
Dromiceius novaehollandiae	4	32500	24 9	0 077		1,3,5
Casuariidae (3)						
Casuarius casuarius	4	33000	31 5	0 095		1,7
Casuarius bennetti	2		24 5			7
Casuarius unappendiculatus	1		32 0			7
Anomalopterygidae (0)						
*Euryapteryx geranoides**	1		24 1			4
Dinornithidae (0)						
*Dinornis novaezealandiae**	1		42 1			4
Apterygidae (3)						
Apteryx australis	4	2250	11 3	0 50		4,7
Apteryx owen	1		7 0			7

* Quaternary species
1 = Hrdlička 1905, 2 = Crile and Quiring 1940, 3 = Portmann 1947, 4 = Starck 1955, 5 = Cobb and Edinger 1962, 6 = Igarashi and Kamiya 1972, 7 = Mlíkovsky this paper

a and b appearing in the allometric equation were determined by the reduced major axis analysis (see Seim and Saether 1983) Calculated regression slopes were compared with predicted values, particularly 0 56 (Dubois 1897, 1913) and 2/3 = 0 667 (Jerison 1961, 1973 , 1977) In the following text I shall refer to these values as Dubois' and Jerison's constant All statistical calculations were carried out according to standard methods (Sokal and Rohlf 1969)

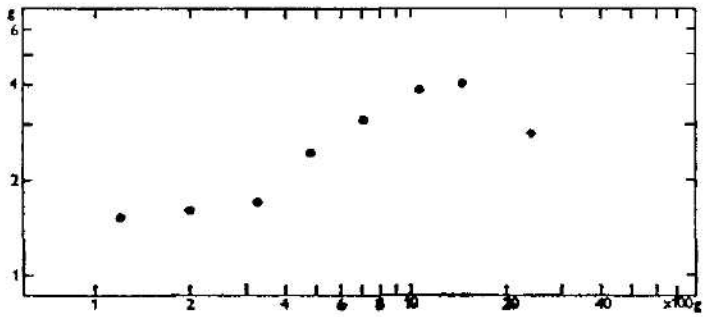

Fig. 1. Relationship between the brain size (Y axis) and the body size (X axis) in Podicipedidae. See **Table 2** for exact data

Table 2. Brain size and encephalization in Podicipediformes. See Table 1 for explanation.

Taxon	n	S	E	I_{rel}	Q_r	Author
Podicipedidae (20)						
Aechmophorus occidentalis	1	1475	4.0	0.27	−3.22	3
Podiceps grisegena	6	720	3.1	0.43	4.47	3
Podiceps major	1		4.7			3
Podiceps cristatus	15	1070	3.8	0.36	6.64	1—3
Podiceps auritus	1	480	2.4	0.50	−2.46	3
Podiceps nigricollis	1	330	1.7	0.52	−17.85	3
Podiceps dominicus	1	120	1.5	1.25	15.67	3
Tachybaptes ruficollis	22	200	1.6	0.80	−2.56	1—3

1 = Portmann and Vischer 1943, 2 = Portmann 1947, 3 = Mlíkovský this paper

The relative brain mass (I_{rel}) was calculated as

$$I_{rel} = 100\ E\ .\ S^{-1}$$

and is given in %. The relative coefficient of encephalization (Q_r) is derived from the allometric equation describing the relation between brain and body mass in individual families as follows:

$$Q_r = E\ .\ b^{-1}\ .\ S^{-1}\ .$$

This coefficient can be used only for comparison within families.

Correlations between brain size and body size were tested for significance using the Hotteling's (1953) modification of the Bravais' correlation coefficient (r_H) for samples with $n \geqq 10$ and using the Spearman's (1904) non-parametric test (r_S) for samples with $4 \leqq n < 10$. In the following, a 5% probability level is taken as significant for Type I errors (cf. Sachs 1974: 96).

Classification of birds

The sequence of families and their delimination follow Storer (1971). Since this is not a taxonomical paper, my decision to use his classification was determined by the need for clarity. It is recognized, however, that this classification now appears to be incorrect in many respects (cf. Wolters 1975—1982, Cracraft 1981, Mlíkovský 1982a, 1985b, Olson 1982, 1985).

RESULTS AND DISCUSSION

The available data on the brain size and the body size of birds are summarized

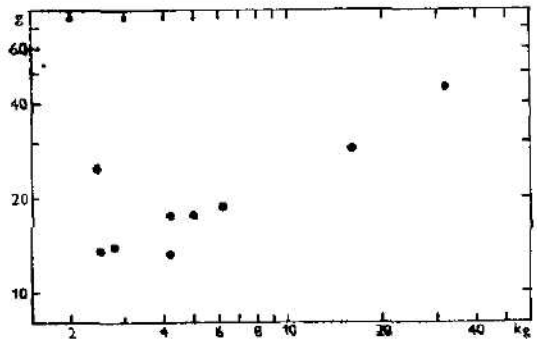

Fig. 2. Relationship between the brain size (Y axis) and the body size (X axis) in Sphenuscidae. See Table 3 for exact data.

in tables and, where appropriate, in figures. Whenever possible, relative brain masses (I_{rel}) and coefficients of relative encephalization (Q_r) are given.

The "Ratitae"

Data on the brain size and the body size in this diverse and probably polyphyletic group are given in the Table 1. The data do not allow the calculation of the regression equation for separate families.

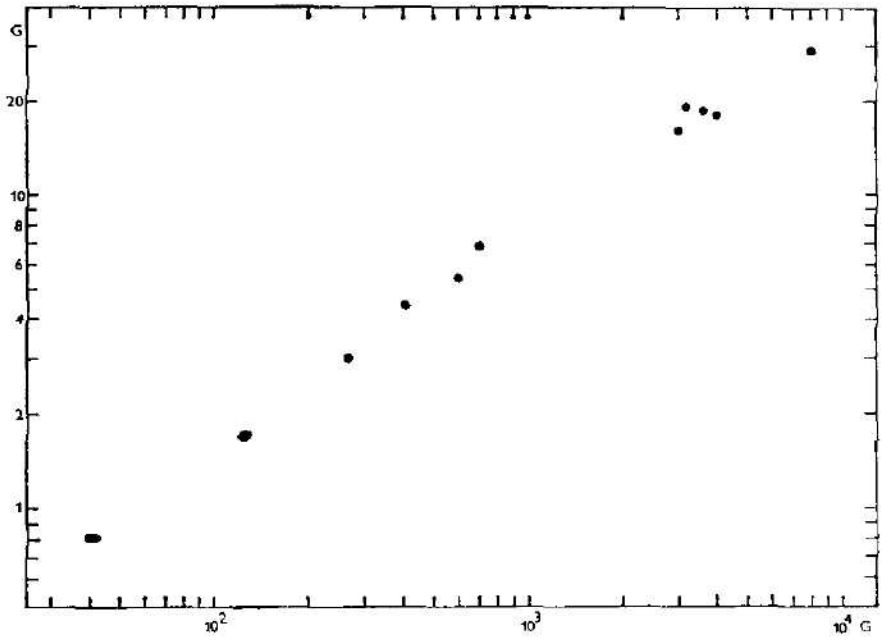

Fig. 3. Relationship between the brain size (Y axis) and the body size (X axis) in Procellariformes. See Table 4 for exact data

Podicipediformes

The data on the brain size and the body size in Podicipedidae, the only extant family of this order, are presented in the Table 2 and Figure 1. Brain size and body size are positively correlated ($r_S = 1.000$; $p < 0.01$) and their allometric relation is $E = 0.142\ S^{0.462 \pm 0.0525}$ ($n = 7$). The slope of this regression is significantly lower than the Jerison's constant ($t_s = -3.898$; $p < 0.01$), but does not significantly deviate from the Dubois' constant ($t_s = -1.867$; $p > 0.05$)

Sphenisciformes

The data on the brain size and the body size in Spheniscidae, the only extant family of this order, are given in the Table 3 and Figure 2. Brain size and body size are positively correlated ($r_S = 0.887$; $p < 0.01$) and their allometric relation is $E = 0.287\ S^{0.481 \pm 0.0450}$ ($n = 8$). The slope of this regression is significantly lower than the Jerison's constant ($t_s = -4.126$; $p < 0.01$), but does not significantly deviate from the Dubois' constant ($t_s = -1.756$; $p > 0.05$).

Table 3. Brain size and encephalization in Sphenisciformes. See Table 1 for explanation.

Taxon	n	S	E	I_{rel}	Q_r	Author
Spheniscidae (16)						
Aptenodytes forsteri	4	32000	44.3	0.14	5.08	2
Aptenodytes patagonicus	1	16000	28.5	0.18	−5.64	2
Eudyptes chrysolophus	1	4200	13.0	0.31	−18.10	2
Eudyptes crestatus	1	2500	13.5	0.54	9.15	2
Pygoscelis adeliae	2	5000	17.5	0.35	1.38	2
Pygoscelis papua	3	6200	18.5	0.30	−3.36	2
Spheniscus humboldti	2	4200	17.5	0.42	10.25	2
Spheniscus demersus	6	2800	13.8	0.49	5.66	1,2

1 = Portmann 1947, 2 = Mlíkovský this paper

Procellariiformes

The data on the brain size and the body size in Procellariiformes are given in the Table 4 and Figure 3. Because of the apparent absence of differences in the level of encephalization of individual families, this order can be treated as a unity. For the aggregate data, brain size and body size are positively correlated ($r_H = 3.260 \pm \pm 0.302$; $p < 0.001$) and their allometric relation is $E = 0.0636\ S^{0.692 \pm 0.302}$ ($n = 12$). The slope of this regression is higher both than the Jerison's constant ($t_s = 1.995$; $p < 0.05$) and than the Dubois' constant ($t_s = 10.394$; $p < 0.001$).

Pelecaniformes

The data on the brain size and the body size in this heterogenous order are given in the Table 5. The data do not allow the calculation of regression equation for individual families.

Table 4. Brain size and encephalization in Procellariiformes. See Table 1 for explanation.

Taxon	n	S	E	I_{rel}	Q_r	Author
Diomedeidae (13)						
Phoebetria palpebrata	1	3000	16.0	0.53	−1.26	2
Diomedea chrysostoma	1	3200	19.0	0.59	12.13	2
Diomedea melanophris	1	3600	18.5	0.51	0.64	2
Diomedea exulans	2	8000	28.8	0.36	−9.84	2
Procellariidae (63)						
Puffinus griseus	1	270	3.0	1.11	−2.01	1
Puffinus tenuirostris	2	600	5.4	0.90	1.50	2
Pterodroma hasitata	1		6.0			2
Daption capensis	1	425	4.4	1.04	4.99	2
Macronectes giganteus	1	4000	18.0	0.45	−8.97	2
Fulmarus glacialis	3	700	6.8	0.97	14.88	2
Hydrobatidae (21)						
Oceanites oceanicus	1	40	0.8	2.00	−2.05	2
Oceanodroma leucorrhoa	1	40	0.8	2.00	−2.05	2
Pelecanoididae (5)						
Pelecanoides urinatrix	1	125	1.7	1.36	−5.39	2

1 = Crile and Quiring 1940, 2 = Mlíkovský this paper

Table 5. Brain size and encephalization in Pelecaniformes. See Table 1 for explanation.

Taxon	n	S	E	I_{rel}	Q_r	Author
Phaethontidae (3)						
Phaethon aethereus	2		3.3			5
Phaethon rubricauda	3		4.7			5
Sulidae (9)						
Sula bassana	5	3200	19.2	0.80		5
Phalacrocoracidae (30)						
Phalacrocorax melanoleucus	2		5.8			5
Phalacrocorax pygmaeus	4	700	4.7	0.67		5
Phalacrocorax carbo	32	2100	10.3	0.49		2, 4, 5
Phalacrocorax olivaceus	3	1150	7.5	0.65		5
Phalacrocorax capensis	1		10.0			5
Anhingidae (2)						
Anhinga anhinga	5	900	4.6	0.51		1, 5
Pelecanidae (7)						
Pelecanus occidentalis	3	3500	24.2	0.69		5
Pelecanus philippensis	1		21.5			5
Pelecanus rufescens	1		19.5			5
Pelecanus onocrotalus	2	9000	33.0	0.37		4, 5
Pelecanus erythrorhynchus	3		24.5			5
Fregatidae (5)						
Fregata magnificens	3	1500	9.2	0.61		3, 5

1 = Hrdlička 1905, 2 = Lapicque 1909, 3 = Crile and Quiring 1940, 4 = Portmann 1947, 5 = Mlíkovský this paper

Anseriformes

The data on the brain size and the body size in this order are presented in the Table 6 and Figure 4. For Anseridae, brain size and body size are positively corre-

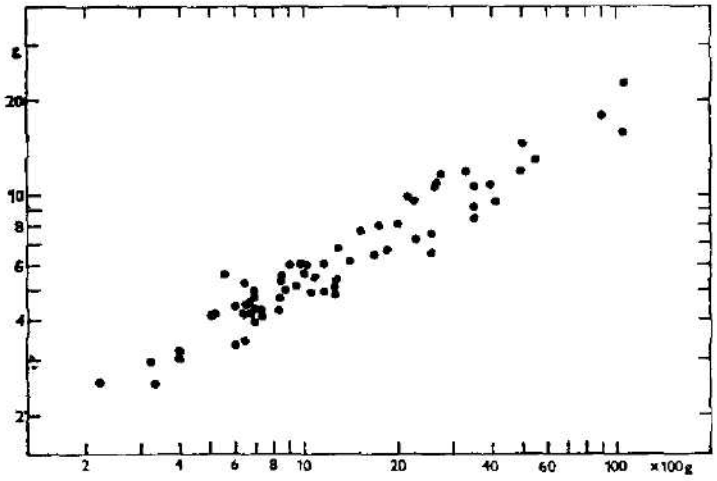

Fig. 4. Relationship between the brain size (Y axis) and the body size (X axis) in Anseridae. * = *Anseranas semipalmata*. See Table 6 for exact data.

Table 6. Brain size and encephalization in Anseriformes. See Table 1 for explanation.

Taxon	n	S	E	I_{rel}	Q_r	Author
Anhimidae (3)						
Anhima cornuta	1		8.5			15
Chauna chavaria	1		8.5			15
Chauna torquata	1		9.0			15
Anseridae (153)						
*Anseranas semipalmata**	3	2200	9 8	0 45	20.26	15
Dendrocygna arborea	1	1150	6 0	0 52	4.99	15
Dendrocygna autumnalis	2	830	4.7	0 57	−1.69	15
Dendrocygna viduata	2	700	4.9	0.70	12.50	15
Dendrocygna arcuata	1	730	4.3	0.59	−3 52	15
*Mionetta blanchardi***	2		3.0			15
Olor cygnus	2	9000	17.5	0.19	−0.62	15
Olor buccinator	1	10500	22.5	0.21	17.44	15
Olor bewickii	1	5500	12.5	0.23	−7.07	15
Cygnus olor	19	10500	15.4	0.15	−19.62	1, 7, 8, 15
Cygnus atratus	2	5000	11.8	0.24	−7.58	15
Cygnus melanocoryphus	3	4000	10.7	0.27	−5.32	15
Coscoroba coscoroba	4	3500	9 0	0.26	−14.33	15
Anser caerulescens	2	2640	10.8	0 41	19.96	15
Anser cygnoides	3	3500	10.3	0.29	−1.95	15
Anser fabalis	5	2800	11.5	0 41	23 68	15
Anser albifrons	2	2230	9.5	0 43	15 72	15
Anser erythropus	2	1850	6.7	0.36	−9.60	15
Anser anser (wild)	50	3350	11.6	0.35	13.10	8, 14, 15
Branta canadensis	3		13.7			15
Branta leucopsis	2	1760	8.0	0.45	10.92	15
Branta bernicla	4	1400	6.1	0.44	−4.15	15
Branta ruficollis	4	1280	5.1	0.40	−15.83	15
Cereopsis novaehollandiae	2	3500	8 3	0.24	−20.99	15
*Cnemiornis calcitrans****	1		15.5			15
Chloephaga picta	1	2580	6.5	0 25	−26.89	15
Chloephaga melanoptera	1	2580	7.5	0 29	−15.64	15
Alopochen aegyptiacus	4	2300	7.2	0.31	−13.77	6. 15
Tadorna tadorna	3	1100	5.5	0.50	−1.39	15
Tadorna ferruginea	2	1250	4.8	0.38	−19.75	15
Tadorna tadornoides	1	1290	5.3	0.41	−12.90	15
Plectropterus gambensis	2	5000	14 5	0.29	13.57	15
Nettapus coromandelianus	4	220	2.5	1.14	8.11	15
Amazonetta brasiliensis	2	400	3 0	0.75	−6.46	15
Aix sponsa	2	630	4.2	0.67	2 15	15
Aix galericulata	3	500	4.2	0.84	15.91	1, 6, 15
Anas sibilatrix	1	830	4.3	0.52	−10.06	15
Anas penelope	5	740	4.2	0 57	−6.46	4, 8, 15
Anas strepera	2	650	3.4	0.52	−18 71	15
Anas crecca	18	325	2.9	0.89	1.30	', 5, 6, 8, 11 − 13, 15
Anas castanea	1	500	4.1	0.82	13.15	15
Anas acuta	2	900	4.4	0.49	−11.96	4, 6
Anas georgica	1	705	4.3	0.57	−1.66	15
Anas bahamensis	1	690	3.9	0.57	−9.75	15
Anas erythrorhyncha	3	600	4.4	0.73	9.91	15
Anas querquedula	10	330	2.8	0.85	−3.01	2, 4, 9, 13, 15
Anas discors	3	400	3.2	0'80	−0.22	15
Anas clypeata	4	610	3.3	0 54	−18.31	4, 15
Anas undulata	1	850	5.5	0 65	13.55	15
Anas poecilorhyncha	1	1000	6.0	0.60	13.34	15

Anas superciliosa	2	670	4.5	0.67	5.82	15
Anas luzonica	2	950	5.1	0.54	−0.92	15
Anas platyrhynchos (wild)	44	1100	6.2	0.56	11.16	2−5, 7−10, 12, 13, 15
*Euryanas finschi****	1		5.8			15
Tachyeres patachonicus	1	2620	10.5	0.40	17.11	15
Tachyeres pteneres	1	4110	9.5	0.23	−17.17	15
Rhodonessa caryophyllacea	1	880	5.0	0.57	1.29	15
Netta rufina	5	1160	4.9	0.42	−14.66	15
Aythya ferina	3	850	5.3	0.62	9.42	15
Aythya collaris	1	700	4.7	0.67	7.61	15
Aythya nyroca	3	560	5.6	1.00	42.26	2, 4
Aythya fuligula	1	660	4.2	0.64	−0.42	15
Aythya marila	4	1000	5.1	0.51	−3.66	6, 11, 15
Somateria mollissima	5	2000	8.1	0.41	4.72	8, 15
Somateria spectabilis	1	1670	6.5	0.39	−7.25	15
Clangula hyemalis	3	650	4.9	0.75	17.15	12, 15
Melanitta nigra	10	980	5.8	0.59	10.78	12, 15
Melanitta fusca	4	1500	7.1	0.47	7.44	12, 15
Bucephala clangula	1	900	6.0	0.67	20.06	15
Mergus albellus	3	650	4.4	0.68	5.20	15
Mergus serrator	5	1050	5.0	0.48	−8.04	6, 8, 15
Mergus merganser	2	1300	6.8	0.52	1.27	15

* Not included into the data set upon which the regression equation is based because of its aberrant taxonomic position.
** Early Miocene species.
*** Quaternary species
1 = Hrdlička 1905, 2 = Lapicque and Girard 1905, 3 = Lapicque and Girard 1906, 4 = Girard 1908, 5 = Timmann 1919, 6 = Crile and Quiring 1940, 7 = Portmann and Vischer 1943, 8 = = Portmann 1947, 9 = Skvorcova 1952, 10 = Senglaub 1957, 11 = Tumanov 1961, 12 = = Senglaub 1963, 13 = Werner 1973, 14 = Schudnagis 1975, 15 = Mlíkovský this paper

lated ($r_H = 1.896 \pm 0.121$; $p < 0.001$) and their allometric relation is $E = 0.121\ S^{0.547 \pm 0.019}$ ($n = 68$). The slope of this regression is significantly lower than the Jerison's constant ($t_s = -6.263$; $p < 0.001$), but does not significantly deviate from the Dubois' constant ($t_s = -0.681$; $p > 0.05$)

The number of data allow here a few comments on the encephalization of some waterfowl tribes and genera: (1) *Anseranas*, which is phylogenetically more ancestral than other Anseridae, has a very high encephalization (2) Dendrocygnini, another ancestral waterfowl group, are medium encephalized. (3) Swans of the genus *Olor* tend to be less encephalized than those of the genus *Cygnus*. (4) Geese (genus *Anser*) belong to highly encephalized waterfowl. (5) Tadornini are generally low encephalized. (6) *Cereopsis* has a similarly low encephalization, which may support its relationships with Tadornini (cf Delacour and Mayr 1945, Veselovský 1970). (7) *Plectropterus*, which used to be allied with Tadornini (e.g., Verheyen 1955, Woolfenden 1961), has a markedly higher encephalization than representatives of this tribe.

Phoenicopteriformes

The data on the brain size and the body size in Phoenicopteridae, the only extant family of this order, are given in the Table 7. The data do not allow the calculation of the regression equation for this family.

Ciconiiformes

The data on the brain size and the body size in Ciconiiformes are presented in the Table 7 and Figures 5–7. The data were sufficient for the calculation of regression equations in the following ciconiiform families: Ardeidae, Plataleidae (but see below) and Ciconiidae.

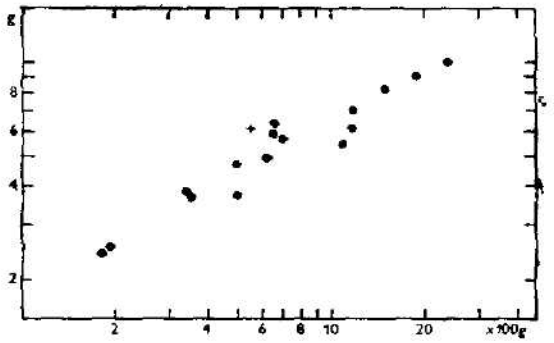

Fig. 5. Relationship between the brain size (Y axis) and the body size (X axis) in Ardeidae. + = *Cochlearius cochlearius*. See Table 7 for exact data.

In Ardeidae (Fig. 5), brain size and body size are positively correlated ($r_H = 1.721 \pm 0.423$; $p < 0.001$) and their allometrical relation is $E = 0.0875\ S^{0.626 \pm 0.423}$ ($n = 18$). The slope of this regression does not significantly deviate from either the Jerison's constant ($t_s = -0.815$; $p > 0.05$) and the Dubois' constant ($t_s = 1\,323$, $p > 0.05$).

In Plataleidae (Fig. 6), brain size and body size are not significantly correlated according to my data ($r_H = 1.243 \pm 0.289$; $p > 0.05$). This is probably an artifact, caused possibly by the limited range in their body size, since this factor is known to

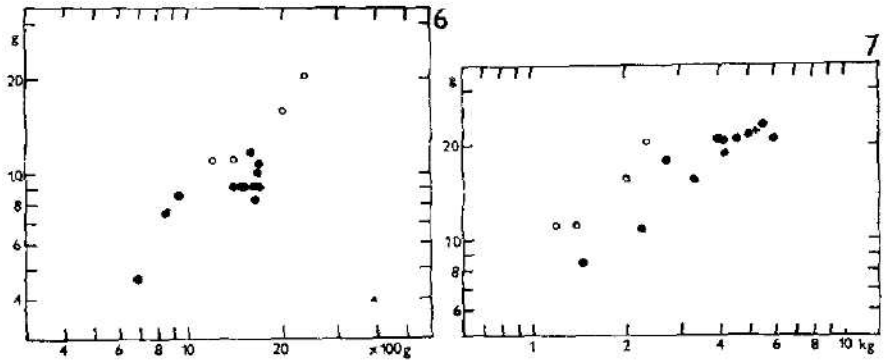

Fig. 6. Relationship between the brain size (Y axis) and the body size (X axis) in Plataleidae (●) and Myxterum (○). See Table 7 for exact data and Figure 7 for comparison with Ciconiidae.

Fig. 7. Relationship between the brain size (Y axis) and the body size (X axis) in Ciconiidae (●), Mycterini (○) and Balaenicipitidae (+). See Table 7 for exact data and Figure 6 for comparison with Plataleidae.

Table 7. Brain size and encephalization in Phoenicopteriformes and Ciconiiformes. See Table 1 for explanation.

Taxon	n	S	E	I_{rel}	Q_r	Author
Phoenicopteridae (5)						
Phoenicopterus ruber	18	3000	10.7	0.36		1, 5, 8
Phoenicopterus minor	10	1500	7.2	0.48		3, 6, 8
Phoenicopterus jamesi	3		9.3			8
Ardeidae (63)						
Botaurus stellaris	5	1150	6.1	0.53	−15.41	5, 8
Botaurus lentiginosus	2	625	4.9	0.78	−0.47	1, 8
Ixobrychus minutus	8	170	1.6	0.94	−26.57	5, 8
Ixobrychus sturmi	1		3.7			8
Tigrisoma mexicanum	1	1160	7.0	0.60	−3.45	8
Nyctanassa violacea	1	660	6.3	0.95	23.68	8
Nycticorax nycticorax	4	650	5.9	0.91	16.94	1, 8
Nycticorax caledonicus	1	700	5.6	0.80	5.96	8
*Cochlearius cochlearius**	2	550	6.1	1.11	34.23	8
Ardeola ibis	5	340	3.8	1.12	13.00	8
Ardeola rallodes	5	180	2.4	1.33	6.27	8
Butorides striatus	6	190	2.4	1.32	2.73	2, 8
Ardea melanocephala	2		7.8			8
Ardea cinerea	19	1500	8.1	0.54	−4.89	4, 5, 8
Ardea herodias	2	2200	10.0	0.45	−7.61	1
Ardea coccoi	2	1900	9.0	0.47	−8.85	8
Egretta garzetta	11	500	3.7	0.74	−13.58	4, 5, 8
Egretta caerulea	2	350	3.7	1.06	8.05	1
Egretta rufescens	1		3.5			1
Egretta alba	4	1100	5.5	0.50	−21.58	3, 5, 8
Egretta intermedia	1	500	4.7	0.94	9.78	3
Balaenicipitidae (1)						
Balaeniceps rex	1	5100	22.5	0.44		8
Scopidae (1)						
Scopus umbretta	4	320	3.9	1.22		3, 8
Plataleidae (31)						
Threskiornis moluccus	1	1670	9.0	0.54		8
Threskiornis melanocephalus	1	1470	9.0	0.61		8
Threskiornis aethiopicus	3	1400	9.0	0.64		8
Nipponia nippon	2		10.0			8
Geronticus eremita	3	1630	8.2	0.50		8
Geronticus calvus	1	1630	9.0	0.55		8
Pseudibis papillosa	1	1470	9.0	0.61		8
Plegadis falcinellus	3	690	4.6	0.67		8
Plegadis chihi	1	700	4.6	0.66		1
Eudocimus ruber	1	935	8.5	0.91		8
Eudocimus albus	1	850	7.5	0.88		8
Platalea ajaja	2	1600	11.3	0.71		8
Platalea leucorodia	3	1700	10.8	0.64		8
Platalea alba	1	1670	10.0	0.60		8
Mycteriini (6)						
Mycteria americana	3	2350	22.3	0.95		1, 8
Mycteria ibis	4	2000	15.4	0.77		8
Anastomus oscitans	1	1400	11.0	0.79		8
Anastomus lamelligerus	2	1200	11.0	0.92		8
Ciconiidae (13)						
Ciconia nigra	4	2700	11.8	0.44	−10.30	8
Ciconia abdimii	2	1450	8.3	0.57	7.42	8
Ciconia episcopus	4	2250	10.8	0.48	−4.04	8

Ciconia maguari	1	4200	20.5	0.49	6.76	8
Ciconia boyciana	2	4000	20.9	0.52	13.49	7, 8
Ciconia ciconia	25	3300	15.3	0.46	−2.05	3, 5, 8
Ephippiorhynchus asiaticus	2	4050	18.3	0.45	−1.68	8
Ephippiorhynchus senegalensis	3	6000	20.7	0.35	−20.56	8
Leptoptilus javanicus	2	4500	21.5	0.48	5.55	8
Leptoptilus dubius	1	5500	26.0	0.47	7.49	8
Leptoptilos crumeniferus	2	5000	22.8	0.46	2.28	8

* Not included into the data set upon which the regression equation is based because of its aberrant taxonomic position.

1 = Hrdlička 1905, 2 = Waterlot 1912, 3 = Crile and Quiring 1940, 4 = Portmann and Vischer 1943, 5 = Portmann 1947, 6 = Spector 1956, 7 = Schuz 1965, 8 = Mikovský this paper

significantly lower the Bravais' correlation coefficient and its derivatives (Smith 1980). For this family I believe, then, that we commit the Type II error, i. e. we reject a correct null hypothesis if we dispute correlation between the brain size and the body size in it. Nonetheless, this mathematical result prevents us from calculating a meaningful regression equation relating the brain size and the body size in Plataleidae.

In Ciconiidae (Fig. 7) (without Mycteriini — see below), brain size and body size are positively correlated ($r_H = 1.870 \pm 0.316$; $p < 0.001$) and their allometrical relation is $E = 0.0152\ S^{0.856 \pm 0.0778}$ ($n = 11$). The slope of this regression significantly deviates from both the Jerison's constant ($t_s = 2.434$; $p < 0.05$) and the Dubois' constant ($t_s = 3.805$; $p < 0.01$).

The tribe Mycteriini with two living genera (*Mycteria* and *Anastomus*) is usually included in the family Ciconiidae in current classifications of birds (Kahl 1972, 1979, Wood 1983, 1984), but it shares various characters with Plataleidae (see Sibley and Ahlquist 1972 for review). The Mycteriini have markedly higher encephalization than proper Ciconiidae (Figure 7), but they appear to fit Plataleidae reasonably well in this respect (Figure 6). This may indicate that Mycteriini are plataleids which evolved toward storks (Ciconiidae).

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NEW SPECIES OF THE GENUS BECKIELLA FROM CUBA (ACARI : ORIBATIDA : DAMPFIELLIDAE)

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A b s t r a c t. Two new species of the genus *Beckiella* Grandjean, 1964, ***B. bloczyki*** n. sp., and *B. cubana* n. sp. are described. Records of other Cuban *Beckiella* species are given.

INTRODUCTION

The genus *Beckiella* Grandjean, 1964 can be considered as one of the most frequently studied genera of oribatid mites of the Cuban fauna. The first Cuban species *B. synlamellata* was described by B a l o g h and M a h u n k a in 1974. Cuban fauna of the family Dampfiellidae was surveyed in their further contributions (B a l o g h. M a h u n k a, 1978 and 1979). Two new species of this genus were determined in rich material of soil mites from Cuba collected and given to me for determination by Dr. Josef Rusek (České Budějovice). Their descriptions are presented in this paper. Records on the occurrence of six other *Beckiella* species in Cuba are also given.

L i s t o f l o c a l i t i e s

K—208/1133, Cuba, Province Sancti Spiritus, Escambray mountains, Topes de Col lantes, 1. 12. 1979, forest of giant ferns, rooting wood sample of moder from a log, leg. J. Rusek.
K—226/1208, Cuba, Province Pinar del Rio, Sumidero, Pica Pica, 8. 12. 1979, mogote forest, soil sample, leg. J. Rusek.
K—279/1261, Cuba, Isla de la Juventud, Arroyo Habo, 16. 10. 1979, brownish sandy soil sample under *Pinus sp.* and *Cocothrinax* sp., leg. J. Rusek.
K—280/1262, Cuba, Isla de la Juventud, Arroyo Habo, 16. 10. 1981, brown sandy soil sample under *Pinus* sp. and *Cocothrinax* sp., leg. J. Komárek.
K—293/1276, Cuba, Province Holguin, Guchillas de Moa, East of Punta Gorda, 20. 10. 1981, submontane forest, sample of 10 cm high lichen layer, leg. J. Rusek.
K—295/1141, Cuba, Province Holguin, Guchillas de Moa, east of Punta Gorda, 20. 10. 1981, wet submontane forest, sample of humus, leg. J. Rusek.
K—296/1142, Cuba, Province Holguin, Guchillas de Moa, east of Punta Gorda, 20. 10. 1981, submontane forest with *Carex* sp., soil sample, leg. J. Rusek.
K—297/1143, Cuba, Province Holguin, Guchillas de Moa, east of Punta Gorda, 20. 10. 1981, submontane forest, sample of mosses, leg. J. Rusek.
K—298/1144, Cuba, Province Holguin, Guchillas de Moa, east of Punta Gorda, 20. 10. 1981, submontane forest, moder sample, leg. J. Rusek.
K—300/1146, Cuba, Santiago de Cuba, Gran Piedra, 21. 10. 1981 montane forest, *Pinus caribea* stand, soil sample with tangel humus, leg. J. Rusek.
K—301/1147, Cuba, Santiago de Cuba, Gran Piedra, 21. 10. 1981 montane forest, *Pinus caribea* stand, soil sample, leg. J. Rusek.
K—304/1150, Cuba, Santiago de Cuba, Gran Piedra, 21. 10. 1981, montane forest, sample of decaying trunks of tree ferns with red moder, leg. J. Rusek.

K—305/1151, Cuba, Santiago de Cuba, Gran Piedra, 21. 10. 1981, North slope, *Juniperus* wood, leg. J. Rusek.
K—308/1154, Cuba, Santiago de Cuba, Gran Piedra, 21. 10. 1981, west slope, tree fern stand, dark moder sample, leg. J. Rusek.
K—316/1162, Cuba, Province Habana, Arroyo Bermejo, 16. 11. 1981, semideciduous forest, sample of decaying twigs, leg. J. Rusek.
K—317/1163, Cuba, Province Habana, Arroyo Bermejo, 16. 11. 1981, semideciduous forest, sample of moderrendzina, leg. J. Rusek.
K—318/1164, Cuba, Province Habana, Arroyo Bermejo, 16. 11. 1981, semideciduous forest, north slope, decaying wood sample, leg. J. Rusek.
K—319/--65, Cuba, Province Habana, Arroyo Bermejo, 16. 11. 1981, semideciduous forest, north slope, litter sample, leg. J. Rusek.
K—330/1176, Cuba, province Pinar del Rio, Sierra del Rosario, Yagrumal, 18. 11. 1981, submontane forest, decaying wood sample, from a log, leg. J. Rusek.
K—333/1179, Cuba, Province Pinar del Rio, Sierra del Rosario, Yagrumal, 18. 11. 1981 ,brown rendzina sample with grasses, leg. J. Rusek.
K—336/1182, Cuba, Province Pinar del Rio, Sierra del Rosario, Vayesito, 18. 11. 1981, submontane forest, dry bark sample from a log, leg. J. Rusek.
K—337/1183, Cuba, Province Pinar del Rio, Sierra del Rosario, Vayesito, 18. 11. 1981, submontane forest, litter and moder sample, leg. J. Rusek.

List of identified Beckiella species

Beckiella borhidii Balogh et Mahunka, 1978, localities: K—317/1163—1 ex., K—318/1164—9 ex., K—319/1165—1 ex., K—316/1162—2 ex.
Beckiella bloszyki n. sp., localities: K—300/1146—1 ex., K—301/1147—1 ex., K—304/1150—1 ex., K—305/1151—1 ex.
Beckiella capitulum Balogh et Mahunka, 1978, localities: K—293/1276—1 ex., K—297/1143—2 ex., K—296/1142—10 ex.
Beckiella cubana n. sp., localities: K—330/1176—3 ex., K—333/1179—1 ex., K—336/1182—3 ex., K—337/1183—1 ex.
Beckiella deficiens Balogh et Mahunka, 1978, localities: K—208/1133—3 ex., K—226/1208—5 ex., K—297/1143—1 ex.
Beckiella duplicata Balogh et Mahunka, 1978, localities: K—295/1141—5 ex., K—298/1144—36 ex.
Beckiella garciai Balogh et Mahunka, 1979, localities: K—279/1261—2 ex., K—280/1262—1 ex.
Beckiella synlamellata Balogh et Mahunka, 1974, localities: K—305/1151—2 ex., K—308/1154—1 ex.

Beckiella bloszyki n. sp.

(Fig. 1 A—C. 2 A—F)*

Dignosis: 9 pairs of notogastral setae, seta ta absent. postanal tectum short, sensillus clavate and smooth.

Description: Length 718—792 μm, mean from 8 measurements 757.5 μm, standard deviation 27,2 μm, width 280—313 μm, mean from 8 measurements 299.8 μm, standard deviation 12.6 μm. Colour light brown, cuticula without thick layer of cerotegument.

Prodorsum (Fig. 1A), rostrum narrowly oval, with smooth margin, surface of the rostrum with some foveolae. Rostral setae longer than lamellar ones, rostral ones externally ciliated with narrow spike, lamellar setae externally ciliated too, from second half of their length. Prodorsal carinae arising behind lamellar setae, posteriorly extending beyond half length of prodorsum, with weak polygonal sculpture on posterior part, surface of posterior and central parts of prodorsum smooth. Exobothridial setae badly visible, minute, situated anteriorly

*The figures 2 and 4 will be found at the end of this issue.

from bothridium, interlamellar ones minute, situated near inner margin of bothridium, longer than exobothridial ones. Small pore-point in front of exobotridial setae. Comparatively short, clavate sensillus with smooth clavus originating in small bothridium. On the posterior border of prodorsum badly visible 4—5 pairs of maculae.

Notogaster (Fig. 1A) smooth, elongated, without dorsosejugal suture separating it from prodorsum, with 9 pairs of notogastral setae, seta ta absent, seta te

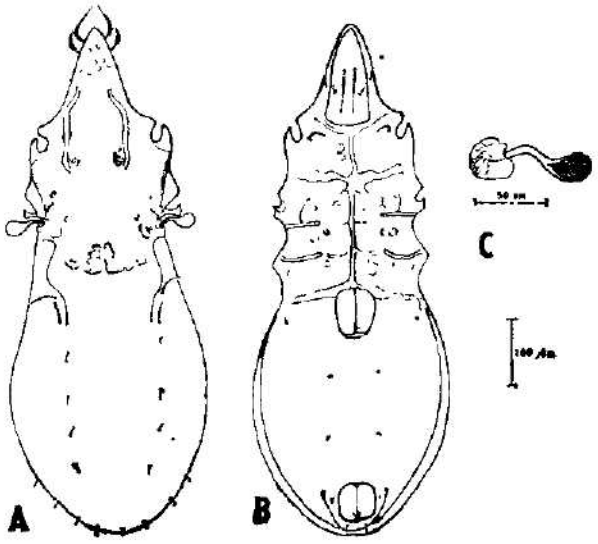

Fig. 1. *Beckiella bloszyki* n. sp. (paratypus), A-dorsal view on body without legs, B-ventral view on body vithout legs, C-sensillus and bothridium. Scale for A, B 100 μ, for C 50 μm.

three times longer than other notogastral ones, smooth, other notogastral setae fine, smooth and equal in length, seta ti in front of half distance between setae te and ms, setae rl originating slightly more anteriorly than setae r3, anterior part of notogaster with shallow hollow.

Epimeral region (Fig. 1B), epimerae distinctly separated from each other with weakly foveolated sculpture, epimeral formula 1-0-2-3, epimeral setae 1b and 3b smooth, longer than 3c, and many times longer than minute 4a, 4b, and 4c setae.

Anogenital region (Fig. 1B), genital and anal plates small, separated from each other, approximately equal in length, genital ones with 4 pairs of minute and smooth genital setae, one pair of minute adgenital ones. Anal plates with 2 pairs of minute and smooth anal setae, 3 pairs of adanal ones. seta ad3 and ad2 minute and smooth, as long as adgenital ones, setae ad1 smooth and longer than other adgenital ones, ad3 in preanal and ad1 in postanal position, postanal tectum short reaching ni front of insertion point of ad2 setae. Infracapitulum suctorial, ovoid, setae h,m, and a approximately equal in length, rutelae badly observable, without teeth and incisions on their anterior margin.

Palps (Fig. 2F), with five joints, trochanter badly observable, chaetotactic formula 0-2-1-3-7(1), solenidion ω twice shorter than seta cm. Length and width of trochanter 4 × 8 μm, femur 25 × 9 μm, genu 13 × 8 μm, tibia 15 × 7 μm and tarsus 20 × 6 μm.
Chelicerae (Fig. 2E), peloptoid, narrow, length and width of digitus fixus 178 × × 33 μm, minimal width 13 μm, digitus mobilis 20 × 12 μm, length of seta cha 85 μm, seta chb absent, Trägardh's organ absent too, digitus mobilis and digitus fixus with 1—3 minute, badly observable, teeth.
Legs (Fig. 2A-D), monodactylous, comparatively long and slim, leg chaetotactic formula I 0-4-3(1)-4(2)-15(2)-1, II 0-4-2(1)-3(1)-14(2)-1, III 1-3-1(1)-2(1)-14-1, IV 0-3-2-2(1)-12-1, length, shape, and position of all leg setae as in Fig. 2A-D. Seta d' on trochanter III, l' on genu III, bv' on femur IV, and l' on genu IV present.

Affinities: This species belongs to the group of species with short postanal tectum. In Cuba *Beckiella fratercula* Balogh et Mahunka, 1987 and *B. deficiens* Balogh et Mahunka, 1978 belong to this group. The new species differs from *B. fratercula* by smooth rostral margin and clavate sensillus, from *B. deficiens* by the shape of clavus of sensillus and by expressively shorter stalk of sensillus. This species is closely related to *Beckiella reticulofemorata* Balogh et Mahunka, 1979 from Cuba, but differs from it by shorter postanal tectum and smooth clavus of sensillus.

Locus typicus: K—304/1150—4 specimens.
Further localities: K—300/1146—1 ex., K—301/1147—1 ex., K—305/1151——1 ex.
Types: Holotypus 21. 10. 1981 — K—304/1150 and 5 paratypes 21. 10. 1981 — K—304/1150 are deposited partly in ethanol, partly as a slide (1 paratypus) in the author's collection in the Institute of Soil Biology, Czechoslovak Academy of Sciences, České Budějovice. One paratypus 21. 10. 1981 — K—304/1150 is deposited in the Ecological Institute of the Cuban Academy of Sciences Habana, Cuba.

Derivatio nominis: The new species was named in honour of my friend. Dr. Jerzy Błoszyk (Poznań, Poland), renowned Polish acarologist, specialist on Uropodina.

Beckiella cubana n. sp.

(Fig. 3 A—B, 4 A—F)*

Diagnosis: 9 pairs of notogastral setae, seta ta absent, postanal tectum short, sensillus sigmoid, clavus of sensillus with spines.

Description: Length 555—670 μm, mean from 8 measurements 610,9 μm, standard deviation 24,0 μm, width 220—285 μm, mean from 8 measurements 253,3 μm, standard deviation 42,1 μm, holotypus: male, length 610 μm, width 256 μm. Colour yellowish brown, cuticula smooth without conspicuous sculpturae and thick layer of cerotegument.
Prodorsum (Fig. 3A), rostrum narrow, oval with smooth margin. Surface of rostrum with weak foveolae, rostral and lamellar setae externally ciliated, rostral setae longer than lamellar ones, tapering with sharp tip. Prodorsal carinae arising behind lamellar setae, and posteriorly extending beyond acetabulae of I pair of legs. Weak polygonal sculpture on their posterior border. Surface of central part of prodorsum smooth, prodorsal margin near acetabulae I and II finely punctated. Exobothridial setae minute, badly visible, situated near

point-pore before bothridium, interlamellar ones minute, situated near inner bothridial margin. Sensillus slightly sigmoid, apically abrubtly incrassate, covered with scattered spines, originating in small bothridium, stalk of sensillus narrow, twice longer than clavus of sensillus. Posterior margin of prodorsum with four pairs of maculae in its central part.

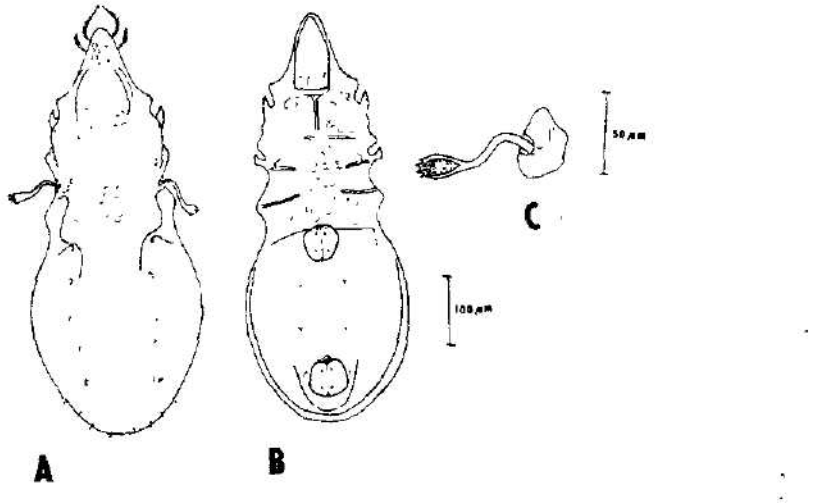

Fig. 3. *Beckiella cubana* n. sp. (paratypus), A-dorsal view on body without legs, B-ventral view on body without legs, C-sensillus and bothridium. Scale for A, B 100 μm, for C 50 μm.

Notogaster (Fig. 3A), narrowly oval, without dorsosejugal suture, with 9 pairs of notogastral setae, seta ta absent, seta te the longest on notogaster, at least three times longer than other notogastral setae, smooth. All other notogastral setae minute, smooth, seta ti nearer to te than to ms, setae rl originating distinctly more anteriorly than setae r3, anterior part of notogaster with shallow hollow.

Epimeral region (Fig. 3B), epimerae distinctly separated from each other with conspicuous foveolated sculpture, epimeral formula 1-0-2-3, epimeral setae 1b, 3b, and 3c long, smooth, many times longer than minute and smooth 4a, 4b, and 4c epimeral ones.

Anogenital region (Fig. 3B), genital and anal plates small, oval, separated distinctly from each other, approximatelly equal in length, genital ones with 4 pairs of minute and smooth genital setae, 1 pair of minute and smooth adgenital setae situated behind genital plates, anal plates with 2 pairs of minute and smooth anal setae, 3 pairs of minute and smooth adanal ones, ad3 in preanal and ad1 in postanal position, postanal tectum short, reaching behind insertion points of ad2. Infracapitulum, suctorial, ovoid, with setae a, m, and h, approximatelly equal in length, with badly observable smooth rutelae.

Palps (Fig. 4F), with five joints, chetotactic formula 0-2-1-3-7(1). Solenidion ω three times shorter than seta cm, length and width of trochanter 3×7 μm, femur 21×8 μm, genu 15×6 μm, tibia 14×6 μm and tarsus 24×5 μm.

Chelicerae (Fig. 4E), peloptoid, narrow, length and width of digitus fixus

148 × 29 μm, minimal width of the most narrow part of digitus fixus 7 μm, digitus mobilis 18 × 7 μm, seta chb and Trägard's organ absent, seta cha smooth, flagelliform, its length 65 μm. One or two very small teeth on anterior part of digitus mobilis and fixus.

Legs (Fig. 4A-D), monodactylous, long and slender, leg chaetotactic formulae I 0-4-3(1)-4(2)-15(2)-1, II 0-3-2(1)-3(1)-14(2)-1, III 0-3-0(1)-1(1)-14-1, IV 0-2-1-2(1)--12-1. Solenidion φ on tibia I extremely long, seta d' on trochanter III, l' on genu III, bv' on femur IV, and l' on genu IV absent. Comparative length, shape, and position of all leg setae as in Fig. 4A-D.

Affinities: This new species belongs to the group of species with short postanal tectum. It differ from all known species of this group by the shape of sensillus. The same shape of sensillus have three species belonging to another group of species: B. interlamellaris Balogh et Mahunka, 1978, B. duplicata Balogh et Mahunka, 1978, which differ from the new species by presence of ta setae, and B. garciai Balogh et Mahunka, 1979, which differs from the new species by the long postnatal tectum.

Locus typicus: K—337/1183—1 specimen.

Further localities: K—330/1176—1 ex., K—333/1179—1 ex., K—336/1182—3 ex.

Types: holotypus 18. 11. 1981 — K—337/1183 and 4 paratypes 18. 11. 1981 — K—330/1176, 18. 11. 1981 — K—333/1179, and 18. 11. 1981 — K—336/1182 are deposited partly in ethanol, partly as a slide (1 paratypus) in the author's collection in the Institute of Soil Biology of the Czechoslovak Academy of Sciences, České Budějovice, one paratypus 18. 11. 1981 — K—336/1182 is deposited in the Ecological Institute of the Cuban Academy of Sciences, Habana,

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ON THE SYSTEMATICS, AGE AND GROWTH OF LABEO DERO FROM GOBINDSAGAR, HIMACHAL PRADESH, INDIA

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Abstract. Systematics, length-weight relationship, age, growth data, harvestable size and the maximum size attained by *Labeo dero* (Hamilton) from Gobindsagar reservoir, Himachal Pradesh, India have been described. Less variable morphometric characters and meristic counts are genetically controlled, therefore can be used for the identification. Characters showing higher ranges of variations are subject to ecological changes. Sexual dimorphism has been confirmed. Length-weight relationship has been found to be: Log W = −3.2385 + 3.6879 Log L ($W = 0.0001732\ L^{3.6879}$).

Scales have been used for age determination. A correction factor of 17 mm has been applied for the back-calculations. Various growth parameters such as specific rate of linear growth, annual increment, specific rate of weight increase, species average size, population weight growth intensity, growth characteristic and growth constant have also been dealt. The harvestable size has been found to be 21.00 cm total length, which is lower than the existing legal limit of 30.00 total length. By plotting Walford's graph, maximum attainable length of the fish has been found to be 62.50 cm total length.

INTRODUCTION

Labeo dero (Hamilton) commonly known as 'Gid' or 'Giddah' (Venkateswarlu, 1984) constitutes miscellaneous fishery in Gobindsagar. Though this fish is considered to be of great commercial value and preferred as good food fish by locals, very little work has been done on its bionomics except the works of Hora and Misra (1936), Singh (1978) and Malhotra and Chauhan (1984). Considering this lacuna, an attempt has been made to study the systematics, age, growth parameters and harvestable size of this species from Gobindsagar reservoir.

MATERIAL AND METHODS

Seventy specimens ranging from 26.00—48.00 cm were collected from Gobindsagar reservoir, Himachal Pradesh, India (longitude 76°20 E; latitude 31° 10 N) during the period October 1984 — April 1985 from the commercial catches (For topography of the reservoir see Johal et. al., 1984). The fishes were caught by using gill-nets. In the field each fish was weighed on a single pan balance to its nearest gram and measured to the nearest millimeter. The morphometric measurements such as total length, forked length, standard length, predorsal distance, prepectoral distance, preanal distance, maximum body depth, minimum body depth, caudal peduncle length, head length, head width, head depth, snout length, interorbital space, preorbital distance, eye diameter, length and width of dorsal, pectoral, pelvic and anal fins and meristic counts such as rays of dorsal, pectoral, pelvic (ventral), anal, caudal (both branched and unbranched) were recorded following the procedure given by Holden and Raj (1974). All the measurements were calculated in the percentage of total length except those of head width, head depth, (snout length, interorbital space, postorbital space and eye diameter, which were calculated in the percentage of head length (Table 1). The morphometric data have been analysed by the method od least squares using the formula:

$$Y = a - bX$$

where X is independent variable such as total length or head length and Y is dependent variable, a is a constant and b is the slope of line.

Table 1. Morphometric analysis of the data on *Labeo dero* (Hamilton) from Gobindsagar, Himachal Pradesh, India.

Character	Present observations N = 74	Range difference	r	Regression equation Y = a + bx
In the percentage of total length				
Standard length	79.75 (77.44—84.34)	6.90	0.9898	= −0.413 + 0.8701 ×
Predorsal distance	32.91 (29.49—36.28)	6.79	0.9494	= −1.997 + 0.3799 ×
Preventral distance	39.63 (36.53—58.14)	21.61	0.9796	= −2.048 + 0.4452 ×
Preanal distance	60.29 (56.16—64.03)	7.87	0.9718	= −3.60 + 0.6970 ×
Max. body depth	21.58 (18.05—23.91)	5.83	0.9306	= −3.177 + 0.2853 ×
Min. body depth	9.69 (7.75—10.69)	2.94	0.9295	= 0,5137 + 0.1576 ×
Caudal peduncle	17.90 (15.29—18.67)	3.38	0.9219	= 0.8680 + 0.1140 ×
Head length	17.20 (15.66—17.81)	2.15	0.9735	= 0.379 + 0.1763 ×
Dorsal fin length	15.79 (13.75—16.91)	3.16	0.9688	= −1.624 + 0.1915 ×
Dorsal fin depth	20.27 (16.38—22.52)	6.14	0.8908	= −0.957 + 0.218 ×
Ventral fin length	14.38 (11.99—15.73)	3.74	0.8527	= −0.628 + 0.1543 ×
Pectoral fin length	15.23 (13.01—16.24)	3.23	0.9051	= −0.221 + 0.1517 ×
Anal fin length	7.01 (5.97—7.41)	1.44	0.9318	= 0 .704 + 0.0849 ×
Anal fin depth	14.83 (12.43—16.70)	4.27	0.9166	= 0.834 + 0.1633 ×
Caudal fin length	25.07	5 09	0.9137	= 0.722 + 0.2219 ×
In the percentage of head length				
Head width	61.16 (53.10—69.73)	16.63	0.9322	= 0.838 + 0.7378 ×*
Head depth	77.34 (66.14—88.15)	22.01	0.9220	= −1.051 + 0.9315 ×*
Snout length	41.56 (37.03—45.78)	8.75	0.9691	= −0.820 + 0.5391 ×*
Interorbital space	39.61 (36.84—42.18)	5.34	0.9709	= −0.155 + 0.4195 ×*
Post orbital space	51.47 (35.18—54.68)	19.50	0.9346	= 0.0005 + 0.5146 ×*
Eye diameter	13.83 (11.53—16.98)	5.45	0.8120	= 0.436 + 0.0726 ×*

r = *coefficient of correlation*; × = total length; ×* = head length

For age and growth studies, scales were removed from the left lateral side below the dorsal fin above lateral line preferably from second or third row and preserved in the envelops as such with the required data. They were then brought to the laboratory for further analysis, where epidermis and dust particles were removed by rubbing inbetween the finger tips and washing them in water. Each scale was studied in dry mounts using Carl Zeiss VEB Dokumator at the magnification of 17.5X. The lateral sveale radius was measured for the construction of graph between total length and scale radius.

For back-calculations and other growth parameters such as growth characteristic (C'_t), growth constant (C_{1t}), specific rate of linear growth (C_l), specific rate of weight increase (C_w), index of species average size (φh), population weight growth intensity ($\varphi('_w)$ and harvestable size were calculated following the formulae given by Tandon and Johal (1983), Johal and Tandon (1985, 1987).

OBSERVATION AND DISCUSSION

Systematics

Labeo dero (Hamilton) is a hill-stream fish inhabiting in the fast flowing waters of moutains and submountain regions all along the Himalayas (Jayram, 1981). The meristic counts and morphometric characters of *Labeo dero* (Hamilton) have been described by Hamilton (1822), Day (1878), Johal and Tandon (1979, 1980), Srivastva (1980) and Baloni (1981) from different waterbodies. Not much variations have been observed in the meristic counts. Earlier workers described the presence of a short pair of maxillary barbels, but Tandon and Arora (1970) reported two pairs of maxillary barbels.

The detailed data on the body proportions have not been described earlier. The body proportions of the present sample are given in table 1. It can be seen from table 1 that the maximum range of variation is in the proportion of TL/P-V distance (21.61%), HL/Postorbital distance (19.50%) and minimum in TL/ minimum depth of body (2.94%), TL/caudal peduncle (3.38%), TL/HL (3.16%), TL/ventral fin length (3.74%), TL/pectoral fin length (3.23%), TL/anal fin length (1.44), TL/caudal fin length (5.09%), HL/interorbital space (5.34%) and HL/eye diameter (5.45%), whereas other body proportions showed moderate range of variations. As far as range of variations is concerned, the present observations are in conformity with those of Day (1878), Srivastva (1980) and Baloni (1981).

Vladykov (1934) divided morphometric and meristic characters into three categories:

1. Characters which do not appear to be modified by the environment such as number of fin rays of caudal and ventral fins. These characters are genetically controlled.
2. Characters which appear to be slightly modified by environment such as pectoral fin rays, gill rakers on the first branchial arch.
3. Characters which appear to be strongly modified by the environment. It includes all morphological characters, metamerism, number of vertebrae, scales, rays in the dorsal and anal fins, colour bars, colour spots and size of the fish.

Normally for preparing the keys, only these characters are used which show minimum range of variations and are genetically controlled. Vladykov's (1934) explanation may be applicable to those fishes inhabiting coldwaters especially in the temperate regions and having wide range of distribution. But in tropical regions, where the total number of fish species is much more and the geographical range is comparatively less as compared to the fishes of temperate region, this explanation is not applicable. Under these conditions all meristic counts and body proportions which show minimum variations can be included in the first category. Day (1878), Johal and Tandon (1979, 1980), Jayaram (1981) used all these characters for the prepration of keys and identification of freshwater fishes.

The number of gill rakers on the first branchial arch is also a good index in systematics in fishes having definite feeding habits. Jayaram (1981) has successfully used this aspect in the identification of the species belongign to the genus *Salmostoma*.

Sexual dimorphism has been observed in this species. In the adult, male bears large number of tubercles especially during the breeding seasons as compared to females. The outer margin of dorsal fin is distinctly concave and first few unbranched and branched rays are more prolonged in male. The present observations are in conformity with those of Hora and Mistra (1936) and Baloni (1981).

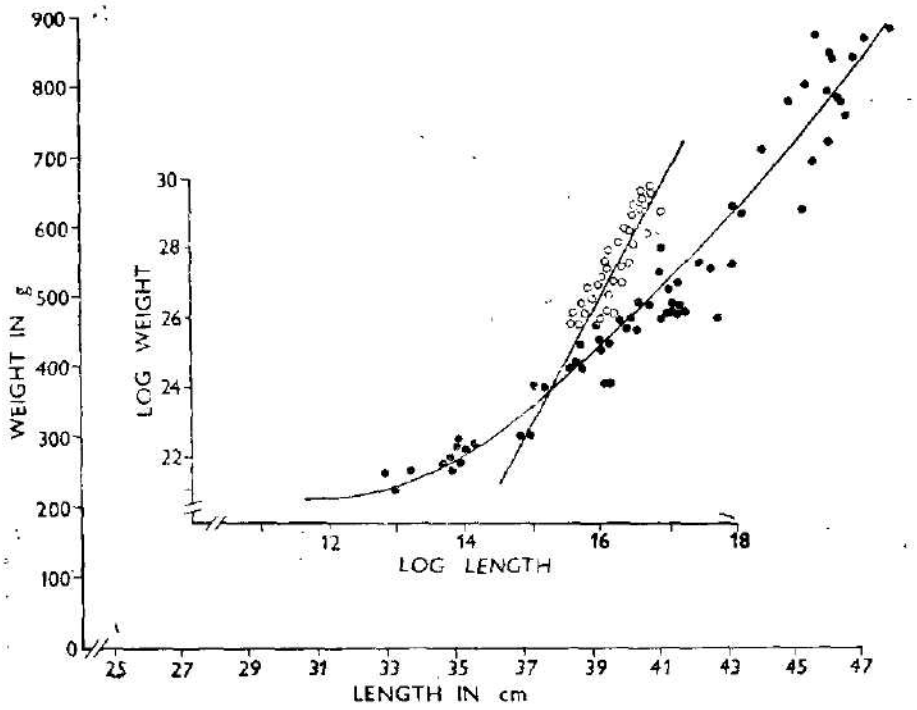

Fig. 1. Length-weight relationship of *Labeo dero* from Gobindsagar. Total length (mm) along abscissa and weight (g) along ordinate. Dots = original readings, circles = log values.

Length-weight relationship

The length-weight relationship has theoretical and practical value in fishery management studies. It is helpful in the determination of spawning seasons (Tandon, 1961), well being, onset of sexual maturity and growth. This relationship is also helpful for calculating the yield of exploitable species in different age groups. It may also indicate some taxonomic differences, metamorphosis and the completion of spawning activity (Bagenal, 1978).

Length-weight relationship has been calculated after Le Cren (1951) and is plotted in Fig. 1. The length-weight relationship has been found out to be:

$$W = aL^n$$
$$\log W = \log a + n \log L$$
$$\log W = -3.2385 + 3.6879 \log L$$
$$W = 0.0001732\ L^{3.6879}$$

Malhotra and Chaunan (1984) described the value of n 3.9512 and 3.3821 in specimens having total length more than 17.00 cm and less than 17.00 cm total

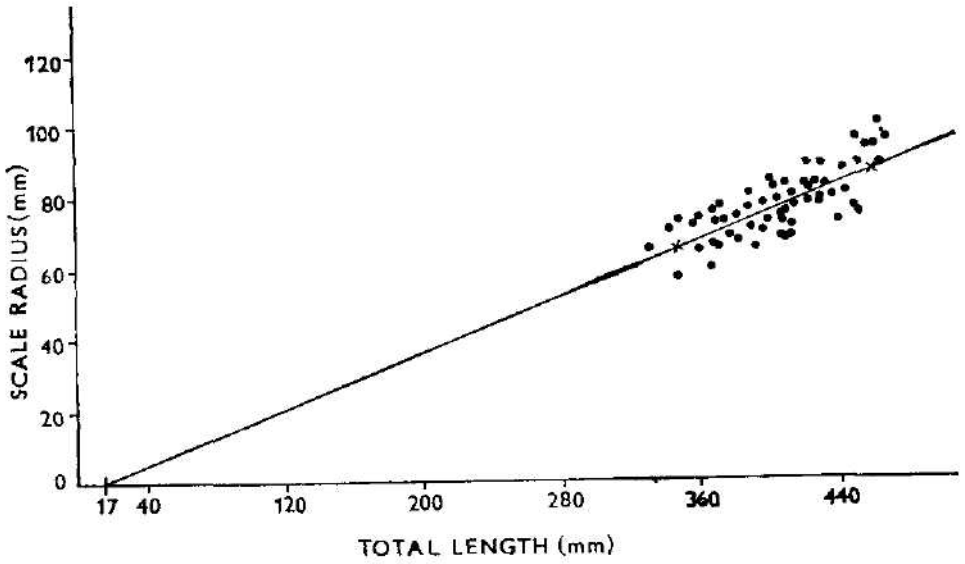

Fig. 2. Relationship between total length (along abscissa) and lateral scale radius (along ordinate).

length respectively from Garhwal region. According to Hora (1937) in the population of *Labeo dero*, females predominates in Garhwal region and attain sexual maturity at a size of 16.00 cm total length. It is evident that in the above sample, the population having high value of 'n' constitute mostly mature sample and with low value of 'n' the immature sample. In the present sample from Gobindsagar, the range is 26.00—48.00 cm and collected mostly during the post-spawning period, therefore the value of 'n' of the present sample lies almost inbetween the values described by Malhotra and Chauhan (1984).

Age and growth

The age of *Labeo dero* (Hamilton) from Gobindsagar has been ascertained from the scales. Each scale is of moderate size, more elongated than broad in the earlier age groups and the length increases in the older age classes. The posterior part of each scale is thick and rough having pigments, whereas anterior part is soft and without pigment granules. The scales are transparent, suitable for study under transmitted light.

On the scales there are present concentric rings of circuli (= sclerites of Chugunova, 1963). The true annulus was recognized by the concentration of circuli all around the scales. The annuli are more visible in the anterior field than the posterior field. The scales also recorded false annuli, which did not traverse all around the scales. In the anterior part of the scales, some radii have also been observed in the higher age classes.

Linear relationship has been observed between the lateral scale radius and total length of the fish (Fig. 2). Correlation coeficient has been calculated to be 0.7995. The regression line, when extrapolated cuts the abscissa at 17 mm indicating that

Table 2. Back-calculated lengths of *Labeo dero* (Hamilton) from Gobindsagar.

Age class	N	Back-calculated lengths (cm)							
		l_1	l_2	l_3	l_4	l_5	l_6	l_7	l_8
2	2	17.94	28.15						
		17.75—18.14	28.03—28.27						
3	10	19.62	28.67	35.73					
		17.60—22.10	26.11—34.14	34.01—38.70					
4	24	17.67	24.11	30.27	35.99				
		14.57—21.60	21.08—27.68	29.32—35.16	32.63—43.17				
5	15	17.33	22.95	28.35	33.73	39.08			
		14.73—23.30	19.76—30.69	25.38—34.96	29.99—39.50	34.04—42.63			
6	7	16.11	21.36	27.20	32.52	38.31	44.00		
		14.97—18.22	19.47—23.21	25.15—28.72	28.60—35.68	36.35—40.26	42.34—44.90		
7	1	17.20	22.83	28.96	33.83	39.18	43.08	45.51	
8	1	18.88	23.05	30.12	34.66	38.72	43.34	43.84	45.22
	60	17.80	24.44	30.10	34.15	38.82	43.47	44.67	45.22
		14.57—23.30	19.47—34.14	25.15—38.70	28.60—43.17	34.03—42.63	42.34—44.90	43.84—45.51	45.22—45.22

N = number of specimens examined in each age class; l_1 l_2 l_3 l_n . . . . = Each age class as determined by scale method.

Table 3. Summary of growth data on *Labeo dero* (Hamilton) from Gobindsagar.

Parameter	Years of life							
	1	2	3	4	5	7	7	8
L(cm)	17.80	24.40	30.10	34.15	38.82	43 47	44 67	45 22
h	17.80	6.64	5.66	4.05	4.67	4.65	1.70	0.55
	37.30	23.16	13.45	13 67		11.98	2 76	1 23
φh				5.65				
W(gm)	23.60	75.98	163.80	260 91	418 58	635 30	702.41	734 84
w	23.60	52 38	87.82	97 11	157 67	216.72	67 11	32.43
C_w	221.95	115 58	59 28	60 43		51.77	10 56	4 61
φC_w				74.88				

Abbreviations
L = back-calculated lenghts, h = annual increment; C_l = specific rate of linear growth, h — = index of species average size; W = weight in gram calculated from length weight relationship; w = annual increase in weight, C_w = specific rate of weight increase, C_n = index of population weight growth intensity.

the scales appear for the first time on the body of the fish at this length. This value has been used as a correction factor for back calculations.

In most of the fishes especially in Indian cyprinids (Singh 1978; Tandon and Johal, 1983; Johal and Tandon, 1981a, 1983, 1985; Johal et al., 1984) linear relationship has been described between total length and scale radius because of indeterminate growth pattern.

In the present collection, seven age classes (2—8) have been recognised. Lateral radius of each annulus was measured for the back-calculations. In tables 2—3 the the back-calculated lengths in each age class and other growth parameters are given. The annual rate of increment and specific rate of linear growth decreases with the increase in age except in the age class 5, where slight increase in length has been observed. This phenomenon is called 'growth compensation' (Tandon and Johal, 1983a).

Table 4. Comparision of growth rate of *Labeo dero* (Hamilton) from different localities

Locality	Author	N	Back-calculated lengths							
			l_1	l_2	l_3	l_4	l_5	l_6	l_7	l_8
Nangal reservoir	Singh (1978)	127	13.80	21.20	28.20	34.40	39.60	44 20	47.50	50 50
Gobindsagar	Singh (1978)	113	13.10	22.50	29.50	35.70	40 50	44.80	48.30	51 10
Present observations		60	17 80	24 44	30 10	34.15	38 82	43.47	44.67	45.22

N = Number of specimens studied

The average weight attained in each age class has been calculated from the length-weight relationship already described. The annual increment in weight increased considerably up to age class 6, then sharp decline has been noticed (Table 3). It is because of the fact that the annual length increment in the older age classes is less. From the yield point of view, the fish should not be allowed to grow after age class 6, as there is negligible addition of weight. The specific rate of weight increase shows the trend similar to that of specific rate of linear growth (Table 3).

Table 5. Growth characteristic (C_{th}), growth constant (C_{lt}) and average growth constants (Av.C_{lt}) of *Labeo dero* (Hamilton) from Gobindsagar.

Age class	L (cm)	Log L	C_{th}	C_{lt}	Av . C_{lt}
1.	17.80	1.2504			
			5.6444	0.4756	
2.	24.44	1.3881			0.3941
			5.0933	0.3126	
3.	30.10	1.4786			
			3.7986	0.1893	
4.	34.15	1.5334			
			4.3712	0.1920	0.1837
5.	38.82	1.5890			
			4.3983	0.1699	
6.	43.47	1 6382			
			1.1824	0 0408	
7.	44.67	1 6500			0.0295
			0.5450	0.0183	
8.	45.22	1.6553			

The growth of *Labeo dero* from Nangal reservoir and Gobindsagar and the present sample is given in Table 4. Singh (1978) did not observe any significant difference in growth rate from the samples collected during 1967—70 from Gogindsagar and Nangal reservoirs, though these reservoirs are ecologically different from each other. The present sample showed better growth up to age class 3, and in the subsequent age classes i. e. between age classes 4—8, the growth is slow. It is apparent that the growth pattern has changed drastically in 15 years. It appears that the population of *Labeo dero* has less cometetion in the earlier age classes and vice versa as fas as food and space are concerned The low growth in the age classes 4—8 may be due to the stiff competition with *Cyprinus carpio* and *Hypophthalmichthys molitrix*, which are extensively stocked by the Himachal State Fisheries Department during the last ten years to augment the fish productinon in this reservoir.

The values of species average size (φh) and specific rate of weight growth intensity (φC_w) have been found to be 5.65 and 74.88 respectively.

The average values of growth characteristic are useful in determining the growth periods where the first ends and second begins (Balon, 1968). From table 5, it is apparent from the sudden decrease in the values that this species enters in the second period between the age classes 3 and 4 and in the third period between the age classes 7—8. The study of growth constants and average growth constants (Table 5) shows that there are three phases of life in the population of *Labeo dero* from Gobindsagar. The first period includes the age classes 1—3, second 4—6 and third 7—8. The observations on the growth characteristics of *Labeo rohita* (Johal and Tandon, 1985) from different waterbodies of Northern India and Russian cyprinids (Chugunova, 1963) have proved that there is a regular growth pattern between different periods. According to Chugunova (1963) for the comparison of growth of different fish species and genera, the growth characteristic of the second period may be used, because it relates to hereditory changes, whereas the first period varies considerably under the influence of external conditions. The study of average growth constants is useful to determine wheather the fish enters the 'old age' or not. The observations on the old age can also be supported with the study of other growth parameters such as annual rate of increment, annual rate of weight increase, specific rate of linear

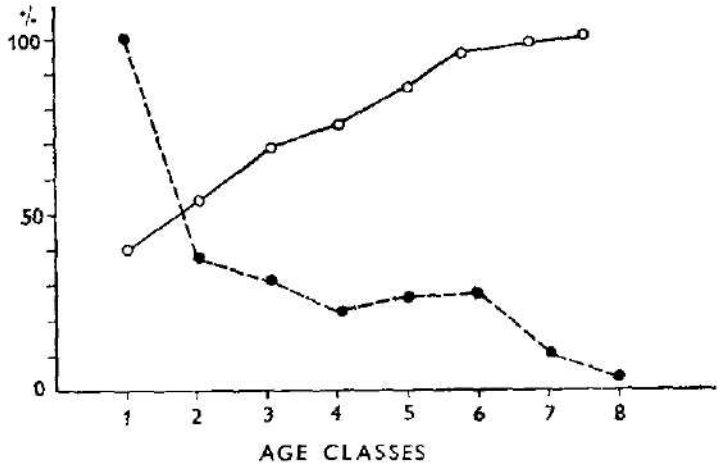

Fig. 3. Graph showing minimum harvestable size of *Labeo dero* from Gobindsagar. Solid line = = total length in percentage of the length of the last growth season. Dotted line = length increment in percentage of the first growth season.

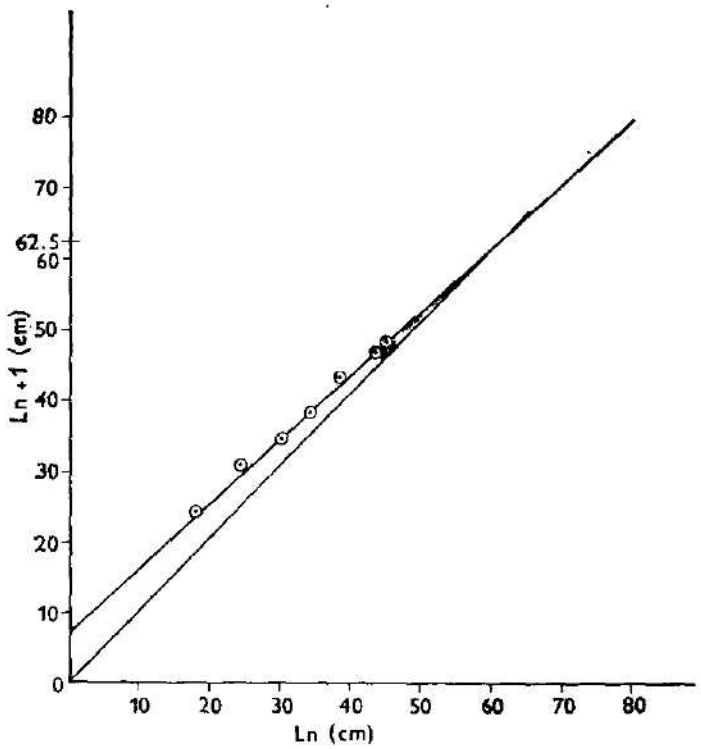

Fig. 4. Walford's graph to determine the maximum size attained by *Labeo dero* from Gobindsagar reservoir.

growth and specific rate of weight increase (Table 3). In these growth parameters the values show sudden decline in the age classes 7—8 i. e. 'old age'. Considering all the aspects of growth, *Labeo dero* should not be allowed to grow more than 40.00 cm.

Harvestable size

Theoretical harvestable size of *Labeo dero* has been determined from the intercept of the length increment in percentage of the length of the first growth season and the length in percentage of the final growth season. The plotting of these two lengths along ordinate and age classes along abscissa give the point of intersection which is considered the theoretical harvestable size. By adopting this procedure, the harvestable size has been found out to be 21.00 cm total length (Fig. 3) and lies between the age classes 1 and 2.

The harvestable size of other Indian major carps (Johal and Tandon, 1987) and *Puntius sarana* (Tandon and Johal, 1983) has been described earlier using this method. It has been observed that the stocks of *Labeo dero* in Gobindsagar are not declining because of the higher legal limit (30.00 cm total length) than the real harvestable size. But observations on Indian major carps are contrary to these findings, as a result the stocks of Indian major carps in this reservoir are depleting (Johal and Tandon, 1983). Considering the present and the earlier observations, it appears that the technique of calculating the harvestable size based on the growth data is reliable and be applied to other commercial fishes.

In most of the commercial fishes harvesting is done after fist maturity. Hora (1937) described sexual maturity in *Labeo dero* at 16.00 cm total length. Considering the observations on the growth data, the size lies in the age class 1 (with a range of 14.57—23.30 cm total length). Therefore, the fish should not be caught in the first year.

Theoretical maximum attainable length

The ultimate length attained by *Labeo dero* has been determined by plotting Walford's graph (Walford, 1946). The length l_n attained in each age class has been plotted along 'x' axis and l_{n+1} along Y axis (Fig. 4). Another line is drawn at an angle of 45° from the 0 mark. The intercept of the two lines give the maximum attainable length by the fish in this waterbody, which has been found to be 62.50 cm total length. In the present collection, the largest specimen has the total length of 48.00 cm, indicating thereby that in Gobindsagar there are present fishes of higher sizes/age classes not included in the present sample. The exclusion of the higher sized fishes in the present sample may be due to the selectivity of the fishing gear employed in this waterbody.

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THE GROWTH PARAMETER — A NEW INDEX FOR THE EVALUATION OF THE GROWTH RATE IN FISHES

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A b s t r a c t. The author introduces a new index based on the growth of the von Bertalanffy equation. The growth equation makes it possible to use the empiricaly ascertained values of growth and allows some prognosis of the further growth. The calculation of the growth parameter — R_p — is based on the use of the so-called Simpson's rule. As the growth parameter the value of the size of the area below the growth curve, received according to the relationship is calculated. There are presented examples of the calculation of R_p for the growth values of the common bream *(Abramis brama)* in various localities.

INTRODUCTION

For the evaluation of the growth of fishes several parameters and indexes are used, which interpret more or less succesfully the growth rate. The simplest of these are the absolute linear increment and the relative increment.

In 1927 S m a l g a u z e n and B r o d y (M i n a and K l e v e l z a l, 1976) introduced the instantaneous growth rate coefficient. V a s n e c o v (1934) recommended the so-called growth characteristic — C_{ch}. S m a l g a u z e n (after T c h u g u n o v a, 1959) established the derived coefficient, the growth constant — C_{lk}. B a l o n (1964) proposed computation of the average values of single indexes (for certain phases of the individual life or population life). B a l o n (1964) introduced also the index of the linear population growth intensity φC_l, which can be obtained by averaging the relative increments of the length or weight growth. Similarly, it is possible to calculate the so-called index of the population growth rate — φC_{lh} after the averaging of the growth characteristics. P i v n i č k a (1972) recommended a further characteristics illustrating the production possibilities of the population studied, the index of production — P_I. This index summarizes the contributions of the individual age groups to the total production of the whole population assuming always as an example one "average" fish (which is characterized with the average values of growth rate of the age group) in each age group. Here it is necessary to know the weight growth. With regard to the fact that it is often necessary to compare the growth rate of individual fish species from various localities, especially from the values of the length growth and none of the indexes cited seems to be quite reliable and fully evaluating the growth intensity, the author introduces a new index based on the growth of the von Bertalanffy equation.

RESULTS AND DISCUSSION

The growth equation makes it possible to use the empiricaly ascertained values of growth and allows some prognosis of the further growth supposing

Table 1. A survey of the length growth of the common bream in various localities

Locality — (author)	Back-calculated values of the body length in previous years													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Caspian Sea (Berg, 1949)	73	162	253	295	332	360	393	405	421	431	437	454	462	
Orlík-valley lake (Závěta, 1981)	59	91	126	157	183	201	219	233	246					
Poltruba-backwater (Oliva, 1958)	55	77	115	153	181	213	269	335						
Kateřina-mining pool (Závěta, 1981)	46	87	111	129	141	151								
Haska Fjärd-Borga (Segerstrale, 1933) (average from Table 30)	25	61	95	121	144	164	184	203	223	240	261	274	295	314

there exists only one unknown, viz., the time — "t". Fishes in general are characterized by unfinished growth which can be expressed asymptotically.

Ricker (1975) described the derivation of the growth equation according to von Bertalanffy up to the final form:

$$l_t = L_\infty (1 - e^{-K(t-t_0)})$$

Using the construction method of von Bertalanffy's curve by Beverton's method (Ricker, 1975), I calculate 3 parameters from the cited equation — i.e. L_∞, K, t_0.

The first two parameters can be obtained from GM functional linear regression l_{t+1} on l_t. Functional regression is used because values X (of the length growth) are conditioned by the natural variability of the symmetric sample of the real or imaginary distribution of an indefinite extent. For the calculation of t_0 the simple linear regression is used, since the values plotted on the abscissa (t) are exactly known. For the calculation of von Bertalanffy's growth and computes all parameters of the curve. By further adding values of all the linear regressions, enables a simple reading of values of the length growth and computes all parameters of the curve. By further adding values "t" into the equation calculated it is possible to calculate new values l_t for each "t". In this way a new ideal growth equation is calculated and its new curve for the given set of length values of a certain locality with regard to a certain fish species.

The calculation of the growth parameter — R_p — is based on the use of the so-called Simpson's rule. As the growth parameter the value of the size of the area below the growth curve, received according to the relationship is calculated. Simpson's rule has the following form:

$$\int_{t_0}^{t_n} f(x)dx = \frac{h}{3} (f_0 + 4f_1 + 2f_2 + 4f_3 + 2f_4 + \ldots + 2f_{n-2} + 4f_{n-1} + f_n)$$

$$h = \frac{t_n - t_0}{n} \qquad t_0, t_n = \text{years}$$

n = the number of subintervals. 2, 4, 6, 8 ... (I use always 8, because here there appear no significant deviations in calculations).

Table 2. **Calculated values of the body length for the ideal form and course of the growth curve**

Locality	Calculated ideal values of the body length in individual years													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Caspian Sea	56	155	231	288	332	366	391	411	426	437	446	452	457	
Orlík	59	90	128	155	179	200	218	234	247					
Poltruba	58	81	109	141	179	223	274	334						
Kateřina	45	85	112	130	142	150								
Haika Fjard-Borga	30	60	89	115	140	164	186	207	226	245	262	278	293	308

To calculate the R_p parameter the ML-09 programme may be used with advantage for calculators TI-58, 59 etc. For the function deposited in the programme memory the programme 09 computes a certain integral for the given limits t_o and t_n, provided the function is continuous in the given interval. I would like to present examples of the calculation of R_p for the growth values of the common bream *(Abramis brama)* in various localities (Table 1) of its distribution, with regard to various deviations in its growth, including small changes, which R_p parameter can distinguish. The growth parameter was always calculated for given limits 0—6, 0—9 etc. years.

Table 3. Parameters of growth equations with values of R_p for individual model localities (0 — 6 year, 0 — 9, 0 — 11, 0 — 13 year of the life of the population)

Locality	L_∞	K	t_o	R_{p0-6}	R_{p0-9}	R_{p0-11}	R_{p0-13}
Caspian Sea	473.2	0.2715	0.5357	1218.9	2418.2	3291.2	4194.8
Orlík	336.5	0.1419	−0.3555	727.0	1403.2		
Poltruba	−80.5	−0.1566	−2.4610	695.8			
Kateřina	167.1	0.3951	0.2016	587.5			
Haika Fjárd-Borga	532.1	0.0619	0.0557	516.8	1104.9	1593.9	2149.9

Following parameters of the growth curve, together with the growth parameters R_p (Table 3) were calculated for the model localities noted. They enclose areas with rapidly growing populations of the common bream *(Abramis brama)* in the southern part of the area of its distribution (the Caspian Sea) and the slowes growth rate in Finland, as well as the median growth rate (riverine lake Orlík in Central Bohemia) and the slowest growth in Czechoslovakia (natural lake Kateřina, filled with water after mining). According to the values parameter R_p the localities given are differentiated to a considerable extent.

From the values cited of the growth parameter (Table 3) it is evident that it is possible to distinguish the rate of growth also within two localities growing similarly very rapidly as, e.g. the riverine lake Orlík and the backwater Poltruba in Bohemia, for the period of 0—6 years of life. The value of the parameter R_p is sufficiently differentiated and it is fully satisfactory also for the differentiation of the rate of the growth within remote localities giving totally different values of growth rate, e.g. the Caspian Sea versus Finland.

Table 4. Basic statistics for R_p, φC_{1h}, φC_1

	Observations	Mean	Variance	Standard deviation	Coeff. of skewness	Coeff. of kurtosis	Coef. variation
R_{p0-6}	228	906.4	56208.54	237.083	0.587	0.756	26.156
φC_{1h0-6}	228	34.3	69.19	8.318	0.294	−0.137	24.279
φC_{10-6}	228	28.7	27.47	5.241	−0.192	0.309	18.271
R_{p0-9}	168	1785.3	159432.29	399.289	0.152	0.152	22.366
φC_{1h0-9}	168	30.8	38.82	6.231	−0.182	−0.452	20.254
φC_{10-9}	168	21.7	12.69	3.563	−0.299	0.668	16.397

Here the value of R_p for the first locality was roughly twice higher than second (Table 3). From these results it is evident, that the values of the ideal growth curve do not differ significantly from the actually determined values of the body length of individual populations, the highest deviation having been found the locality "Caspian Sea" (Table 2).

Table 5. Correlation matrix

	φC_{1h0-6}	φC_{10-6}	R_{p0-9}	φC_{1h0-9}	φC_{10-9}
R_{p0-6}	0.8028	−0.2870	0.9799	0.6862	−0.5098
φC_{1h0-6}		0.2886	0.8520	0.9003	0.1001
φC_{10-6}			−0.2797	0.1545	0.9594
R_{p0-9}				0.8133	−0.3579
φC_{1h0-9}					0.1571

I used this index to compare the rate of growth within its whole area of its distribution according to the literary data from 228 localities. I have also tested the use of other indexes (especially φC_{1h}, φC_1), but none has made it possible the construct a decreasing succession of localities that would correspond to actual changes in the rate of growth. The above growth parameter R_p has always appeared as the most advantageous.

For the total number of 228 localities from which I have obtained the data concerning the length growth of the bream, I have calculated the indexes presented in Table 4, where only the extent up to the ninth year of life is covered The growth parameter R_p covers the data from the whole area of distribution. Statistical values are included in Table 4. The correlation matrix shown in Table 5 presents the relation between the indexes studied. They reach significant values only with:

$R_{p0-6} \times \varphi C_{1h0-6} = 0.8028$
$R_{p0-6} \times \varphi C_{1h0-9} = 0.6862$
$R_{p0-9} \times \varphi C_{1h0-9} = 0.8133$
$R_{p0-9} \times \varphi C_{1h0-6} = 0.8520$

The high correlation reach naturally:

$R_{p0-6} \times R_{p0-9} = 0.9799$
$C_{1h0-6} \times \varphi C_{1h0-9} = 0.9003$
$\varphi C_{10-6} \times \varphi C_{10-9} = 0\ 9594$

Finally, I would like to draw the reader's attention to some disadvantages of the use of this parameter. It is not possible to apply it when calculating regressions, especially in the Walford's graph, when the age t+1 is plotted against the values of the body length at the age "t", where the axis between the abscissa and the ordinate cannot cut the straight line of the graph, as it was clearly shown by Ricker (1975: 223). In this case it is also impossible to calculate the growth equation, which forms the basis for the calculation of the growth parameter R_p.

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ABSTRACTS OF PAPERS

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Permanent transmission of coccidia in large-scale cattle farms.
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A thorough coprological examination proved a permanent transmission of coccidia between animals kept under different regimes: 1 — calves separated from their mothers and kept in special pens; 2 — calves right after the transfer to great central calf-houses; 3 — calves in central calf-houses for up to 6 months of age; 4 — young cattle, 6 to 8 months; 5 — mothers of calves; 6 — nurse cows; 7 — cattle on pastures. The table below gives the numbers of animals examined and the prevalence percentage of coccidian species in the different regimes.

	1	2	3	4	5	6	7
Eimeria	2084	1129	3483	4357	669	200	700
alabamensis	3.4	16.7	4.7	4.3	14.1	6.0	6.7
auburnensis	1.3	3.3	34.2	18.7	9.3	14.0	18.4
bovis	21.1	26.3	49.4	50.5	59.0	49.0	73.1
brasiliensis			1.2	0.1			0.6
bukidnonensis	1.9	8.9	5.9	3.6	23.2	9.5	4.6
cylindrica	2.3	2.0	12.4	5.1	31.1	40.5	9.1
ellipsoidalis	6.8	9.2	37.5	26.6	21.8	39.0	25.6
subspherica	7.2	12.0	10.6	7.9	29.6	22.5	29.0
wyomingensis	0.1	0.4	0.03	0.1	4.9		
zuernii	26.5	37.6	42.2	30.4	81.9	76.5	55.4
Isospora spp.	0.05	0.2	2.4	0.8	2.2		2.7

A great number of coccidian species is being transmitted from maternity sheds to other rearing regimes of cattle. In industrial rearing technologies with frequent animal transfers it is impossible at the present to prevent the continuous transmission of coccidia.

Observations on the survival of coccidia in nonspecific hosts.
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In 1972, Dubey and Frenkel (J. Protozool. 19: 89—92, 1972) observed for the first time the survival of sporozoites of Isosporan coccidian in tissues of nonspecific hosts. Naciri and Ivoré (C. R. Acad. Sc. Paris, t. 294, série 3, 219, 1982), later also Kogut and Long (Z. Parasitenk. 70: 287—295, 1984) recorded a similar phenomenon in coccidia of the genus *Eimeria*.

We have verified the infectivity interval of *Eimeria tenella*, a parasite of chickens, after inoculation into mice. The mice were inoculated with 500,000—700,000 oocysts/

/mouse and their homogenized lungs and livers were used for the infection of specific hosts, 3-week-old chickens Organs of mice killed on days 3—7 p i induced the infection, but organs of mice killed on days 8, 10, 12, 14 and 20 p i were no more infective for chickens The same phenomenon was studied with a heteroxenous coccidian, *Sarcocystis dispersa*, the intermediate host of which is the mouse (*Mus musculus*) Sporocysts of this species were inoculated into two chickens (10^6 sporocysts/chicken) and the chicken were killed on days 5 and 7 p i Homogenized livers, lungs, muscles, and other organs (kidney, heart, small intestine) were used for the infection of mice (two mice in each case) The mice were examined for the presence of sarcocystis in muscles $2^1/_2$ and 3 months infection, but none of them was found to be infected In our opinion, this result corresponds with our previous experience that sarcosporidian sporozoites are only sporadically released from the nonspecific hosts (Černa Ž et al Folia Parasitol 25 201—207 1978)

Surface changes of silk glands of the wax moth, Galleria mellonella due to the microsporidian, Vairimorpha plodiae
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Last instar larvae of *Galleria mellonella* were infected by intracoelomic injection of *Vairimorpha plodiae* spores (Weiser, Věst čs Společ zool, 42 311, 1978) On day 30 p i, the silk glands were excised from the infected larvae and prepared for the examination in the scanning electron microscope (SEM) Tesla BS-300 A dissecting microscope reveals milk-white, hypertrophic sections of the silk gland There the gland wall is thickened all around its circumference and the cytoplasm of its cells is repleted with spores In the SEM, hypertrophic sections of the gland appear globular with a smooth surface, the spores formed within the cells do not show Hemocytes — single and in clusters — adhere to the unaltered sections of the gland The hemocytes contained microsporidian spores, which were also free between the cytoplasmic projections of the hemocytes The surface of the noninfected silk glands from control larvae was unaltered and free from hemocytes The initiation of infection in the silk glands by the intracoelomir spore injection proves that the parasites invade the glands from haemocoele The irregular distribution of the infection foci confirms the random origin of infection in the gland Our observations have demonstrated the causal relation between the presence of hemocytes and the microsporidian infection in the silk glands of the host

Studies on rumen protozoa of the genus Epidinium in vitro
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Epidinium spp were isolated from the bovine rumen fluid in a medium containing 10% prepared fresh rumen fluid Protozoal growth was stimulated more by the fresh rumen fluid than by the autoclaved or freeze-dried fresh rumen fluid stored for one month

An episymbiotic association of methanogenic bacteria with *Epidinium* spp was observed during 4 months of in vitro growth The methanogenic bacteria on the surface of protozoa were identified by fluorescence microscopy The episymbiotic association was studied with pyromellitic diimide (PD), an inhibitor of methanogenesis One or 2 mg of PD, added to 10 ml culture medium markedly decreased the number of methanogenic bacteria on the protozoal surface and in the medium during 9 days Protozoal growth was decreased by PD and culture treated with PD had a higher proportion of dead protozoal cells than the control cultures after 9 days

The beneficial effect of the adherent methanogenic bacteria on protozoal growth seems to be a probable explanation for the better growth in control cultures However, the possibility of a toxic effect of PD on protozoal metabolism cannot be ruled out

The cytoskeleton of protozoa A review
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The cytoskeleton (CS) is a significant principle necessary for the organization and

function of all eukaryotic cells In protozoa it has an unusual structural variability In addition to basic CS structural elements present in most eukaryotic cell, such as microtubules (MT), microfilaments (MF) and intermediate filaments (IF), some protozoans posses other filaments, such as periodic fibres, membrane skeletons and nonactin filaments

The CS of protozoa is remarkable by the great variability in the organization of its structural elements MT are organized, in addition to a typical ciliary axoneme, kinetosome or centriole in a number of other formations such as the nemadesma, axostyle, kinetosome rootlet, ribbon, cytospindle etc Actin-based MF create a complex network in the cortical layer of Rhizopoda Ciliates, e g , *Paramecium* with several CS subsystems in the cortex contain actin in the granulo—fibrillar meshwork located in the surface ridges, around contractile vacuoles and the cytoproct, and near the oral apparatus IF have so far been suggested only in a few species, e g , in euglenoids, *Trypanosoma*, *Crithidia*, *Gregarina* and some ciliates The periodic fibres involve ciliate kinetodesmata, rhizoplasts and parabasal fibres in flagellates, trichomonadine costa and connections between kinetosomes Much evidence from studies on protozoans was accumulated to suggest that the CS and its associated proteins are responsible for three principal cell functions — structural, locomotory and informational function

The presence of actin in the cortex of regenerating Paramecium caudatum
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The technique of indirect immunofluorescence with the use of anti-actin rabbit serum and a secondary antibody SwAR FITC enabled us to detect actin in the cortex of *Paramecium caudatum* and in its regenerating fragments Prior to exposure to the antibodies, unfixed specimes were permeabilized by Triton X-100 in a special buffer (PHEM)

Fluorescence showed actin as a network of regular polygons corresponding to the margins of kinetids This pattern of actin distribution is most probably identical with the granulofibrillar meshwork identified at corresponding sites in ultrathin sections The actin is distributed more or less evenly all over the cortex, with higher density being found around the oral apparatus, in contractile vacuole pores and in the cytoproct area

In regenerating fragments, intense fluorescence was found all over the area of the injured cell pole within two minutes of merotomy, which indicates an increase in the actin concentration in the cortex and possibly also in the cytoplasm In cells affected by the pressure of micrurgical instruments, an increased concentration of actin was seen just in the compressed area The original location of actin in polygon ridges, however remained unaffected The findings are in agreement with our previous observations on ultrathin sections It is suggested that the accumulation of actin in regions where injury occurred plays an important role in the cell s healing process

New findings of myxosporean proliferative stages in the blood of freshwater fish
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These stages (Csaba stages" or UBO) were first detected by C s a b a (1976) in Hungary in carp (*Cyprinus carpio*) fingerling blood They represent one part of the life cycle of *Sphaerospora renicola* Dykova and Lom, 1982 Until now, these stages have been described from other freshwater fish — *Gobio gobio, Rutilus rutilus, Tinca tinca* and *Thymallus thymallus* in Czechoslovakia, from *Blicca bjoerkna* in Hungary, from *Gila bicolor* in the USA and from *Gasterosteus aculeatus* in England

During our studies of protozoan parasites of fish, we have found the sphaerosporan blood proliferative stages in 8 more fish species — in *Abramis brama, Alburnus alburnus, Gymnocephalus cernua, Leuciscus cephalus, Lota lota, Perca fluviatilis* and *Scardinius erythrophtalmus* In fresh blood sample, these stages can be rarely observed due to mostly very light infections

One can presume the existence of blood stages in more *Sphaerospora* species from other fish hosts There are indications, that such a developmental phase may also be found in the genus *Chloromyxum*

Some data on the ultrastructure of rumen protozoa.
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Protozoa were isolated from the rumen fluid in cultures and/or separated by filtration method. The typical representatives of rumen microfauna in small ruminants, *Entodinium caudatum*, *Entodinium simplex* and *Ophryoscolex caudatus* were observed by TEM and SEM methods.

On the surface of the ciliates, adherent rumen bacteria were present. The *E. simplex* surface has striated structure and oval form. The *O. caudatus* surface is porous, slightly bent with lateral projections and a caudal spine. In the endoplasm, starch granules, glycogen particles, vacuoles, hydrogenosome—like structures and in *O. caudatus* also skeletal plates were present.

Marginal zone consists of 4 layers: Surface membrane, homogenous layer, microtubular and microfilament layers. Oral part of *E. simplex* was marked by the adoral ciliary zone.

Concurrent infections of enterocytes with endogenous stages of Eimeria scabra and other enteropathogens.
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In the ileum of pigs, our ultrastructural studies detected mixed infections of enterocytes with the coccidian *E. scabra* either with chlamydia or with undetermined bacteria or with cryptosporidia. *Chlamydia*, intracellularly located bacteria and cryptosporidia were only detected in enterocytes with developmental stages of *E. scabra*. These findings evidence the changes of enterocytes due to the infection with *E. scabra*, making possible the infection with other agents. With respect to the intracellular localisation of secondary infectious agents, these changes take place in the cytoplasmic membrane of the host cell, in the membrane of microvilli of the enterocyte. The study of ultrastructure of enterocytes infected with *E. scabra* proved reduction of their microvilli and changes in the terminal microfilamentous web in apical parts of the enterocytes.

Ultrastrutural features of some developmental stages of Chloromyxum sp. from burbot (Lota lota).
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The kidney of burbot collected in Bohemia harbored a *Chloromyxum* sp. Trophozoites were found in glomerular capillaries and in Bowman's space, sporogonic trophozoites occurred in the lumen of renal tubules. Young trophozoites contain large vesicles (2 μm) with dense inclusions.

The epithelial cells of the tubules harbored intracellular trophozoites probably belonging to the same species. In the primary cells there were secondary cells and tertiary cells.

The spore formation follows the pattern known in other myxosporeans. During a transient stage of the polar filament formation the inner layer of the polar filament wall appears as a reticulated structure quite unlike its appearance in other species. The lucent outer layer of the wall is subtended by a corset of microtubules (with a diameter 7 to 8 nm) which we found also in some other myxosporea. These "thin" microtubules are transitory structures in the development of the polar filament. The sporoplasmosomes, dense bodies in the sporoplasm are unit membrane bound and seem to develop from simple lucent vesicles.

The spores within the polysporic trophozoites are formed in disporic pansporoblasts. This agrees with our earlier observations on *C. cristatum* but is at variance with *C.* cf. *leydigi* from *Torpedo marmorata* where separate spores originate without pansporoblasts. Thus the sporogenesis in this genus may proceed both with and without pansporoblasts while other genera adhere either to one or to the other way of sporogenesis.

Protozoan grazing on bacteria under experimental and in situ conditions.
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Protozoan clearance rates were studied using inert fluorescent particles (McManus, Fuhrman, Limnol. Oceanogr. 31: 420, 1986). To estimate the time dependence of ciliate ingestion rates, clone culture of *Colpidium campylum* (Stokes, 1888) was tested. A linear increase both in the number of ingested particles and newly formed food vacuoles was verified during 30 minutes incubation. The estimated individual clearance rate (average for total number of ciliates) varied from 0.5 to 26 nl . h^{-1} depending on a growth phase of the original culture. Grazing of *C. campylum* was studied in a continuous-flow system (repeated food batch) with nitrilotriacetic acid (NTA) as the only organic carbon source. More than 90 % of the total bacteria were dispersed growing NTA degraded clone No. 4 (Čech, Hartman, unpublished data), which was not sufficient to support the growth of ciliates as the only food source. Estimation of individual clearance rate (up to 1 nl . h^{-1}) verified that grazing efficiency on dispersed bacteria is rather low as compared to that of mixed-bacterial batch culture with the same ciliate growth rate (0.5 d^{-1}). Apparently, additional sources are used by ciliates, such as admixture of bacteria in a biofilm or bacterial flocs.

In situ clearance rates of protozoa (Římov Reservoir; Southern Bohemia) indicated that up to 21 % of bacterial standing stock is grazed daily by zooflagellates and ciliates during the period of summer phytoplankton bloom (clearance rate of zooflagellate with particles ingested in average up to 10 nl . h^{-1}, that of ciliate up to 60 nl. . h^{-1}).

Cryopreservation of rumen protozoa cultivated in vitro.
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A simple technique for cryopreservation of the rumen ciliate *Entodinium simplex* is described. After anaerobic equilibration at 312.2K with cryoprotectant, the protozoan suspension was transferred into Eppendorf polyethylene tubes. The tubes with protozoan samples were placed into a cooling vessel consisting of an internal container insulated with commercial granulated building material (Perlit). The bottom of the cooling vessel was placed 0.2 m above the level of liquid nitrogen (LN_2) in a 30 l Dewar flask during cooling the protozoan samples from 296.5K to 150K. During cooling from 150K to 84K the vessel was placed on the level of LN_2. At 84K the tubes were immediately immersed in LN_2. After 2 months storage in LN_2 the protozoan samples were warmed up in the water bath at 313.2K and the presence of motile protozoa was evaluated microscopically. Growth ability of the cryopreserved protozoa was confirmed by cultivation.

The best survival of *E. simplex* (about 9 %) was observed by using 30 min equilibration of protozoa with 3 % DMSO as cryoprotectant, the protozoan concentration of 60 000 per ml and the cooling rate obtained with the described technique.

Free-living protozoa in sources of drinking water.
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World-wide increase of pollution not only of surface waters but nowadays even of underground waters does require an exact determination of free-living protozoa in drawn-up ground water, since the presence of some species in underground water is held to be indicative value of the water quality. A merely quantitative assessment of individuals present (according to Czechoslovakian standards for drinking water), gives no information on the water quality. Species of flagellates and ciliates which are characteristic of polluted surface waters are also found in "clean" waters underground, as they are associated with organic matter which may be formed by surface autotrophic activity and percolated into ground water. Such species may also derive from run-off from cultivated fields. Water of a poor quality was also found in wells and bore holes from which it was pumped at irregular intervals. Unsuitable waters were less common in continually pumped wells; however, excessive exploitation of ground water and the ensuing penetration of pollutant from surface may result in poor water quality in these wells, too. A minimum amount of

water must always be pumped up, otherwise casings of wells become clogged. The decline in water quality also results from such stagnation of water flow. This situation is referred to as "self-pollution" and is associated with the appearance of species of protozoa typical of poor water quality.

The prevalence and species composition of coccidia of hares in Czechoslovakia.
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In a total of 350 European hares (*Lepus europaeus*) investigated the following species of coccidia were recognized: *Eimeria babatica* (with prevalence of 28 %), *E. europaea* (24 %), *E. hungarica* (6 %), *E. leporis* (31 %), *E. macrosculpta* (2 %), *E. robertsoni* (34 %), *E. sculpta* (9 %), *E. semisculpta* (13 %), *E. townsendi* (70 %). In *E. babatica*, *E. macrosculpta* and *E. sculpta* this is the first record in Czechoslovakia.

Division of Trypanoplasma borreli in the blood of Carassius auratus.
H. Pecková, Institute of Parasitology, Czechoslovak Acad. Sci., Branišovská 31, 370 05 České Budějovice.

Trypanoplasma borreli strain used in this study was initially isolated from the carp, *Cyprinus carpio*. It has been maintained by blood inoculation in goldfish, *Carassius auratus*, and also was stored in liquid nitrogen. The division process of trypanoplasma was observed in Giemsa stained smears. Flagelates multiply in the blood of goldfish by longitudinal binary fission. The early division stages could be recognized by shortened, more rounded body and by the anterior flagellum extening posteriorly along the cell margin, paralleling the recurrent flagellum. The kinetoplast was usually almost spherical. Afterwards, the formation of two new short flagella took place. This was followed by nuclear division; the two daughter nuclei were connected by a thin chromatin strand until the kinetoplast division was completed. The kinetoplast divided by transverse constriction As division continued, the new flagella grew long and the distance between the daughter kinetosomes increased; eventually, they occupied position on opposite sides of the cell apex. Eventually, two daughter flagellates were separated along the longitudinal axis. Both original flagella of the maternal cell became the recurrent flagella of the new daughter individuals. The anterior flagella of the new daughter cells were produced de novo.

Relatively few dividing forms were observed in the blood of experimentally inoculated goldfish. The percentage of division stages never exceeded 0.3 % suggesting that the peripheral circulation may not be the primary site of parasite division

Adaptability of Plasmodium falciparum continuous culture to low temperature — preliminary results.
I. Rubík and P. Mirovský, Research Laboratory of Tropical Healthcare, Postgraduate Medical and Pharmaceutical Institute, Prague.

P. falciparum clone T9/96, isolated in Thailand (1980) was held in continuous culture in vitro. Red blood cells (RBC) — O type — (5 % hematocrite), 10 % human serum (mostly A+), RPMI 1640 supplemented with 25 mM HEPES buffer, 27 mM $NaHCO_3$ and 70 ug/ml of Gentamicin were used for cultivation. Culture flasks were gassed with 6 % CO_2, 4 % O_2 and 90 % N_2 gas mixture. Fresh uninfected RBC were added every 4th—6th day. All cultures were kept at 37,5 °C with daily changes of medium. The level of parasitaemia and morphological characteristics of parasites were determined daily from blood films by counting the number of infected cells per 10 000 of RBC. After 5 months of gradual decrease of temperature the above mentioned strain grows succesfully in 35 °C without any signs of morphological alteration. All cultures entering our experiments had about the same number of rings, trophozoites and schizonts and the initial parasitaemia between 10—15 %. The temperature was always decreased by 0,5 °C stepwise but never before the full stabilization on culture and in not less then 6 passages. A drastic decrease of parasitaemia (20 fold) was observed on day 1 with high predominance of ring stages. The culture reached again 5 % parasitaemia on day 5—6 after the start of experi-

ment. The duration of schizogony was prolonged on the average two times in comparison with the control culture (37,5 °C).

Indicator value of freshwater ciliates of the genera Stylonychia, Oxytricha and Tachysoma.

V. Sládeček, Department of Water Technology and Environmental Engineering, University of Chemial Technology, Prague.

Seventeen species of freshwater Hypotrichida were classified as indicators of saprobity. The saprobic valence in 10 balls for 5 levels of limnosaprobity x = xeno-, o = oligo-, b = beta-meso-, a = alpha-meso- and p = polysaprobity, the indicative weight of species I_i and the individual saprobic index S_i were given.

Taxon	x	o	b	a	p	I_i	S_i
Stylonychia muscorum Kahl	—	—	10	—	—	5	2.0
Stylonychia mytilus Ehrenberg	—	—	1	9	—	4	2.9
Stylonychia notophora Stokes	—	—	7	3	—	4	2.3
Stylonychia pustulata Ehrenberg	—	—	10	—	—	5	2.0
Stylonychia putrina (Stokes)	—	—	2	7	1	3	2.9
Stylonychia vorax Stokes	—	—	10	—	—	5	2.0
Oxytricha aeruginosa Wrzesniowski	—	—	10	—	—	5	2.0
Oxytricha chlorelligera Kahl	—	—	—	10	—	5	3.0
Oxytricha fallax Stein	—	—	1	8	1	4	3.0
Oxytricha ferruginea Stein	—	7	3	—	—	4	1.3
Oxytricha ludibunda Stokes	—	—	—	2	8	4	3.8
Oxytricha platystoma (Ehrenberg-Stein)	—	—	6	4	—	3	2.4
Oxytricha setigera Stokes	—	—	4	6	—	3	2.6
Oxytricha saprobia Kahl	—	—	—	3	4	3	3.4
Opisthotricha similis Engelmann	—	—	5	5	—	3	2.5
Tachysoma furcata Kahl	—	—	2	4	4	2	3.2
Tachysoma pellionella (O. F. Muller) Stein	—	1	2	3	4	1	3.1

Lectin activity of a protozoan parasite Tritrichomonas foetus.

K. Ševčíková[1], J. Mácha[2] and J. Kulda[1], Departments of Parasitology[1] and Physiology[2], Charles University, Viničná 7, 128 44 Prague 2.

Using formaldehyde fixed rabbit erythrocytes (2×10^8 / ml) we have examined hemagglutination activity of the whole cells and extracts of *T. foetus* and of the *TYM* culture medium in which these organisms were grown. The erythrocytes adhered to the surface of the living parasites and formed large agglutinates after addition of trichomonad extracts. No activity was observed in the cell-free culture medium. The active extracts, used in all subsequent experiments, were prepared by freezing and thawing of PBS washed, pelleted cells. Disintegrated cells were then diluted with an equal volume of 0,1 M phosphate buffer (pH 7,2) and spinned in a refrigerated centrifuge at 14 000 × G for 1 hour. Removal of membranes by centrifugation at 100 000 × G for 1 hour abolished almost completely hemagglutinating activity of the supernatant, indicating that the agglutinin is membrane bound.

Inhibitory assays were performed with 40 carbohydrates (in final concentration 15 mM), with bovine serum (10 %) and two glycoproteins: ovalbumin and fetuin (50 mg/ml). Serum, fetuin, galactose and all galactose glycosides (lactose, melibiose, gentiobiose, galactosamine, methyl-α-D-galactopyranoside, β-D-thiogalactoside, α-allyl-lactoside, 4-nitrophenyl-β-D-galactopyranoside, neuraminil-lactose) partially inhibited the agglutination. The inhibitory activity of fetuin was strongly reduced by desialisation but the n-acetyl neuraminic acid alone had no inhibitory effect. Agglutination was completely inhibited by a mixture of fetuin and galactose. The inhibitory effect of galactose was also markedly enhanced by a 3 mM neuraminil-lactose These results suggest that *T. foetus* possesses two lectins, one specific to galactose, the other to some glycoside of neuraminic acid.

Comparison of metronidazole resistant and susceptible Tritrichomonas foetus by restriction endonuclease analysis of DNA.

R. Tachezy and J. Kulda, Department of Parasitology, Charles University, Viničná 7, 128 44 Prague 2.

Strains of *T. foetus* can develop an in vitro anaerobic resistance to metronidazole by prolonged cultivation under the drug pressure. To check whether the development of resistance is accompanied by genome amplification, as observed in some other drug-resistant cells and parasites, restriction analysis of DNA was performed in a drug-susceptible clone KVc-1 and in four of its sequential resistant derivatives. Organisms used were representative of a given phase of resistance development and showed minimal inhibitory concentrations (MIC) for metronidazole (anaerobic) 10, 20, 40 and 100 μg/ml, respectively, while the MIC of the parent clone was 0.5 μg ml. Nucleic acids were extracted from the log phase trichomonads in the presence of 8 M guanidin thiocyanate. DNA fragments obtained by digestion with restriction endonuclease were separated by agarose gel electrophoresis. Restriction patterns of resistant stabilates obtained with the aid of 5 enzymes (*BamHI, BspRI, HindIII,* HpaII, BglII) were all identical with those of the parent, drug susceptible clone. The results indicate that the development of the anaerobic resistance to metronidazole is not accompanied by the amplification of genome or other genomic changes detectable by the technique employed. The lack of genome amplification is in accordance with biochemical findings which show that the elimination of the metabolic pathway required for reductive activation of the drug, rather than increased synthesis of a target or drug inhibiting molecule, represents a key mechanism of the resistance.

Comparison of trichomonad species and strains by restriction endonuclease analysis of DNA.

R. Tachezy[1], J. Flegr[2] and J. Kulda[1], Department of Parasitology, Charles University[1], Viničná 7, 128 44 Prague 2, and Institute of Molecular Genetics[2], Czechoslovak Acad. Sci., Flemingovo 2, 166 50, Prague.

Five species of the family Trichomonadidae belonging to 3 different genera were subjected to the restriction endonuclease analysis of the nuclear DNA, to evaluate sensitivity of this method for characterizing of trichomonad taxons. DNA for analysis was obtained by lysis of cells in 8 M guanidin thiocyanate, deproteinisation with the chloroform—isoamylalcohol mixture, and RNase treatment. Fragments of DNA resulting from digestion by restriction endonucleases were separated electrophoretically in an agarose gel. Reproducibility of the assay was proved by repeated treatment of a single strain of *Tritrichomonas foetus* with 3 different endonucleases (Eco RI, Hind III. Hpa II). The restriction patterns for each enzyme were identical in all experiments. To examine whether different schizodemes occur within trichomonad species, 5 strains of *Trichomonas vaginalis* isolated in different geographical areas in Europe and USA and differing in their sensitivity to metronidazole or virulence for laboratory animals, were compared using 3 enzymes (Eco, RI, HindIII, BglII). No differences in restriction patterns were found among the strains. Five strains of *Tritrichomonas foetus* from Czechoslovakia, Poland, USA and Cuba also shared their restriction patterns in assays with 4 enzymes (Eco R1, HindIII, BlgIII and Bam HI). Restriction patterns, however, differed remarkably between the two species. Finally we compared with each other 2 species of the genus *Trichomonas (T. vaginalis* and *T. gallinae),* 2 species of the genus *Tritrichomonas (T. foetus* and *T. nonconforma)* and a member of the genus *Trichomitus (T. batrachorum)* using 9 restriction enzymes (BglI, Bsp RI, Bam HI, Eco RI, Hind III, PstI, BcnI SalI, and HpaII or Msp I). Restriction patterns differed in all examined organisms and were characteristic of species. The results indicate that the restriction analysis of DNA might be useful for identification of trichomonads at the species level.

The interaction of fish trypanosome culture forms with some lectins.

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The agglutinability of fish trypanosome culture forms by 11 purified lectins (Con A, LCA, PSA, UEA I, PNA, RCA_{60}, SBA, HPA, PHA, WGA) was studied. Ten

stocks isolated from ten different freshwater fish species (*Abramis brama, Blicca bjoerkna, Carassius auratus, Carassius carassius, Cyprinus carpio, Esox lucius, Perca fluviatilis, Rutilus rutilus, Scardinius erythrophthalmus, Tinca tinca*) collected in South Bohemia were compared by the agglutination test in microwell plates using the standard final lectin concentration 1 mg/ml. Three basic types of cell—lectin interactions were observed on the microscopical level.

The strong agglutination of all stocks regardless of their original host was found in the presence of Con A, PS A and $RCA_{I/h}$, RCA_{120}, respectively, which implies the presence of relatively high amounts of sugar residues of D-galactose, in the surface of culture forms of these parasites.

In some stocks weak agglutination was observed in the presence of LCA, PNA, SBA, and WGA lectins, but their very low intensity makes them not sufficiently reliable for stock characterization.

The lectins UEA I, HPA, and PHA did not cause any agglutination of any of the stock examined.

In conclusion, in case of unequivocal results no remarkable differences in interactions of various stocks of trypanosomes culture forms with lectins used were observed. This obviously reflects the high degree of similarity of their main cell surface saccharide structures.

Ultrastructure of schizogony of the coccidian, Adelina tribolii.

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There have been only a few papers dealing with the ultrastructure of coccidia of the genus *Adelina* (*A. dimidiata* infecting the centipede *Scolopendra cingulata* (Tuzet and Galangau, 1969; Tuzet, 1970) and *A. tribolii* from the beatle *Tribolium castaneum* (Žižka 1969; 1985).

The larvae of *T. castaneum* infected with *A. tribolii* were fixed in phosphate or cacodylate buffered OsO_4.

Young schizogony stages are covered by a membrane complex 35 nm thick which consists of a three-layered envelope (the innermost electron dense layer 18 nm thick, middle layer 5 nm, outer electron dense layer 12 nm) to which the limiting membrane of the parasitophorus vacuole (PV) is apposed consisting of three electron dense and two lucent layers. During schizogony, a gap of up to 2 nm develops between the two membranes. After the schizogony has been completed, the enveloping membranes break and their borders roll up. In the PV or in the host tissue free spirally wound membranes can thus be found. The merozoite ultrastructure is similar to that of other apicomplexans. The cytoplasmic membrane (three electron dense and two lucent layers) is about 30 nm thick. There is an apical complex consisting of a conoid, apical ring, 32 subpellicular microtubules, rhoptries and micronemes. In the cytoplasm are vesicular mitochondria and reserve inclusions.

REVIEWS

The Mollusca. Vol. 11. *Form and Function,* by E. R Trueman & M. R. Clarke, 1988. United Kingdom Edition published by Academic Press Inc. (London) Ltd., 24—28 Oval Road, London NW1 70X, 504 pages, with 195 figures.

This multivolume work, The Mollusca, has its origins in the mid-1960's. It is a very important project intended to serve several discipline — zoology, biochemistry, physiology and paleontology. The skin, shell, muscle, excretory system and luminescence, which have developed characteristically in the Mollusca and the knowledge of which has advanced significantly in the past decade, are treated in detail in the present volume. Fifteen authors collaborated to integrate the questions of the functions of the important structure of the molluscan body. E. R. Trueman and M. R. Clarke have reviewed the main features of molluscs and their evolution in the introductory chapter. The following seven chapters deal with the skin and shell: (2) Molluscan Skin (excluding Cephalopods) (3) The Skin of Cephalopods (Coleoids): General and Special Adaptations, (4) Shell Structure, (5) Adaptive Morphology of the Shell in Bivalves and Gastropods, (6) Form and Function of the Nautilus Shell: Some New Perspectives, (7) Functional Morphology and Adaptive Patterns of the Teuthoid Gladius, (8) Shell Form and Strength. In chapter 9 (The Arrangement and Function of Molluscan Muscle), muscular hydrostats receive the greatest attention. The next two chapters summarize some data on the pallial cavity: (10) The Pallial Cavity and (11) The Mantle Muscle and Mantle Cavity of Cephalopods. Chapter 12 (The Structure and Function of Digestive Systems) includes structural and functional accounts of the alimentary system of each class (most of the available information concerns Gastropods, Bivalvia and Cephalopoda), outlining the comparative morphology as well as analysing radiation of the digestive tract in the Mollusca. Chapter 13 (Excretory Systems of Molluscs) is based on the information that the mechanisms of excretion and solute regulation in moluscs and vertebrates are strikingly similar. The chemistry of molluscan luminiscence has been reviewed in Volume 2 of this series; therefore, the object of chapter 14 (Luminiscent Organs) is to provide a comprehensive review of recent literature in the general framework of the ecology of bioluminiscence and ways in which it can be affected by the structure and operation of the luminous organs and tissues.

The data which have been treated by authors reviewing his or her special field offer excellent material for further research in Mollusca and a stimulus to new research in various branches of biological sciences.

J. Buchar

Sokolov, V. E. (Ed.) (1988): *Dictionary of animal names in five languages. Amphibians and reptiles.* Publ. House Russky yazyk, Moscow, 555 pp. Price 5.40 R.

The second volume of this Latin-Russian-English-German-French dictionary of animal names contains 4414 amphibian and 7712 reptilian taxa. Included are all contemporary orders, suborders, families and genera. In the individual genera 90—100 % of their species are published. Many Russian terms were proposed for the first time in this book. But some species are presented only with their Latin and author's name. Each taxon is characterized by its geographical distribution which is a very favourable feature for the users. Only orders are presented in taxonomic arrangement, their families, genera and species are arranged alphabetically. At the end of the book the lists of all taxa in five languages are given .The dictionary represents a very useful publication for scientific workers, pedagogues and students, as well as for translators. Especially the herpetologists and batrachologists will welcome its appearance.

V. Černý

Fig. 1. Cross section through the eye of a *Suncus murinus* embryo at day 15 showing constricted margin of the lens pit. A = amnion; LA = lenticular aperture; PE = = pigmented epithelium Haematoxylin-eosin, 900×.

Fig. 2. Cross section of head of *Suncus murinus* embryo at day 15. Note optic stalk cavity between arrows leading from the optic vesicle to the diocele. A = = amnion; Ss = skin surface; OV = optic vesicle; D = diocele Haematoxylin-

Fig. 3 Cross section of the eye of *Suncus murinus* at day 17.5 of embryonic development. Note hyaloid vessels between trilaminar lens (detailed in Fig. 4) and retina. Cells at the region of the future choroid-sclera arranging in layers (between arrows) around pigmented epithelium. A = amnion, E = eyelid rudiment; PE = pigmented epithelium. Haematoxylin-eosin, 215×.

Fig. 4 Detail of lens constituents from Fig. 3, day 17.5. H = hyaloid artery; LE = lens epithelium; PF = primary lens fibers, PZ = proliferative zone. Haematoxylin-eosin, 860×.

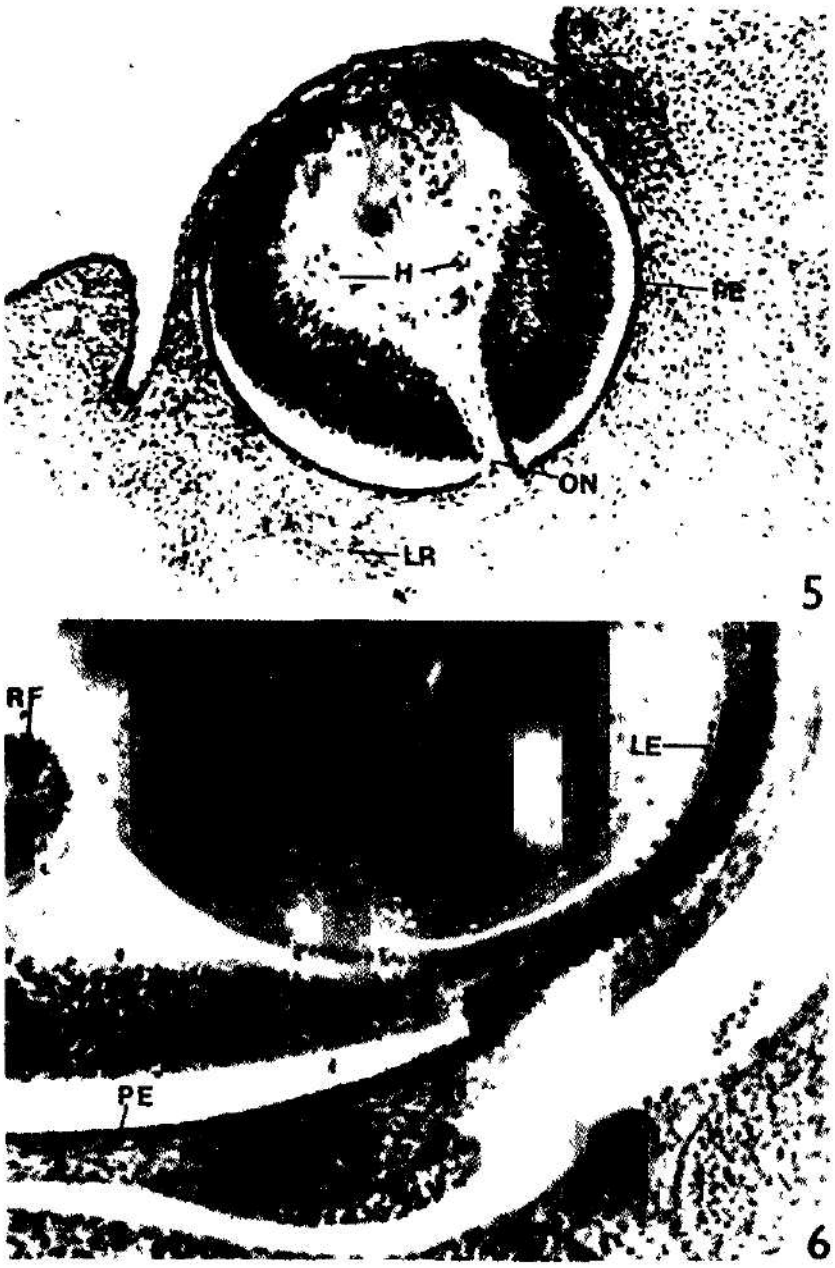

Fig 5. Longitudinal section at day 19 through the origin of the optic nerve. Note extensive invasion of the optic cup by hyaloid vessels. The choroid plexus (arrows) is forming behind the pigmented epithelium. E = eyelids; H = hyaloid artery; LR = lateral rectus muscle; ON = optic nerve; PE = pigmented epithelium. Haematoxylin-eosin, 270×.

Fig. 6. Longitudinal section through fused eyelids (arrow) at 23 days LE = lens epithelium separated from body of the lens; NM = nictitating membrane; PE = = pigmented epithelium; RF = retinal cyst attached to lens. Haematoxylin-eosin

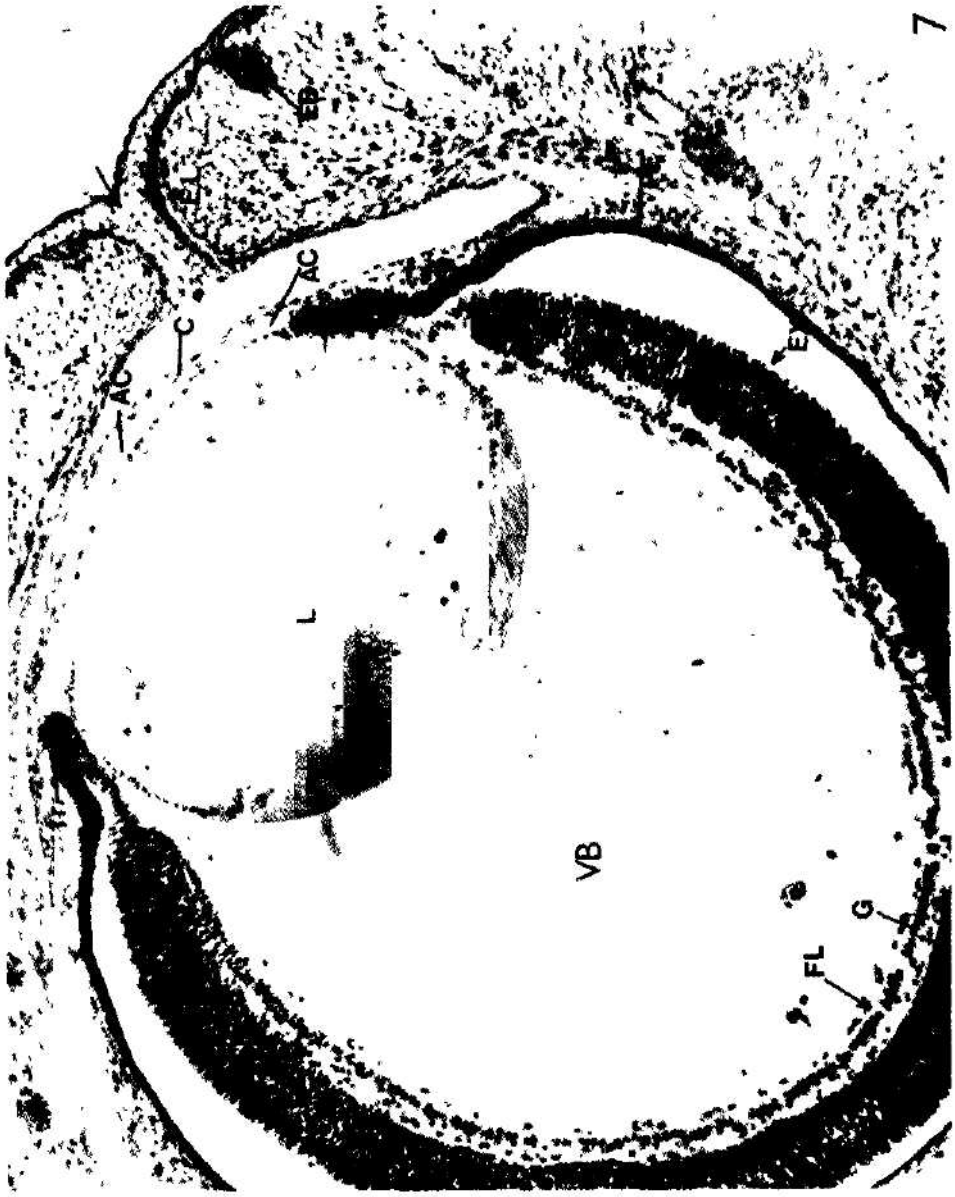

Fig. 7 Twenty-eight day embryo's eye with fused lids (arrow). AC = anterior chamber; C = cornea; EB = epithelial bud; EL = eyelid; EX = external limiting membrane, FL = nerve fiber layer; G = ganglion cell layer; Ir = iris; L = lens; VB = vitreal body; PE = pigmented epithelium. Haematoxylin-eosin, 200×.

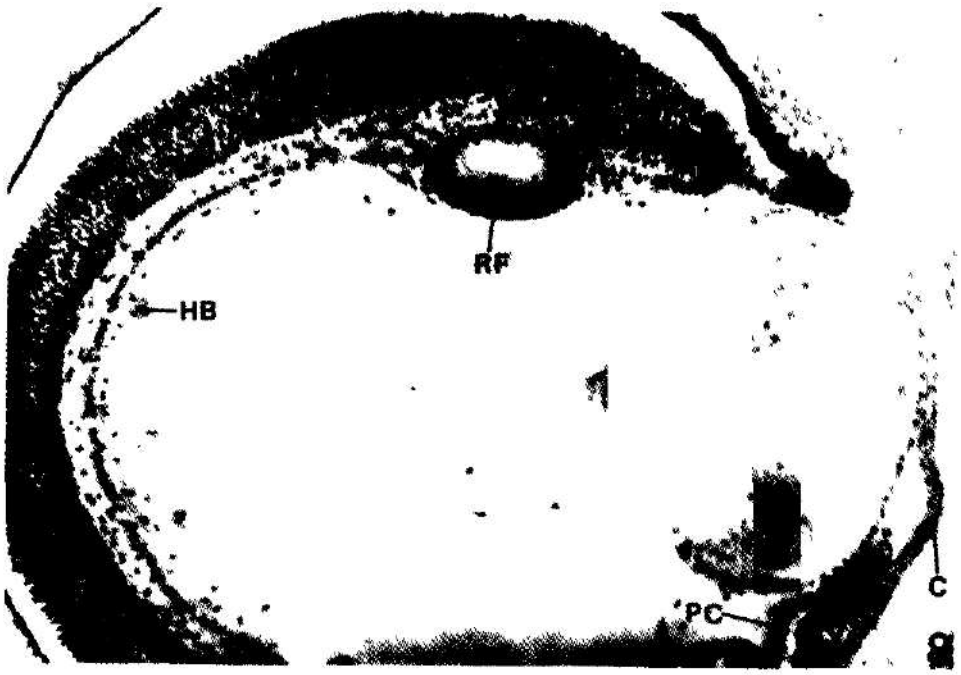

Fig. 8 Longitudinal section through eye at 28 days showing retinal cyst on anterio-lateral aspect of the eye. C = cornea; HB = hyaloid artery branch; L = lens; PC = pars ciliaris retinae; RF = retina folded into a cyst. Haematoxylin-eosin, 150×.

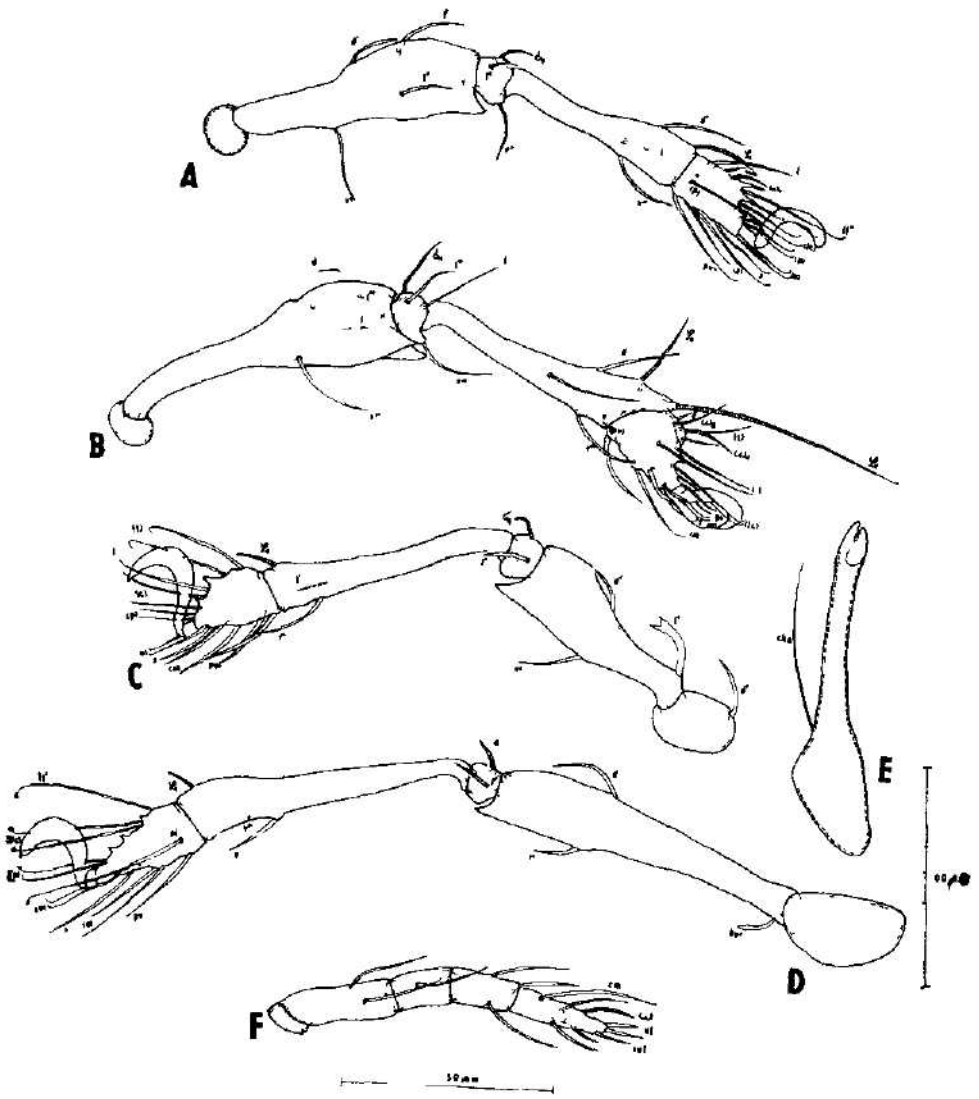

Fig 2. *Beckiella bloszyki* n sp (paratypus), A-right leg II, antiaxial view, B-right leg I, antiaxial view, C-right leg III, antiaxial view, D-right leg IV, antiaxial view, E-right chelicera F right palpus Scale for A—D and F 100 μm, for E 50 μm

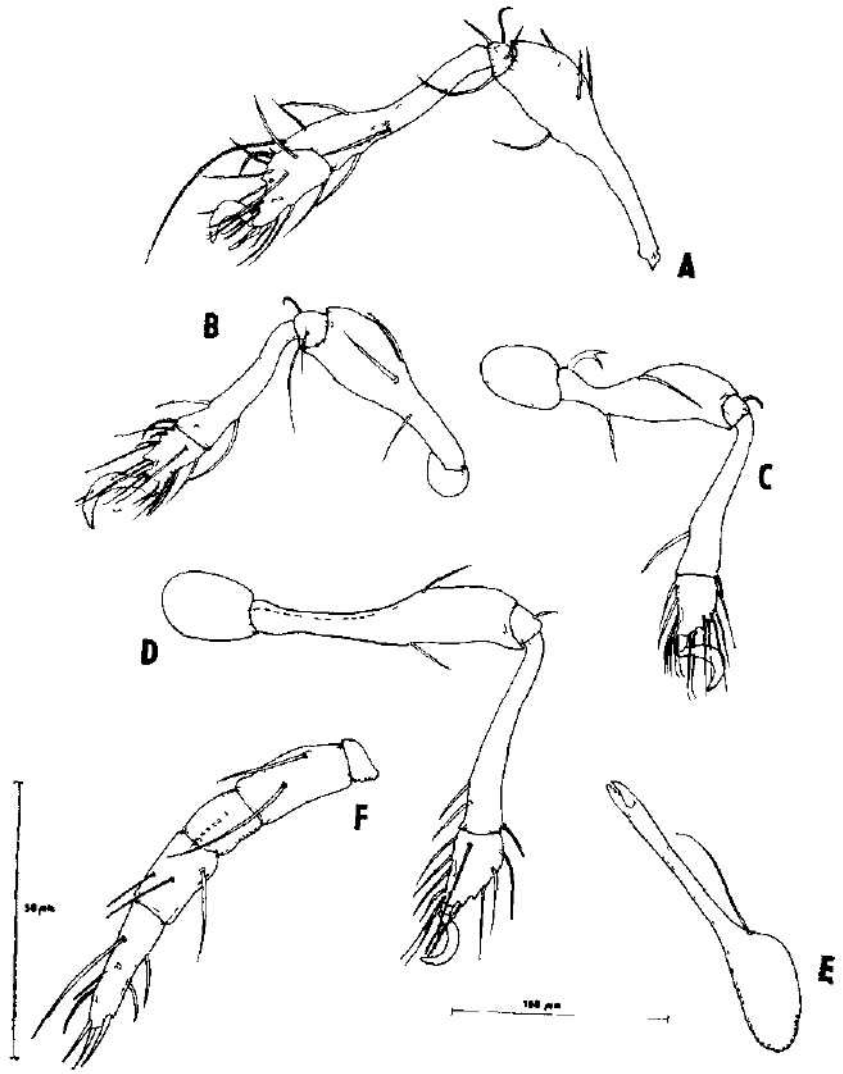

Fig. 4. ***Beckiella cubana*** n. sp. (paratypus), A-left leg I, antiaxial view, B-left leg II, antiaxial view, C-left leg III, antiaxial view, D-left leg IV, antiaxial view. F-left palpus, E-left chelicera Scale for A—E 100 μm, for F 50 μm.

POKYNY PRO AUTORY

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Hlavička práce. 1. Název práce (u prací taxonomických v závorce za názvem systematické zařazení druhu nebo skupiny — např. Ostracoda: Cyprinidae), obojí v řeči, v níž je práce psána. 2. Jméno a příjmení autora. 3. Název pracoviště a adresa.

Vlastní práce. 1. Velmi stručný abstrakt, v rozsahu nejvýše 15 řádek, v angličtině. 2. Úvod do problematiky (stručně). 3 Materiál a metodika (u známých metod pouze odkaz). 4. Vlastní část experimentální nebo popisná 5 Diskuse. 6. Závěr. 7. Seznam citované literatury (nikoliv bibliografie!). 8. Tabulky, texty k obrázkům a grafům. Celý rukopis je průběžně stránkován.

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Přepis cyrilice proveďte podle mezinárodních pravidel transliterace (nikoliv fonetické transkripce — viz ISO Recommendation R 9. International system for the transliteration of cyrilic character 1. Ed. October 1955, nebo Zekalle, R., 1964: *Pedobiologia*, 4: 88—91, Jena

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V taxonomických pracích dodržujte zásady, ustanovení a doporučení mezinárodních pravidel zoologické nomenklatury.

V rukopisu nepředpisujte zásadně žádné typy písma, označte pouze tužkou po straně části, které mají být vysazeny petitem.

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