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DEVELOPMENT AND CONFIGURATION OF THE BASE OF THE SKULL AND THE NOTOCHORD IN CHICK EMBRYOS WITH EXPERIMENTAL EXENCEPHALIA

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Abstract · In 4- to 13-day chick embryos with experimentally inducible and standardly reproducible malformation of the head and brain, the authors studied the development of the base of the skull and the notochord and found that the experimental operation produced uniform results and regard it as a suitable model for the study of causal sequences of experimental embryology.

A spiral course of the notochord in the base of the skull and contact of the notochord both with the roof of the pharynx and the floor of the brain are typical for embryos with experimental exencephalia. The posterior half of the base of the skull is only irregularly attenuated, while the anterior half is severely shortened and turns up.

INTRODUCTION

Exencephalia is a malformation of the central nervous system and the head, which can be imitated in chick embryos by performing a relatively easy microsurgical operation (Jelínek, 1959, 1960). The method is simple, can be standardized and yields uniform results. The principle of the operation is to form a cerebrospinal fistula, which, at the crucial time, compensates the pressure difference between the ventricular system of the brain and the amniotic cavity (slight overpressure in the brain vesicles is essential for their normal development – Jelínek and Pexieder, 1968, 1970; Pexieder and Jelínek, 1970). The best time for the experimental operation is the 4th day of embryogenesis. After localizing the embryo by illumination, we open the egg by the usual window technique, gain access to the amniotic cavity by perforating the residue of the vitelline membrane with two well-sharpened tweezers and look for the tiny avascular field in the roof of the rhombencephalon (the area membranacea ventriculi IV). With the points of the tweezers we perforate the roof of the 4th ventricle in the centre of the avascular field and expand the opening ventrodorsally. Owing to the drop in intraventricular pressure, the brain vesicles collapse (Jelínek, 1961; Klika and Jelínek, 1962), the mesenchyme over the brain convexity is disorganized and thins out and the whole process culminates in inhibition of desmogenic ossification of the neurocranium (Jelínek and Klika, 1961; Klika and Jelínek, 1961a). Since growth of the brain vesicles causes the skin defect over the operation site to widen as far as the telencephalic hemispheres, from

the 8th day of incubation the brain's sole covering is a coherent layer of fibroblasts (Klika and Jelínek, 1961b)

Experimental exencephalia is thus so well elaborated that it can be used as a model malformation for studying morphogenetic interactions of the organ primordia of the head In our preceding study (Doskočil and Jelínek, 1974), we investigated the development of the pituitary in embryos with experimental exencephalia In this study we noticed striking changes in the base of the skull and a peculiar course of the notochord. We therefore paid special attention to this question and submit the results of our observations in the present communication.

MATERIAL AND METHODS

We treated 25 complete series of histological sections of the heads of 4- to 13-day chick embryos with experimental exencephalia. We studied the configuration and proportions of the base of the skull, the course of the notochord and its relationship to the base of the skull, the roof of the brain, the pituitary and the roof of the pharynx. The operation on the embryos was performed by the method described in earlier papers (Jelínek, 1959, 1960).

The controls were a series of normal chick embryos treated by Doskočil (in the monograph published in 1970, which gives a list of the author's earlier papers on this subject, we can also find most of the relevant figures). We chose embryos corresponding to these as nearly as possible, as regards both age and differentiation of the pituitary region For this type of comparison we found the degree of differentiation to be a more satisfactory criterion than the chronological age of the embryo

From the 6th to the 10th day of incubation, we always allocated a control embryo, of the nearest possible age and degree of differentiation, to each exencephalic embryo Using an Abbe apparatus and a constant system, in both sets of sections (experimental and normal) we traced the contours of the floor of the brain and compared them.

RESULTS

Before beginning the study proper, we verified whether the experimetntal treatment actually produced typical exencephalia. In the roof of the fourth ventricle we always found a defect gaping into the amniotic cavity The brain vesicles were collapsed and shrunken and the normal integument of the cranial vault was missing. Our embryos thus clearly had experimentally induced exencephalia characterized by a defect in the roof of the fourth ventricle, shrinkage of the brain vesicles and absence of the bony cranium.

In verified embryos we studied the configuration of the base of the skull and the course of the notochord. Fig. 1 shows a sagittal section in the area of the upper cervical spine (bottom right) and at the level of the foramen magnum. In this region, the cartilaginous primordia of the cervical vertebrae are arranged normally and the notochord is wide and follows the axis of the cartilaginous spinal column Popova-Latkina (1961) points out that in normal human embryos also, the notochord is widest precisely in the cervical region. Any anomalies in the construction of the axial skeleton in our embryos were thus confined to the skull.

The base of the skull in exencephalic embryos displayed typical anomalies compared with the controls Fig. 2 shows a sagittal section of the base of the skull between the foramen magnum (bottom left) and the dorsum sellae (top right). The cartilaginous primordium of the base of the skull does not form a regular plate, but is much thinner towards the posterior wall of the pharynx. The notochord is twisted and the irregularities in its thickness are caused by its deviation from the plane of the sections. If we evaluate the

82

entire series of sections as a whole, we find that the notochord is the same thickness throughout and that it forms a slightly irregular spiral. Fig. 3, which illustrates the most rostral part of the notochord, shows its spiral course and its typical termination on the dorsal surface of the adenohypophysis. In normal embryos of this age it is the rule for the notochord to pass through the dorsum sellae and terminate on the adenohypophysis, but in exencephalis embryos it was the exception. In this case the notochord passed normally through the dorsum sellae, but in most cases we found an anomalous relationship between the notochord and the cartilaginous base. In Fig. 4, the notochord reaches the under surface of the base of the skull at a thin spot and this brings it into close contact with the pharynx (the semilunar cavity bottom right).

In other cases (or in another segment of the notochord in the same case) the notochord leads to the upper surface of the cartilaginous base of the skull, so that it lies directly below the floor of the brain (Fig. 5).

The normal relationship between the notochord and the dorsum sellae is usually impaired in exencephalic embryos. The notochord lies on the dorsal surface of the dorsum sellae, just below the perichondrium (Fig. 6). In some cases it even skirts the dorsum sellae by coiling itself round its upper margin (Fig. 7). The situation detected in this figure further shows premature sings of incipient regression of the notochord (at least two days sooner than normal).

Fig. 8 shows an extremely atypical situation in a 13-day embryo. The notochord lies in the perichondrium of the cartilage forming the dorsum sellae; its rostral end is already being resorbed and is sharply pointed and its leading end lies on the dorsal surface of the dorsum sellae.

The atypical shape of the pituitary and the altered topographical relationships between the pituitary and the floor of the brain described in our last paper (Doskočil and Jelínek, 1974) led us finally to investigate changes in the configuration of the floor of the brain as a whole. When we compared
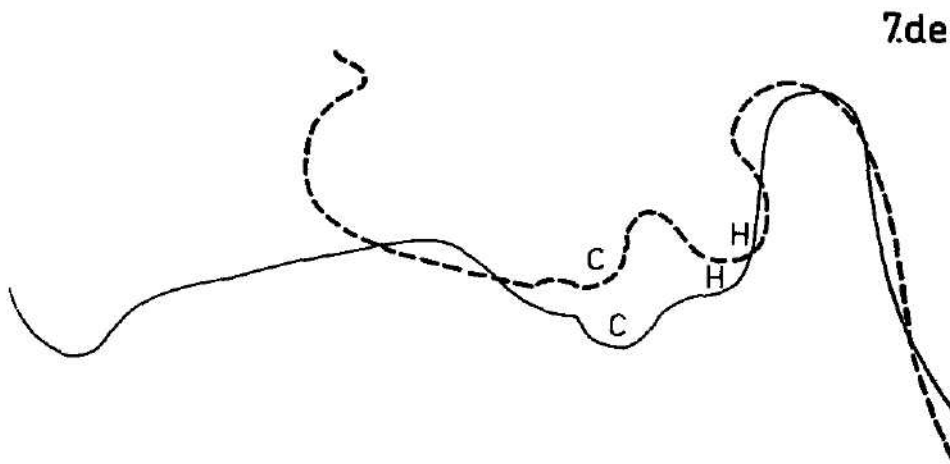

Fig. 9. Contours of base of skull in normal embryo (unbroken line) and exencephalic embryo (broken line). Median section. C — optic chiasma, H — sella turcica. 7th d.e.

the contours of the floor of the brain, in the median plane, in normal and exencephalic embryos (of the same age and degree of differentiation) by the previously described method, we found (Fig. 9) that the posterior parts, up to and including the dorsum, were the same, so that they acted as fixed points for comparison. In exencephalic embryos the pituitary region was shortened and the pituitary was compressed between the dorsum sellae and the chiasma and often actually touched it. The greatest changes occurred in the anterior part of the floor of the brain, rostrally from the chiasma. This part was severely shortened and was tilted upwards. The picture was typical and constant The base of the skull followed the configuration of the floor of the brain more or less exactly. It was likewise shortened and anteriorly tilted, while posteriorly its configuration was normal.

DISCUSSION

In study of the configuration of the base of the skull and the course of the notochord in embryos with experimental exencephalia, two facts were particularly striking:

1. Although the operation was performed on the roof of the 4th ventricle, i.e. in the posterior part of the head, malformation occurred explicitly in the anterior half of the base of the skull and brain. We regard this as evidence that local trauma was not the actual cause of malformation. The operation altered pressure relationships inside the brain vesicles, thereby leading to shrinkage of the vesicles and to further pathological development of the central nervous system, which was most pronounced in the telencephalic area. We therefore regard the changes in the base of the skull as secondary and dependent on malformation of the brain. Posteriorly, the configuration and size of the base are normal, but it is irregularly attenuated; the changes are thus only quantitative.

2. The course of the notochord in the base of the skull of exencephalic embryos is atypical; it is undulating or forms an irregular spiral and does not follow the axis of the cartilaginous primordium of the base of the skull. Popova-Latkina (1961) states that the notochord, in human embryos, runs through the base of the skull close to its under (i e. outer) surface, that is to say, it does not follow its axis. Minot (1897, 1907) already described the course of the notochord in human embryos as undulating to spiral. Baur (1967) studied this question in mammalian embryos and came to the conclusion that these findings were artefacts formed during the preparation of histological sections. We are convinced that in our case they are not artefacts, since nowhere is the notochord detached from the surrounding cartilage does not display the slightest irregularities which could be ascribed to shrinkage during dehydration of the material. The phenomenon is very striking. Since irregular organization of the posterior part of the cartilaginous base of the skull and the course of the notochord and malformation of the anterior part of the base of the skull are both confined to areas in contact with the deformed part of the central nervous system, we are of the opinion that they are the secondary outcome of malformation of the brain, which in turn is due to absence of the morphogenetic function of the encephalic fluid pressure This view is supported by the fact that the notochord, the spinal cord and the vertebral primordia in the cervical area are normally formed.

84

In recent years, Slípka (1971, 1972a, 1972b, 1974) has studied the development of the notochord from the comparative aspect.

He found that the notochord could run through the cartilaginous base of the skull, or partly over its cerebral or pharyngeal surface. If we adopt Slípka's very neat nomenclature, the course of the notochord in exencephalic chick embryos can be characterized as a combination of suprabasal and subbasal, while in normal embryos it is intrabasal.

In our opinion, there are two possible, completely hypothetical, explanations for the anomalous course of the notochord in relation to the base of the skull in exencephalic chick embryos: either the notochord originally follows a normal course and only the base of the skull is deformed, i.e. it does not develop evenly on all sides of the axis represented by the notochord, or else the two formations are developmentally less dependent upon each other than is commonly supposed. Because of the irregularities in the posterior half of the base of the skull, we incline to the former view. We should not forget that the experimental operation is not performed until the third day of incubation, i.e. when the elementary relationships of the axial structures of the head have not only been founded, but are already largely fixed. The spiral course of the notochord and its irregular relationship to the base of the skull should therefore be regarded as an adaptation originating from the impaired growth relationships of the brain vesicles and the adjacent mesodermal structures. This concept likewise fits our findings of an irregular course of the notochord in segments of experimentally induced myeloschisis, which are shorter than the corresponding control segments (Jelínek, 1968, unpublished results).

The relationship of the notochord to the dorsum sellae is a specific one. In normal embryos, the notochord describes an arc through the dorsum and terminates in front of its ventral surface near the pituitary. Doskočil (1970) described changes in the position of the leading end of the cord during normal development of the chick embryo and attempted to explain them. In exencephalic embryos, the notochord encircles the dorsum, so that it *crosses its dorsal surface and sometimes skirts its upper margin*. Our only explanation for this is that the dorsum develops later, at a time when the relationship of the notochord to the pituitary and to the deformed primordium of the central nervous system is already fixed.

The atypical course of the notochord in embryos with exencephalia somewhat resembles the situation in *Lacerta agilis*, in which, according to Gawrilenko (1926), the notochord is just above the foregut, grows forwards and curls round the ventral end of the gut. The course of the notochord in exencephalic embryos has a parallel in the normal development of the notochord and the base of the skull in a number of vertebrates (Slípka, 1974) and further, by analogy, offers a fairly logical explanation for the position of tumours originating from notochord residues in man, as described by Jedlička (1954).

The malformation of the anterior half of the base of the skull was the most striking finding in this study, in which it was constant and uniform. At first glance, the anterior half of the base of the skull appeared to be shortened to half the normal length. That was not exactly the case, however, since although the base was severely shortened, it was also tilted upwards. Malfromation of the base was also associated with malformation of the upper

mandible and the orbit, which will be discussed separately. Study of the malformation of this part of the skull inevitably brings a bulldog's skull to mind. Malformation of the base of the skull and of the floor of the brain go hand in hand, but we regard the former as secondary and determined by the malformation of the brain.

SUMMARY

The authors studied the configuration of the base of the skull and the course of the notochord in chick embryos with experimental exencephalia. Their findings were as follows:

1. The posterior half of the base of the skull had a normal form and was only irregularly attenuated.

2. In the cranial segment, the notochord followed an irregular spiral course; in places it broke through to the under surface of the cartilaginous base and came into contact with the pharynx. Sometimes it broke through to the upper surface and came into contact with the floor of the brain.

3. At times, the notochord actually led over the dorsum sellae instead of through it.

4. The relationship of the rostral end of the notochord to the pituitary was practically the same as in normal embryos. The small differences compared with normal were due to unequal delays in the development of the various components of the pituitary region.

5. The anterior half of the base of the skull and floor of the brain was severaly deformed.

REFERENCES

Baur R., 1967: Über die segmentalen Wellen der Chorda dorsalis und ihre Deutung. *Acta Anat.*, **66** : 631—638.

Doskočil M., 1970: Development of the chick hypophysis. *Acta Univ. Carol. — Medica, Monogr. XL.*

Doskočil M., R. Jelínek, 1974: Die Entwicklung von Hypophyse bei Hühnerembryonen mit experimentell hervorgerufener Exencephalie. *Zchr. mikr. anat. Forsch.*, **88** : 545—566.

Gawrilenko A., 1926: Beobachtungen über die Entwicklung der Chorda dorsalis bei Lacerta agilis. *Anat. Anz.*, **60** : 449—459.

Jedlička V., 1954: Chordomy, chordoblastomy a ekchordosy. *Čs. onkologie*, **1** : 284.

Jelínek R., 1959: Experimentální exencephalie u kuřat. *Čs. fysiologie*, **8** : 204—205.

Jelínek R., 1960: Development of the experimental exencephalia in the chick. *Čs. morfol.*, **8** : 368—378.

Jelínek R., 1961: K otázce tzv. "přerůstání" neurální trubice. *Čs. morfol.*, **9** : 151—161:

Jelínek R., E. Klika, 1961: Proliferační aktivita při tzv. "přerůstání" neurální trubice. *Čs. morfol.*, **9** : 406—414.

Jelínek R., T. Pexieder, 1968: The pressure of encephalic fluid in chick embryos between the 2nd and 6th day of incubation. *Physiol. Bohemoslov.*, **17** : 297—305.

Jelínek R., T. Pexieder, 1970: Pressure of the CSF and the morphogenesis of the CNS I. Chick embryo. *Folia morphol.*, **18** : 102—110.

Klika E., R. Jelínek, 1961a: Histogenesis of the experimental exencephalia in the chick. *Čs. morphol.*, **9** : 151—161.

Klika E., R. Jelínek, 1961b: Histologická skladba pokryvu mozku při vývoji experimentální exencephalie. *Čs. morfol.*, **9** : 274—281.

Klika E., R. Jelínek, 1962: Výklad mechanismu vzniku fenomenu svraštění mozkových váčků. *Folia morphol.*, **10** : 114—124.

Minot C. S., 1897: Human embryology. Mc Millan comp. N. Y.

Minot C. S., 1907: The segmental flexures of the notochord. *Anat. Rec.*, **1** : 42—50.

Pexieder T., R. Jelínek, 1970: Pressure of the CSF and the morphogenesis of the CNS II. Pressure necessary for normal development of brain vesicles. *Folia morphol.*, **18** : 181—192.

Popova-Latkina N. V., 1961: O razvitiji pozvonočnovo stolba v embrionalnom periodě u čelověka. *Vopr. antropol.*, 6 : 21—29.

Slípka J., 1971: Significance of developmental varieties of the notochord. *Plz. lék. sbor.*, 36 : 5—8.

Slípka J., 1972a: A contribution concerning the notochord-epithelial relationship. *Plz. lék. sbor.*, 38 : 15—18.

Slípka J., 1972b: Early development of the bursa pharyngea. *Folia morphol.*, 20 : 138—140.

Slípka J.: Individuality of the pharynx development as a result of entero-chordal relation in early ontogeny. In press.

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

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ON THE OCCURRENCE OF FAR EAST PLANTIVOROUS FISHES IN THE DANUBE RIVER WITH REGARD TO THE POSSIBILITY OF THEIR NATURAL REPRODUCTION

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Dedicated to Dr. Carl L. Hubbs, Professor Emeritus of Zoology, on the occassion of his 80th birthday

Abstract: The author deals with the occurrence of Far East plantivorous species *Ctenopharyngodon idella*, *Hypophthalmichthys molitrix* and *Aristichthys nobilis* in the Danube river and discusses the possibility of their natural reproduction here. He states that the environmental conditions of the Danube river, mainly the coincidence between the rising of the water level, concentration of suspended solids and temperature as well agree with those claimed for the rivers of natural distribution of these fishes and rivers in which the natural reproduction after introduction was stated. Although the spawning of these fishes in the Danube river was not observed yet the records of grass carp with developed gonads suggest that the natural propagation is possible, and that the plantivorous species, mainly the grass carp are probably at the first stage of acclimatization. Possible negative effect of acclimated species on the native fish fauna is also mentioned.

INTRODUCTION

The first introduction of plantivorous fishes into the Danube river drainage of the Danubian countries was in Roumania in 1960, followed by Hungary and Yugoslavia in 1963, Bulgaria and Austria in 1964, Czechoslovakia 1965, and in USSR in 1971*) (Nicolau, 1962: Dinkov and Karakašev, 1965; Berinkey, 1966; Djisalov, 1968; Krotov and Kukuradze, 1972; Putschögl, 1972; Weber in litt., 1974). Most were the grass carp *(Ctenopharyngodon idella)* and the silver carp *(Hypophthalmichthys molitrix)* and in addition the bighead carp *(Aristichthys nobilis)***) with the black or snail carp *(Mylopharyngodon piceus)***) were imported and used in farm fishery.

From all Danubian countries only Austria realizes the introduction of the grass carp directly into the main stream or backwaters connected with the Danube, in all other countries which are the members of International Agreement on the Fishing in the Danube introductions were made only into

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*) In USSR the first introductions of the grass carp were realized already in 1949, but the fish was planted into water bodies belonging to Volga river basin (Burmakin, 1963). First introduction into the closed lakes of the Danubian delta in the territory of USSR was realized probably not earlier that in 1971 (Krotov and Kukuradze, l.c.). Similarly in Czechoslovakia the first introduction of the grass carp was performed in 1961, but the planting of fish into the water bodies of the Danube basin has been realized four years later.

**) These two species feed on zooplankton and benthos respectively, but for convenience are also here placed together with the grass carp and silver carp under the common name "plantivorous species".

fishery farms. Some exceptions are the USSR, Roumania and Hungary which are introducing the plantivorous species, mostly the grass carp and silver carp, into suitable arms and lakes cut off from the main stream, and Czechoslovakia, which plants the grass carp into few distant channels not connected with the Danube. Already in 1966 the first specimens of the grass carp were recorded in the catches from the Danube (Tóth, 1971; Anonymous, 1971). From that time the catch of both the grass carp and silver carp in Danube was regularly observed (Anonymous, 1972a, b, c, 1973a, b, Niculescu-Duvez and Tabacopol, 1973; Djisalov and Pešić, 1973; Balon, 1968; Holčík, 1969; 1970; Holčík and Pár, 1970; Holčík and Geczö, 1973) in the middle and lower stretch. Since the question of natural reproduction of these species is subject of contradictive discussions of ichthyologists from Danubian countries joined in the International Agreement on the Fishing in the Danube river, the purpose of this paper is to contribute to this problem by analyzing of the environmental conditions of the Danube river and available data on the records of adult fishes. Special attention is paid to the Czechoslovak-Hungarian stretch of the Danube, from which all necessary data could be only gathered and which seems to be the upper range of the possible spawning area of the above mentioned species.

OCCURENCE OF PLANTIVOROUS FISHES IN THE DANUBE RIVER

Although the problems connecting with acclimatization of plantivorous species in the Danube basin are of prime importance, there are only scarce data on their presence in the Danube river and much more attention has benn paid to their breeding in fish farms. This fact is, to some extent, very surprising, mainly in Roumania which is considered to have been the first country that introduced all three speies and planted them in a mass scale into the water bodies cut-off from the main stream, chiefly in the terriotory of the Danube delta. Roumanian official statistics introduces the catch of grass carp, silver carp and also the bighead carp taken in the Danube river, but the data concern only the above mentioned closed waters and not the main stream According to these statistics (published regularly in Materials of the Joined Commision of the International Agreement on the Fishing on the Danube since 1958) first data on the catch of grass carp in the Rou manian section of the Danube river appeared only in 1966, when 2,000 kilograms were reported. From that year the catch of plantivorous species in Roumanian waters shows the increasing trend and in 1973 more than 3 million kilograms were taken. In this year for the first time also the catch from the Danube proper is introduced yielding 24,731 kg of plantivorous species without giving the exact species composition and place of capture (Niculescu-Duvez and Tabacopol, 1970). This figure is in sharp contrast with the previous reports from Roumania according to which only single specimens of plantivorous fish, mainly the grass carp, are caught in Roumanian stretch of the Danuble river (Anonymous, 1972c; Radu, 1973).

From the Soviet section of the Danube, which covers practically only the Kilia arms of the delta, only single records are reported. According to Vinogradov (1974), only 3 specimens of the grass carp were taken in September 1973 weighing 400—760 grams and ageing 2+ — 3+ years, and one specimen of the bighead carp, caught in May 1973, measuring 51 cm and ageing 3 years.

Table I. Statistics of the total catch of fish (in kilograms) and share of plantivorous species taken from the Danube river in some Danubian countries, according to data of Joined Commission of the International Agreement on the Fishing in Danube.

Country	Catch of fish	Year						
		1967	1968	1969	1970	1971	1972	1973
Bulgaria	Total catch	724,949	538,719	408,207	540,882	529,980	508,491	421,987
	Grass carp	—	—	—	1,177	793	350	555
	Silver carp	—	—	—	—	—	—	+
	Bighead carp	—	—	—	—	—	—	—
	Plantivorous species (% of total catch)	—	—	—	1,177 (0.22)	793 (0 15)	350 (0.07)	555 (0.13)
Yugoslavia	Total catch	2,128,100	1,425,700	858,200	1,022,727	1,251,960	1,070,782	1,244,050
	Grass carp	—	—	+	+	156	315	420
	Silver carp	—	—	+	+	120	206	400
	Bighead carp	—	—	—	+	—	—	—
	Plantivorous species (% of total catch)	—	—	— (?)	+ (?)	276 (0.05)	521 (0.05)	820 ((0.07)
Hungary	Total catch	1,141,598	1,077,937	892,766	1,007,613	1,083,270	918,447	882,285
	Grass carp	11	14	102	48	667	561	234
	Silver carp	—	—	3	3	—	—	—
	Bighead carp	—	—	—	—	—	—	—
	Plantivorous species (% of total catch)	11 (0.001)	14 (0.001)	105 (0.01)	51 (0.01)	667 (0.06)	161 (0.02)	234 (0.03)
Czechoslovakia	Total catch	208,708	224,178	162,447	109,974	132,133	155,270	156,835
	Grass carp	74	37	69	—	9	461	416
	Silver carp	—	1	—	—	1	—	—
	Bighead carp	—	—	—	—	1	—	4
	Plantivorous species (% of total catch)	74 (0.03)	38 (0.02)	69 (0.04)	—	11 (0.01)	461 (0.30)	420 (0.27)

Note: + = presence recorded only but not amount

In more upstream situated countries, however, there are more records from the Danube proper and in contrast with Roumania more serious statistics are given. Published data allowed us to construct a table (Tab. I), which gives the catch of plantivorous species in Bulgaria, Yugoslavia, Hungary and Czechoslovakia.

In Bulgaria there is almost exclusively the grass carp, which appeared firstly in 1970 in a considerable number. From that time the catch shows more or less decreasing trend, dropping from initial 1,177 kg in 1970 to 555 kg in 1973. Report of Bulgaria on the fishing results in 1973 introduces that "together with grass carp also the silver carp is present, though in a neglible amount" (Anynomous, 1974a). Most fish were caght in the lower part of Bulgarian section, between Silistra and Vidin, with decreasing trend in upstream direction (Anonymous, 1973b).

Yugoslavian statistics introduce the plantivorous species as early as in 1969, when first specimens appeared, but the figures on catch were not recorded, similarly as in 1970. From 1971 the catch increases continuously (tab. I) and almost equally it is divided between the grass carp and the silver carp. Records originated mostly from the Yugoslavian-Roumanian and Yugoslavian-Hungarian boundaries.

After Roumania Hungary is the only country which plants plantivorous fishes in a mass scale into the Danubian arms cut-off from the main stream. The catch of grass carp and silver carp from these water bodies yielded the following figures in particular years: 1969 — 5,534 kg, 1970 — 11,099 kg, 1971 — 12,103 kg, 1972 — 24,508 kg and in 1973 60,590 kg of plantivorous fishes. Records from the Danube proper were summarized by Tóth (1971) and Jaczó (1974).

According to these authors the first specimens of the grass carp were caught already in 1966. From that time the records are more numerous ranging from 11 to 667 kg per year, composed mostly of the grass carp and only single specimens of the silver carp. Practically the whole Hungarian stretch of the river is now inhabited by plantivorous species. As follows from the table introduced by Tóth (l.c.) while in 1966 the grass carp was taken only between Paks and Rácalmás (river kilometer 1531—1587). in 1969 to 1970 most fishes originated from the upstream part of the river between Helemba (Chľaba) and Tát (river kilometer 1712—1724). The single silver carp record in 1969 was caught near Yugoslavian border at Apatin (r. km. 1401).

In Czechoslovakia, all three species were taken under consideration, but also here mostly grass carp appears. In contrast to other countries, some of caught fish were more thoroughly studied here (Balon, 1968; Holčík, 1969, 1970; Holčík and Pár, 1970; Holčík and Geczö, 1973). In comparison with other Danubian countries, where the plantivorous species are known only from the Danube proper, in Czechoslovakia particular species were taken also in major tributaries of the Denube i.e. in the rivers Hron, Váh and Morava. A short survey of fishes which were positively identified are summarized in Table II. The fishery statistics on the catch of grass carp show a rapidly increasing trend in the last two years (Tab. II). From my own experience I can say, however, that the real catch must be higher because many fishermen and anglers do not distinguish the grass carp from the big specimens of chub *(Leuciscus cephalus)*. Moreover, the figures for Czechoslovakia presented in Table II represent the catch of anglers only — statistics

Table II. List of the findings of the grass carp, silver carp and bighead carp in the Czechoslovak stretch of the Danube river and its tributaries. Introduced only trustworthy identified or studied specimens.

Date of capture	Species (locality, sex, standard length, weight, age)	Published by
	Ctenopharyngodon idella	
11. 5. 1967	Danube river (1749[1])), juv. female, 404 mm, 1.5 kg, 2+	Balon, 1968
10. 7. 1967	Danube river (1717), juv., 404 mm, 1.7 kg, 2+	Balon, 1968
10. 9. 1968	Morava river (8.2), juv. male, 499 mm, 2 3 kg, 3+	Holčík, 1969
15 10. 1969	Hron river (30), sex?., 520 mm, 2 8 kg, age?	new data
23. 8. 1969	Morava river (8), juv male, 467 mm, 1.7 kg, 3+	new data
30. 6. 1971	Danube river (1739), juv. male, 156 mm, age?	Žitňan, 1972
14. 7. 1971	Hron river (62), sex?, 622 mm, 4.4 kg, age?	new data
Sept. 1971	Váh river (7), adult female, 680 mm, 7.1 kg, age?	Bastl, 1974
August 1972	Morava river (3), adult male, 850 mm, 11.2 kg, age?	new data
	Hypothalmichthys molitrix	
15 7. 1968	Danube river (1749), juv male, 396 mm, 1 2 kg, 2+	Holčík, and Pár, 1970
	Aristichthys nobilis	
14. 11 1971	Váh river (13), juv., 205 mm, 0.2 kg, 1+	Holčík and Geczo, 1973

[1]) figures in brackets mean river kilometer, checked from the mouth of Danube into the Black Sea, or from mouth of respective rivers into the Danube river.

of the commercial fishery do not consider the grass carp or any other plantivorous fish, though at least the grass carp is regularly caught (Mr. Kronauer, pers. comm.) It can therefore be presumed that the total catch of the grass carp only along the Czechoslovak shore of the Danube river varies at least between 500 and 1,000 kg yearly. The fish recorded from the rivers Morava, Váh and Hron arrived here from the Danube, while those from the Danube proper are represented by specimens which escaped from fish farms or other water bodies in Hungary or from Austrian reach. It is noteworthy that the grass carp penetrated into the Czechoslovak Danubian tributaries rather high upstream as determined from fish weighing 4.4 kg caught in the Hron river at the vicinity of Kálna nad Hronom, i.e. 62 km from the mouth of the river into the Danube.

From Austria there are no published observations, but according to Weber (letter of March 3, 1974) the grass carp as well as the silver carp were recorded here. The first species was taken several times in the stretch of the Danube river between Hainburg (r. km. 1882) and Aschach (r. km. 2203), and also in the Austrian part of the Morava river at Marchegg. The silver carp was caught only once near Vienna.

The share of the plantivorous species in the total catch of fish varies considerably, but from the data presented in Table I it can be seen, that in the Czechoslovak, Hungarian and Yugoslav parts of the river, i.e. in the middle Danube, it seems to be higher than in the lower one. If the Roumanian

catch of 23 tons of plantivorous fishes reported for 1973 originated actually from the Danube proper, then their share on the total Roumanian yield is only 0.19%, i.e. less than in Czechoslovakia for the same year. It seems, that the fishes perform upstream migrations, as follows also from the occurrence of grass carp in some bigger tributaries of the Danube on the Czechoslovak territory, as already mentioned above.

Obviously the presence of these exotic species in the Danube can be explained by their escaping through various ways from hatcheries, fish farms and the Danubian backwaters and lakes where they are bred. This escaping is most likely from the last mentioned water bodies situated near the main stream. Although normally they are not connected with the Danube proper, this connection is renewed in years with abnormal floods, such as it was in 1965. Thus the lower reach of the Danube is inhabited by fish penetrating here from the Roumanian territory, while the fishes in the middle stretch originate from Hungary. These two countries are the only ones which realize their mass planting and breeding just in water bodies situated near the main stream. It is obvious, indeed, that precautions drawn to prevent the penetration of these exotic species into the main stream were unsufficient and by this way the agreement of all the Danubian states to forbid their introduction into the Danube river has not been respected.

As regards the size of freely living plantivorous species in the Danube, we have only scarce information. In the Soviet section of the river, only small fishes were caught not exceeding 1 kg of weight From the Roumanian stretch there are no data on size with exception of Radu (1973) who writes on specimens of grass carp weighing 0.25—10.0 kg. In Bulgarian catches the grass carp weighed 1.5—5.0 kg in 1971—1972, but 5—9 kg in average in specimens caught in 1973. According to Djisalov (1973, 1974) mean weight of grass carp in the Yugoslavian stretch of the Danube waried from 1.5 to 6.0 kg and that of the silver carp between 3.0 and 4.0 kg, being lower in the upper part of the Yugoslavian stretch and higher at the lower one From the Hungarian reach of the river there are at disposal only some data from older records gathered by Tóth (1971), according to which most of the grass carps caught from 1966 to 1970 weighed from 1 1 to 5.0 kg, while two silver carps recorded weighed 1.9 and 3.0 kg respectively (the second figure is according to Jaczó, 1974). The mean weigth of the grass carp from the Czechoslovak stretch of the Danube waries from 1.5 to 3.1 kg, but the individual weight reaches up to 11 kg. Other two species represented by single specimens only did not exceed 1 5 kg, being lower for the bighead carp. Austrian records of the grass carp vary between 4 and 6.5 kg and the single specimen of silver carp caught near Vienna weighed about 2 5 kg (Webber in litt.). Concerning the growth rate, the only data are from the Roumanian and Czechoslovak stretches, and are summarized in Table III. As can be seen, the growth of grass carp both in the lower and middle Danube is better than that of fishes from the Amur river or from the Aral Sea. This can be said probably also for the silver carp and bighead carp, as mentioned previously by Holčík and Pár (1971) and Holčík and Geczö (1973).

Summarizing the data mentioned above it can be stated that:

1) Plantivorous species which penetrated into the Danube river from the adjacent waters or through various ways from the fish farms and hatcheries from Roumania, Hungary and also Austria (where are intentionally planted

Table III

Data on the linear growth of grass carp from some natural water bodies (back calculated standard length in mm)

Locality (author)	Year of life								
	1	2	3	4	5	6	7	8	9
Amur river (Gorbač, 1961)[+]	99	203	301	391	466	524	589	652	688
Ussuri river (Gorbač, 1961)[+]	101	192	279	346	430	514	581	672	695
Boloň lake (Gorbač, 1961)[+]	95	178	266	363	445	512	568	649	679
Aral Sea (Markova, 1968)	78 61—88	150 133—164	238 218—268	298 295—300					
Lower Danube[++] (Radu, 1973)	265 248—320	460 365—540	508 420—580	563 520—640	640 600—690	685 670—725	730 700—770	780 730—830	810 800—850
Middle Danube[+++]	122 108—136	250 204—300	426 384—467						

[+] Mean data derived from values of different years
[++] Length at the of capture converted from weights using the length-weight graph constructed from values introduced by Nikolskij (1966)
[+++] Including the lower part of the Morava river. Condensed data of Balon (1968) and Holčík (1969, 1970)

also directly into the main stream), now inhabit the whole lower, middle, and also part of the upper, reaches of the Danube, i.e. about 2,200 kilometres long stretch from its delta up to the Morava river in Czechoslovakia and middle part of Austrian reach. From the Danube proper these species penetrate into bigger tirbutaries migrating to considerable distances from their mouth (grass carp).

2) The stock of these fishes is composed mainly of grass carp and only to a small extent of silver and bighead carp. The latter is represented only by single specimens.

3) It seems that density of grass carp in the middle reach of the Danube is higher that in the lower one, especially in the Czechoslovak-Hungarian stretch, thus suggesting the trend to migrate upstream. However, it is not excluded that this stretch is supplied also by fish descending from the Austrian Danube, whose conditions are more severe.

CAN THE PLANTIVOROUS SPECIES NATURALLY REPRODUCE IN THE DANUBE RIVER?

The question of natural reproduction of plantivorous fishes in the Danube river is of primary importance, but still unsolved due to the lack of direct observation. However, there is some indirect indication suggesting that this possibility exists and, with reference to the grass carp, it is highly probable. In the Roumanian stretch of the river adult specimens weighing up to 12 kg were caught several times. The females had fully developed ovaria and displayed a high gonosomatic ratio ranging between 6.41 and 9.12 (Anonymous, 1972c; Radu, 1973). According to Radu (l.c.) the growth of these specimens was faster, the gonosomatic ratio and the ratio DNA/RNA in gonads and hypophysis was higher than those in fishes of the same age from fish farms and hatcheries. The author concludes that the natural reproduction of the grass carp in Danube is a definite possibility.

The last discoveries of grass carp with developed gonads suggest that the natural teproduction of this species is possible also in the Czechoslovak stretch of Danube. Bastl (1975) recorded the catch of a female weighing 7.1 kg and measuring 680 mm caught in the mouth of the Váh river in September 1971. Its ovarium contained 790 470 eggs in two portions. One, composed of eggs measuring 0.89 mm in diameter, contained 77% and the second composed of eggs measuring 0.44 mm contained 23% of the total number. The gonosomatic ratio was rather high — 5.20. With regard to these facts and considering the date of capture, Bastl is of the opinion that no eggs were laid in 1971, probably due to the lack of suitable thermical conditions. The second finding is the catch of a fully ripened male with freely running milt. This male weighed 11.2 kg and was caught in the Morava river near the mouth into the Danube river. To complete these data it is necessary to introduce that in 1973 Bulgarians reported the presence of young grass carp weighing 80—100 grams in Danube near Vidin (Anonymous, 1973).

Three principal factors are of vital importance for successful spawning of all three plantivorous species (Chen and Li, 1935; Gorbač, 1965; Nikolsky, 1956):

1) water temperature ranging from 15 to 30 °C;
2) increasing water level stimulating the spawning; and
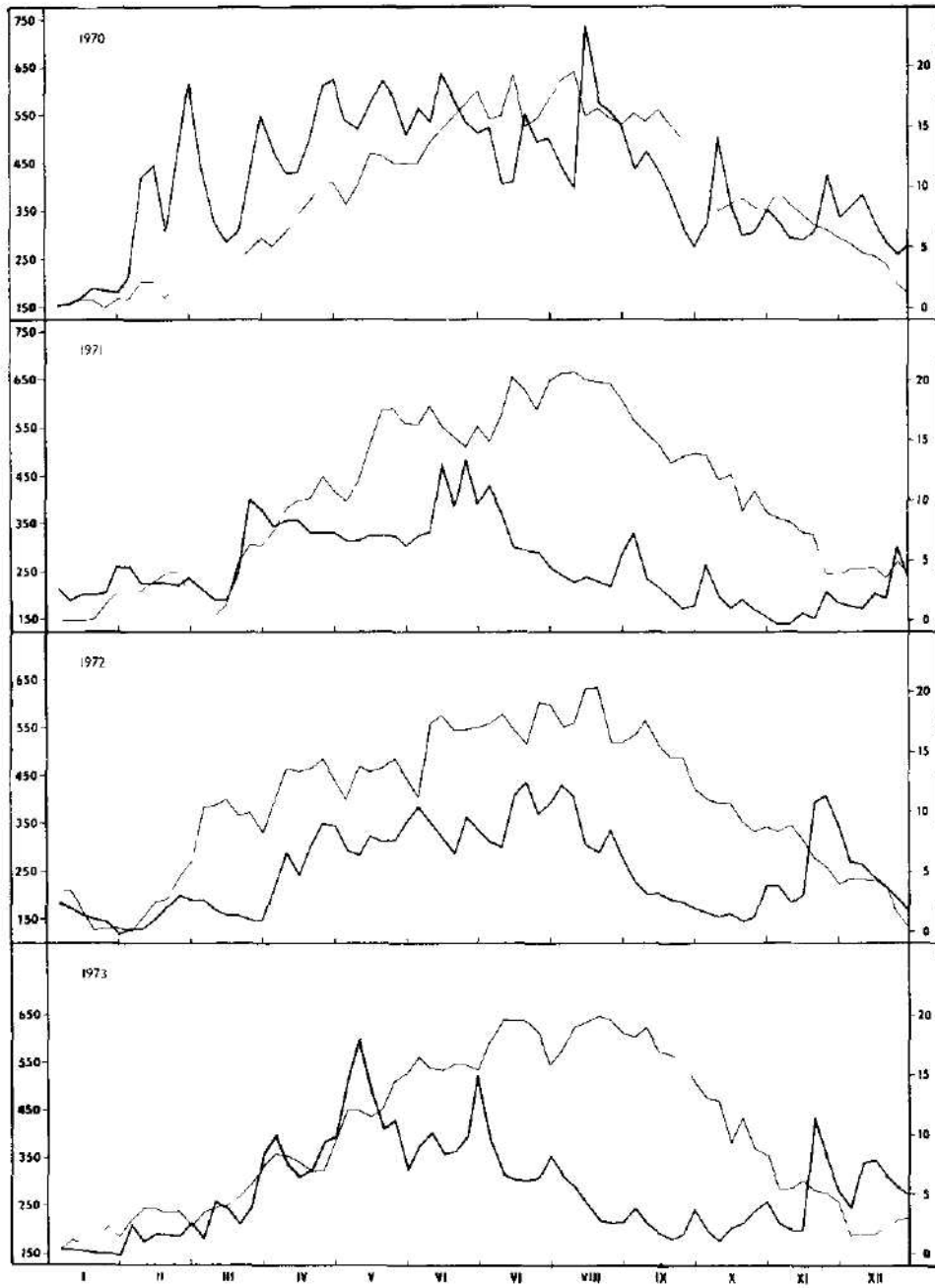3) stream velocity not exceeding 3 m/sec.

Fig. 1. Course of the water level (in cm — left ordinate and heavy line) and water temperature (in C° — right ordinate and weaker line) of the Danube river at Bratislava (river kilometer 1869) in 1970—1973.

Generally the same conditions are valid for all three species (Wu and Ling, 1964) with some deviations in temperature and place of spawning. The spawning temperature in the northern is lower that in the southern regions and the threshold spawning temperature for the silver carp, grass carp and the bighead carp is 15, 17 and 20 °C respectively (Nikolskij, 1956; Gorbač, 1965; Wu and Ling, 1964; Bizjajev, 1968; Motenkov, 1972). The silver carp spawn at the surface, grass carp in a short distance under the surface and the bighead carp in the middle or bottom layers of water (Suchanova, 1966).

According to Bizjajev (1968) the main factor stimulating the natural reproduction of plantivorous fishes is not the increasing water level but the suspended solids concentrations. He suggests that the natural reproduction of the grass and silver carps is possible only in rivers with the suspended solids concentration equal to 1.2 kg/m³ during the spawning period. He concludes this is the main reason why the natural reproduction of these species introduced into several Soviet rivers was recorded only in Amu-Daria and Kuban respectively, both of which characterized by the high concentration of solids. He does not indicate, however, whether the figure 1.2 kg/m³ means the average or total concentration and, if it is the the mean, maximum or threshold value. The situation is not so clear as follows also from the observations of Motenkov (1972) made on the same river (i.e. Kuban) According to this author the increase or decrease of the water level and the concentration of the suspended solids are not those factors which are of primary importance for the spawning of plantivorous species. Motenkov (l. c., and his letter to the author of this paper of February 18, 1975) says that it is the water temperature along with the velocity of the current which play the decisive role in this respect.

All of the above mentioned abiotic conditions can also be found in the Danube river. In regard to the increasing water level, the Danube is one of the few European rivers with floods in late spring and summer. The culmination of water outflow in the lower stretch comes in April, May and June, while in the middle stretch it sets in May and June and ends in July or August. Temperatures higher than 15° C in the lower stretch are regularly observed at the end of April and the beginning of May while in the middle one it is the second half of June. The stream velocity in the Czechoslovak-stretch (which forms the beginning of the middle stretch and also the transition reach between the mountain and lowland zone) varies from 2.0 to 2.4 m/sec, then gradually decreases downstream and reaches 0.5 m/sec in the lower stretch (delta) (Lászlöffy, 1965, Hydrological Yearbook, 1950—1970). In the Czechoslovak stretch, which is under the direct influence of thawing alpine glaciers, some cooling of water is observed during the sudden water level increase (Fig. 1). Despite this there exists the spawning possibility though the extent of reproductive period is less than in the lower stretch and it is disintegrated into several shorter parts, mainly when the river stretch between kilometres 1880 and 1812 is considered (Tab. IV). When however, the opinion of Motenkov (1972) on no influence of the water increase is right, then the length of the spawning period is about twice longer than suggested in Tab. IV, where only the days with increasing water level were checked. In more downstream shifted stretches, however, the conditions appear to be more suitable. At Komárno (river kilometer 1767), situated 100 km

97

Table IV. Time of potential spawning of the grass carp and silver carp in the Czechoslovak stretch of the Danube river during 1970—1973.

		Ctenopharyngodon idella		
Year	1970	1971	1972	1973
from — to	25. 6. — 12. 8.	13. 7. — 5. 9.	25. 7. — 22. 8.	15. 7. — 5. 9.
number of days with temperature above 17° C and increasing water level	13	25	15	23
number of periods	3	6	2	2

		Hypophthalmichthys molitrix		
from — to	10. 6. — 27. 9.	30. 5. — 30. 8.	13. 6. — 25. 8.	3. 5. — 3. 9.
number of days with temperature above 15° C increasing water level	52	43	48	33
number of periods	12	8	7	5

downstream from Bratislava (r. km. 1869), the mean temperature in May — August is 0.6° C and at Štúrovo (r. km. 1717) 1.5° C higher than the mean temperature in the same period at Bratislava (Mucha et alii, 1966). As seen in Table IV, where the number of days and periods suitable for spawning of the grass carp and silver carp were stated according to the actual daily values of temperature and water level increase,*) the possible spawning period for the grass carp is shorter than that for the silver carp, for which the spawning threshold temperature is lower.

In regard to suspended solids concentration, the Danube river can be placed among the rivers suitable for reproduction of these species. According to Szolgay and Náther (1958) the suspended solid concentration in the Czechoslovak stretch reaches maximal values at the end of spring and coincides with the water level fluctuation (Fig. 2). The highest recorded value near Bratislava was 1.56 kg/m³ in July 1954, but the authors suggest that the absolute maximum should be between 2 and 2.5 kg/m³. In the delta of the Danube at Vilkovo (r. km. 13) Almazov and Majstrenko (1961) found maximal suspension concentration ranging from 0.85 to 1.3 kg/m³. They also observed the positive correlation between the water level and the amount of suspension. Their figure seems to be lower than those for the middle reach of the river but it is necessary to indicate that due to different sampling

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*) On Fig. 1 the 5 day averages are plotted for better construction of the graph and its interpretation, so the general trend is somewhat deformed.

and treatment methods the comparison of values supplied by different authors is difficult or impossible.

In discussing the possibility of the natural reproduction the life conditions for the existence of hatched fry should be considered as well. As cited by the above authors (e.g. Nikolsky 1956; Gorbač 1965 etc), fry after hatching drift on the flooded shores of rivers where they feed intensively. The lack of such floodplain can lead to increasing losses and eventually to
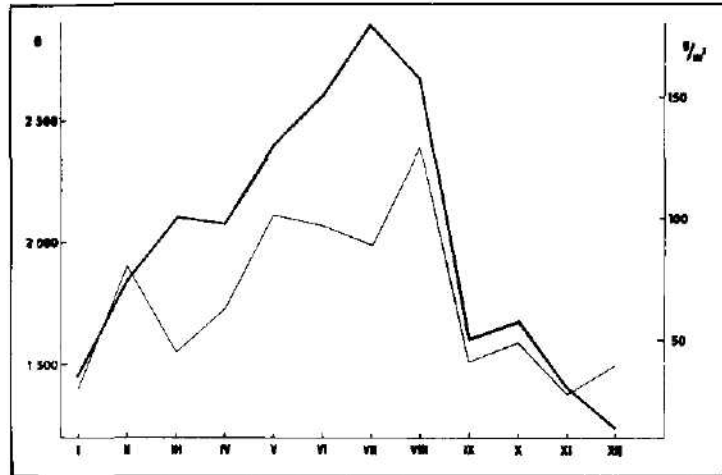

Fig. 2. Mean monthly suspended solids concentration (in grams per cubic meter of water — right ordinate and weaker line) and water discharge fluctuation (in cubic meters per second — left ordinate and heavy line) of the Danube river at Bratislava during 1958—1960.

total mortality (Nakamura 1969). In this respect the environmental conditions of the Danube river are suitable, primarily at the beginning of the middle reach. Here, between kilometres 1862 and 1790, an extensive floodplain is situated, the only one at the present time which is connected with the main stream. It covers about 25,000 hectares from which more than 3,000 ha fall in arm systems which are permanently connected with the river. The floodplain is regularly flooded during the spring and summer months.

The environmental conditions of the Danube river as a whole are thus very similar to those in rivers at the northern boundaries of the natural distribution of the species under consideration. Similar conditions to the Danube are also found in the Amu-Daria in Central Asia and the Kuban flowing from the Caucasus, the single rivers where the acclimatization of the grass carp silver carp and bighead carp was succesful (Alijev, 1965; Bizjajev, 1968).

Evaluating the existing data and the environmental conditions in the Danube river it is postulated that the plantivorous species, chiefly the grass carp are probably at the first stage of acclimatization. Fishes escaping from fish farms and hatcheries gradually adapt themselves to the new conditions and begin to form self-sustaining stock. The lack of direct evidence of re-

production can be ascribed to the low density of grass carp. Since the countries which signed the *International Agreement On The Fishing In The Danube River* (Bucarest 1958) banned the introduction of all exotic species, the population density of the grass carp as well as other two species depends almost exclusively on the accidental penetration from fish farms hatcheries or bodies of water cut off from the main stream and its arms. This is the prime reason for slow forming of population *sensu stricto*, in which only single and rather isolated sexually matured specimens exist.

The situation is complicated also by the fact that in the Danube river evidently two strains of plantivorous fishes live, one from China and the other from the Amur river. In both strains different biological characteristics genetically fixed can be supposed as followed from the grass carp studies of Prichodko and Pistun (1971) and Andrjaševa (1973).

The adaptation to the new environment does no appear important. The data show that the hydrological and thermical conditions of the Danube river are similar to those in the native area of their distribution. Moreover, all these species display rather wide adaptive potential. The growth of these fishes in the Danube river is very good and it is higher than in fishes from some other waters. Both the grass carp and the silver carp can live also in waters with higher salinity as shown by Tanasijčuk (1961), Markova (1968), Motenkov (1972) in the northern Caspian Sea and Aral Sea, respectively, and also the larvae of these species survived in saline water (Rykova, 1964; Dorošev, 1964 — according to Markova, l.c.). As our records show all three species can also live in highly polluted water, since the Morava, Váh and Hron rivers are heavily polluted by both the industrial and domestic waste material. It is true however, that pollution could have and adverse effect on eggs laid and hatched fry primarily in those sections of the Danube proper which are under the direct influence of sewage from oil refineries.

Although the successful acclimatization of plantivorous species could eventually have a positive influence on the Danubian fish industry, one has to consider also the negative effects which appear to be very serious and override the positive effects. It could be not only competition in food with the native bentho- and zooplanktoneaters but also the real danger from exotic parasites, such as *Bothriocephalus gowkongensis*. This tapeworm was introduced with the grass carp from Chine; it is dangerous for European cyprinoids (carp, crucian carp, ide. bream, roach and others) and now it is found in fish farms in the USSR, Roumania and also Hungary. The invasion of this parasite in Danubian native fish can be expected too, since Žitňan (1972a, b, 1973) recently found this tapeworm just in the grass carp caught in the Czechoslovak section of the Danube river.

SUMMARY

1) According to available data the records of Far East plantivorous fishes show that this group is composed mainly of the grass carp and to a lesser extent, of the silver carp and bighead carp. These inhabits the whole lower and middle stretch of the Danube river from its delta up to the Morava river and part of the Austrian stretch.

2) It seems that plantivorous fishes escaping from the fishery farms, hatcheries, breeding lakes and other water bodies undergo upstream migra-

tions. From the Danube proper they enter also the bigger tributaries such as are the Morava, Váh and Hron rivers on the territory of Czechoslovakia.

3) From the existing data on the catch of sexually matured specimens of the grass carp, the growth of particular species, their discovery in different places in the Danube river and its tributaries and on the basis of the analysis of hydrological and temperature conditions of the river it can be postulated that the natural reproduction of plantivorous pecies in the Danube river is realistic. One of the most suitable is the middle reach of the Danube, mainly its Czechoslovak-Hungary part. The lack of direct evidence of natural spawning is most probably due to low population density of stock, formed mainly by sexually immature fish. It seems that plantivorous species and primarily the grass carp are now in the first stage of natural acclimatization, beginning to form self-sustaining stock.

4) Besides the positive influence of plantivorous fishes on the Danubian fish industry also the negative effect can be expected with regard to introduction of exotic fish parasites, from which the tapeworm *Bothriocephalus gowkongensis* has been recently discovered also in the Danube.

REFERENCES

Aliev D S , 1965 Razmnoženije belogo amora (Ctenopharyngodon idella (Val.)), belogo i pestrogo tolstolobikov (Hypophthalmichthys molitrix (Val), Aristichthys nobilis Rich.) vselennych v bassein Amu Daru *Voprosy Ichtiologii,* 5 4 (37) 593—599.

Almazov A M and Ju G Majstrenko, 1961· Gidrologičeskaja i gidrochimičeskaja charakteristika sovetskogo učastka Dunaja. In „*Dunaj i pridunajskie vodojemy v predelach SSSR*". *Trudy Instituta gidrobiologii AN USSR,* **36** : 13—36

Andrjaševa M A , 1973. Žiznesposobnost gibridov rastitelnojadnych ryb. *Izvestija GosNIORCH,* **85** . 73—86

Anonymous, 1972a: Informacija o rezultatach rybnoj lovli, o sostojanii zapasov, uslovij razmnoženija i otkarmlivanija ryb na bolgarskom poberežie reki Dunaja v 1971 g i rabota po ochraneniju i uveličeniju rybnych zapasov *Materialy 14 zasedanija Smešannoj komissii po priloženiju soglašenija o rybnoj lovle v vodach Dunaja* Ruse 1972 · 16—21

Anonymous, 1972b. Informacija Vengerskoj Storony o rezuľtatach ulova ryby, formirovaniju rybnogo zaselenia, uslovijach jego pitania i razmnoženia, a takže o meroprijatiach prinjatych Vengerskoj Storonoj v interesach obespečenija blagoprijatnych uslovij dlja razvitia rybnogo zaselenia. *Idem* · 27—33.

Anonymous, 1972c. Soobščenije o pojavlenii, povedenii i uslovijach razmnoženija rastitelnojadnych ryb v vodach Dunaja *Idem* : 76—78.

Anonymous, 1973a: Informacija Vengerskoj Storony o polučennych dostiženiach v 1972 godu na vengerskom učastke Dunaja, o formirovanii sostava zapasov, ob uslovijach pitania i tech rasporaženiach, kotoryje byli vydany Vengerskoj Storonoj dlja obespečenia blagoprijatnych uslovij razvitija zapasov ryb. *Materialy 15. sessii Smešannoj komissii po primeneniu Soglašenija o rybolovstve v vodach Dunaja.* Budapest 1973 : 25—29.

Anonymous, 1973b: Informacija o rezuľtatach rybnoj lovli, o sostojanii zapasov, uslovij raz-
množenia i otkorma ryb po bolgarskomu poberežiu reki Dunaja v 1972 godu i o rabote po
ochranemiu i uvelhčeniu rybnych zapasov. *Idem* : 95—101.

Anonymous, 1974: Informacija o rezuľtatach rybnoj lovli, o sostojanii zapasov, uslovij raz-
množenija i otkorma ryb po bolgarskomu poberežiu reki Dunaja v 1973 godu. *Materialy*
16. sessii Smešannoj komissii po primeneniu Soglašenija o rybnoj lovle v vodach Dunaja. Brati-
slava 1974 : 107—115

Balon E. K., 1968: Fund eines Graskarpfens Ctenopharyngodon idella (Valenciennes, 1844))
in dem Hauptstrom der Donau beim km 1749. *Věstník Čs. spol. zool.*, **32** (2) : 97—103.

Bastl, I., 1975: O náleze pohlavno dospelej samice amura bieleho (Ctenopharyngodon idella)
v rieke Váh. *Biológia*, **30**, (2) : 133 -136

Berinkey L., 1966: Halak-Pisces. Akadémiai Kiadó Budapest, 135 pp.

Bizjajev I. N., 1968: Nekotoryje osobennosti akklimatizacii rastiteľnojadnych ryb v severnom
Kavkaze. *Akklimatizacija ryb i bezpozvonočnych v vodojemach SSSR.* Moskva 1968: 178—181.

Burmakin Je. V., 1963: Akklimatizacija presnovodnych ryb v SSSR. *Izvestija GOSNIORCH*,
55 : 3—317.

Chen C. S. and S. Y. Lin, 1935: The fish fry industry of China. *Bull. Chekiang Prov. Fish. Exper.*
Station, 1 : 4.

Dinkov C. P. and B. Karakašev, 1965: Pervite rezultati ot aklimatiziraneto na bjal amur,
pestri tolstolob i bjal tolstolob. *Ribno stopanstvo*, **12** (2) : 15—16.

Djisalov N., 1968: Aklimatizacija belog amura u Jugoslaviji. *Ribarstvo Jugoslavije*, **23** (6)
: 145—147.

Djisalov N. and Z. Pešić, 1973: Informacija ob ulove rastiteľnojadnych ryb v jugoslavskom
sektore Dunaja v 1972 godu. *Materialy 15. sessii Smešannoj komissii po primeneniu Soglašenia*
o rybolovstve v vodach Dunaja. Budapest 1973 : 261—262.

Gorbač E. I., 1961: Vozrastnoj sostav, rost i vozrast nastuplenija polovoj zrelosti belogo Cteno-
pharyngodon idella (Vall.) i černogo Mylopharyngodon piceus (Rich) amurov v bassejne
r. Amura. *Vopr Ichtiol.*, 1, 1/18/ : 119—126.

Gorbač E. I., 1965: Sozrevanije i razmnoženije belogo amura Ctenopharyngodon idella (Val.)
v srednem Amure. *Vopr. Ichtiol ., 5, 3/36/* : 426—441.

Holčík J., 1969: Discovery of the Chinese Grass carp — Ctenopharyngodon idella (Valenciennes
1844) in the Morava river, Czechoslovakia. *Vést. Čs. spol. zool.*, **33** (4) : 334—336.

Holčík J., 1970: Biely amur — Ctenopharyngodon idella (Valenciennes, 1844), nový druh pre
ichtyofaunu Slovenska. *Poľovníctvo a rybárstvo*, **22** (5) : 19.

Holčík J. and V. Geczö, 1973: First record of the bighead — Aristichthys nobilis (Richardson
1844) from the Váh river (Danube basin), Czechoslovakia. *Ibid.* **37** (4) : 250—252.

Holčík J. and O. Pár, 1970: First record of the silver carp — Hypophthalmichthys molitrix
(Valenciennes, 1844) in the Danube river. *Ibid.* **34** (2) : 107—109.

Jaczó I., 1974: Nabljudenia v svjazi s rastiteľnojadnymi rybami na vengerskom učastke Dunaja
i predloženie o celesoobraznosti vselenia ich v Dunaj. *Materialy 11. sessii Smešannoj komissii*
po primeneniu Sqglašenija o rybnoj lovle v vodach Dunaja. Bratislava 1974 : 167—170

Krotov A. V. and A. M. Kukuradze, 1972: Informacija o rezuľtatach promysla, sostojanu
zapasov, uslovijach razmnoženija i nagula ryb v vodojemach Dunaja v 1971 godu. *Materialy*
14. zasedanija Smešannoj komissii po priloženiju Soglašeni o rybnoj lovle v vodach Dunaja.
Ruse 1972 : 81—88.

Lászlóffy W., 1965: Die Hydrographie der Donau (Der Fluss als Lebensraun). *Limnologie*
der Donau, 1 (2) : 16—57.

Markova Je. L., 1968: K biologii nekotorych ryb, akklimatiziru]emych v Araľskom more.
Akklimatizacija ryb i bezpozvonočnych v vodojemach SSSR. Moskva, 1968 : 112—115.

Motenkov Ju. M., 1972: Rezultaty vselenija belogo amura, belogo i pestrogo tolstolobikov
v vodojemy bassejna r. Kubani i perspektivy promyšlennogo ispoľzovanija vselencev. *Theses*
of dissertation (Avtoreferat dissertacii na soiskanie učenoj stepeni kandidata biologičeskich nauk).
Leningrad, mimeographed, 23 pp.

Mucha V. (edited by), 1966· Limnológia československého úseku Dunaja. SAV Bratislava, 327 pp.

Nakamura M., 1969: Cyprinid fishes of Japan. Studies on the life history of cyprinid fishes
of Japan. *Res. Inst. Nat. Res., Tokyo, Spec. publ.* 4 (Contrib. 1198) 455 pp.

Nicolau A., 1962: Rezultatele cercetalilor experimentale efectuate la Nucet in anii 1960, 1961
si 1962 cu privire la cresterea in helesteie si iernarea speciilor Ctenopharyngodon idella si
Hypophthalmichthys molitrix. *Bul. Inst. Cer. Proiect. Pisc.*, 21 (4) : 25—37.

Niculescu-Duvez M. and P. Tabacopol, 1973: Soobščenie o rezuľtatach promysla, usloviach
pitania i razmnoženia ryb v vodach rumynskogo učastka Dunaja v 1972 g. *Materialy 15. sessii*
Smešannoj komissii po primeneniu Soglašenia o rybolovstve v vodach Dunaja. Budapest 1973 :
: 147—153.

102

Niculescu-Duvez M. and P. Tabacopol, 1974: Comunicare asupra rezultatelor pescuitului, situatia rezervelor, despre conditiile de inmultire si de nutritie a pestilor, precum si despre masurile luate privind cresterea rezervelor de pesti, in apele Dunarii de pe teritoriul R.S.R., in anul 1973. *Materialy 16. sessii Smešannoj komissii po primeneniu Soglašenija o ryble lovle v vodach Dunaja.* Bratislava 1974 : 234—240

Nikolsky G. V., 1976: Ryby bassejna Amura. Moskva, 551 pp.

Prichodko V. A. and A. M. Pistun, 1971: Osobennosti sozrevania belogo amura v prudach Ukrainy. *Sb. Rybnoe chozjajstvo,* 12, Kiev (not seen in original).

Putschógl V., 1972: Zkušenosti s výtěrem amura bílého. *Rybářství,* 12 : 261.

Radu D., 1973: Soobščenie o pojavleni, povedeniu i usloviach razmnoženia rastitelnojadnych ryb v vodach Dunaja. *Materialy 15. sessii Smešannoj komissii po primeneniu Soglašenija o rybolovstve v vodach Dunaja.* Budapest 1973 : 165—168.

Suchanova A. I., 1966: Razvitie pestrogo tolstolobika (Aristichthys nobilis (Rich.)). *Voprosy Ichtiologii,* 6, 2/39/ : 264—276.

Szolgay J. and M. Lehocký, 1960: Stanovenie prietokov plavenín na Dunaji a výustných tratiach riek Moravy, Váhu, Nitry a Hrona. *Final report from the Hydrological Research Institute Bratislava,* 53 pp. Unpublished.

Szolgay J. and B. Náther, 1960: Výskum splavenín a plavenín na Dunaji, Laborci a Uhu a na výustných tratiach riek Moravy, Váhu a Hrona. *Final report of the Hydrological Research Institute Bratislava,* 247 pp. Unpublished.

Tanasijčuk N. P., 1961: Ob akklimatizacii belogo amura v nizovjach Volgi. *Voprosy Ichtiologii,* 17 : 176—178.

Tóth J., 1971: Data on the presence of plantivorous fishes imported from the Far East in the middle reach of the Danube. *Ann. Univ. Sci. Budapest., sect. Biologica,* 13 : 327—328.

Vinogradov B., 1974: Informacija o razmnoženiu rastitelnojadnych ryb v jestetstvennych vodojemach SSSR. *Materialy 16. sessii Smešannoj komissii po primeneniu Soglašenija o rybnoj lovle v vodach Dunaja.* Bratislava 1974. In print.

Wu Hs.-w. and Ch. Ling, 1964: Progress and achievements in the artificial propagation of four farm fishes in China. *Contrib. at the 1964 Peking symposium, Gen.* 160 : 203—218.

Žitňan R., 1972a: Helminty aklimatizovaných rastlnožravých rýb na Slovensku. *Sborník referátů z ichtyologické konference, Brno 16.—17. 3. 1972* : 94—103. Mineographed.

Žitňan R, 1972b: Doterajšie poznatky o ichtyofaune Dunaja pod Komárnom. *Sborník referátů z ichtyologické konference, Brno 16.—17. 3. 1972* : 76—80. Mineographed.

Žitňan R., 1973: Nebezpečná pásomnica ohrozuje naše kaprovité ryby. *Poľovníctvo a rybárstvo,* 25 (4) : 29—30.

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TULLBERGIA (MESAPHORURA) SPELAEA SP.N. A NEW SPECIES OF COLLEMBOLA

JOSEF NOSEK & HEINZ NEUHERZ

Description. Length of body 540—550 μm, body colour white. Clothing of short and longer setae. Skin granulation very fine, especially on the anterior and posterior margins of tergits. Pseudocelli dorsally as follows: 11/011/10011. Chaetotaxy exactly as in *Tullbergia (Mesaphorura) italica* Rusek, 1971.

Head. Antennae shorter than diagonal of head. Ant. IV with 5 distinct sensory hairs (sensillae $a-e$), and 2 very short and thin ones (sensillae f and g). Sensilla b is 2 times broader than sensilla e at basis. Sensilla e is the longest, overtoping the base of sensilla c, (Figs. 1—3). Sense organ of Ant. III consists of 2 small sensory rods concealed behind a moderately high integumentary fold, 2 sensory clubs which are thick, cylindrical, rounded at the tip, strongly bent towards each other and 4 guarding setae (Figs. 1—3). Postantennal organs consist of about 45 primary tubercles (Fig. 4).

Thorax. Prothorax with 4+4 setae (m_1 and m_3 are short) (Fig. 5). Mesonotum with seta m_4 and 1+1 pseudocelli situated between p_5 and m_5. Sensilla s is seta-like, sensilla s' is very small (Figs. 6 and 7). Claw III (unguis) without inner tooth, approximately as long as anal spine, empodial appendage short (Fig. 8).

Abdomen. Abd. V posteriorly with 1+1 pseudocelli (Fig. 9), and a spine-like sensilla s (Fig. 10). Abd. IV with 1+1 pseudocelli situated between p_2 and p_3 (Fig. 11). Ventral tube with 5+5 setae apically. Female genital plate with 5 setae (Fig. 12). Anal spines well developed, slightly curved (Fig. 13). Chaetotaxy of anal lobi see Fig. 14.

Affinity. This species is closely related to *Tullbergia (Mesaphorura) italica* Rusek, 1971 but differs from it in the length of sensilla e and in the breadth of sensila b on Ant. IV, in the form of sensilla s on meso- and metanotum, and in number of tubercles in PAO.
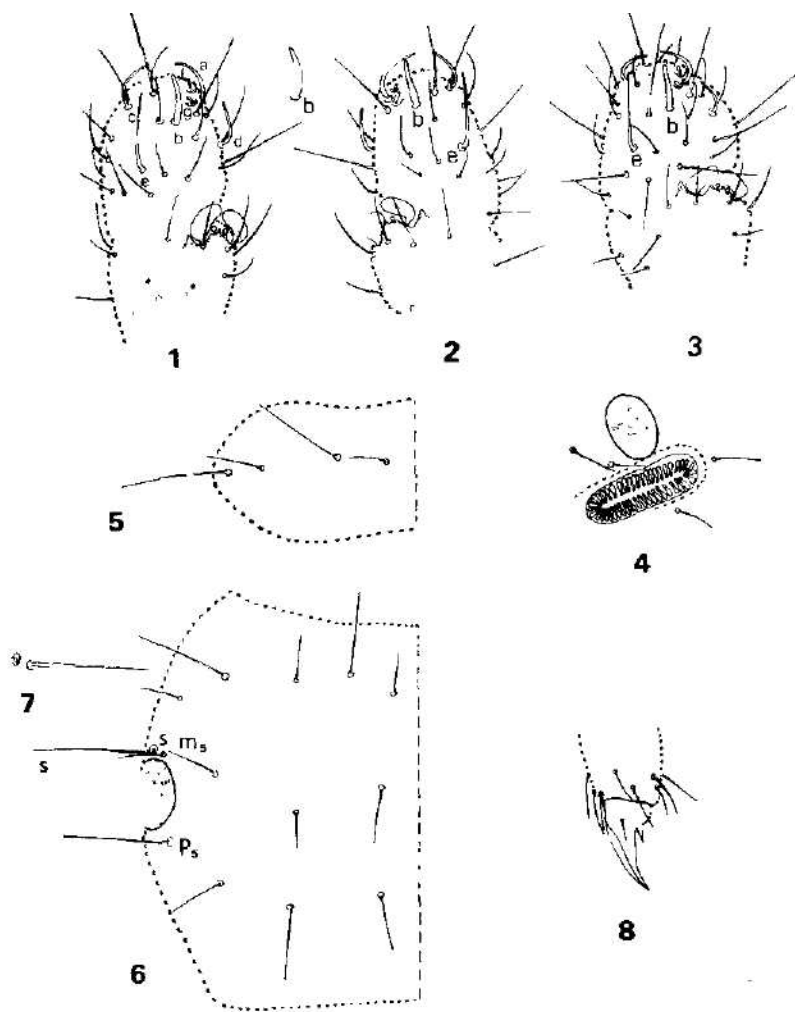
Figs. 1—8. *Tullbergia (Mesaphorura) spelaea* sp. n.: 1—3. Ant. III + IV; 4. PAO; 5. Prothorax; 6. Mesonotum; 7. Sensillae s and s' from mesonotum; 8. Apical part of the third leg (Magnification 100 × 10).
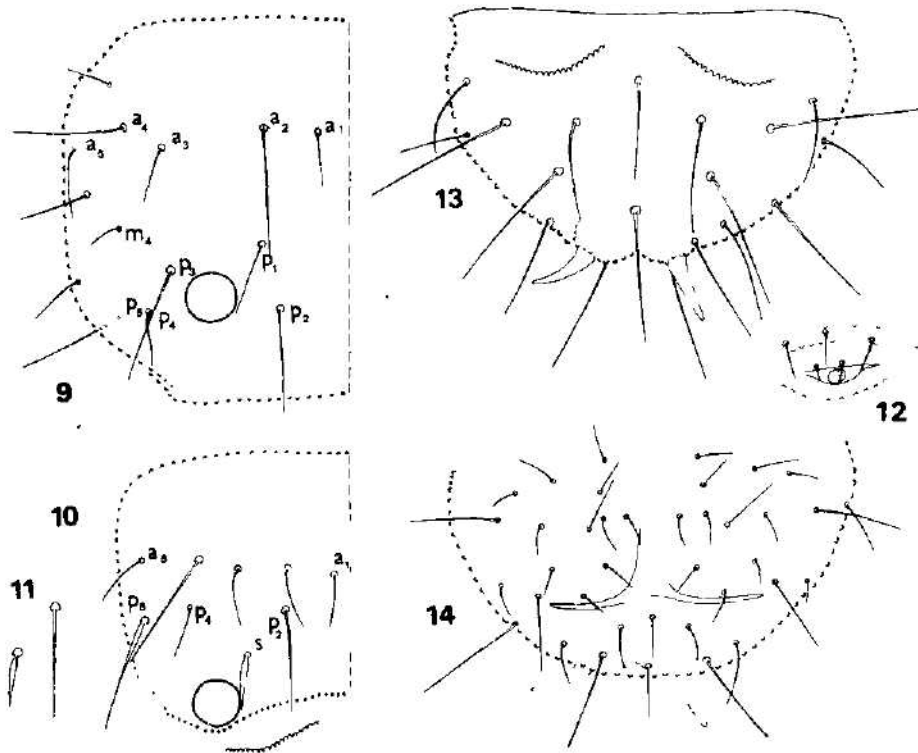
Figs 9—14. *Tullbergia (Mesaphorura) spelaea* sp. n.: 9. Abd. IV; 10. Abd. V; 11. Spine like sensilla from Abd. V; 12. Female genital plate; 13. Abd. VI; 14. Lobi anales (Magnification 100×10).

REFERENCES

Gisin H., 1960: Collembolenfauna Europas. Genève: Muséum d'Hist. naturelle de Genève 312 pp.

Rusek J., 1971: Zur Taxonomie der Tullbergia (Mesaphorura) krausbaueri (Borner) und ihrer Verwandten (Collembola). *Acta ent. bohemoslov.*, **68** : 188—206.

Rusek J., 1974: Zur Taxonomie der Tullbergiinae (Apterygota: Collembola). Vést. Čs. spol. zool., **38** : 61—70.

Salmon J.T., 1974: Concerning the Collembola Tullbergiinae. Zoology Publications from Victoria University of Wellington No 67 : 1—9.

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106

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EINFLUSS TIEFER TEMPERATUREN AUF DIE MORTALITÄT DER EIER EINIGER SCHMETTERLINGE (LEPIDOPTERA)

Jan PATOČKA

Abstract: Results of experiments with low temperatures in the laboratory indicate that the direct influence of late frosts in spring, as a rule, does not cause mass decay of lepidopterous on oaks in Slowakia.

In den Jahren 1969—1975 versuchte ich durch eine Serie von Laborversuchen aufzuklären, ob durch direkte Wirkung der Spätfröste höhere Mortalität der Eier einiger an Eichen vorkommenden Lepidopteren eintreten kann. Ich versuchte vor allem die extremen Temperaturbedingungen vom Freien im Labor nachzuahmen.

MATERIAL UND METHODIK

Für die Versuche benützte ich die Eier folgender Lepidopteren:

1. *Archips crataegana* (Hb.). Die Eier wurden den 13. 3. 1969 in einem Auewald bei Veľké Kapušany (Südostslowakei) gesammelt. Die Population befand sich in mässiger Akkreszenz. Die Eigruppen wurden von der Rinde abgeschnitten und im Kühlschrank bei 5 °C aufbewahrt. Die Versuche verliefen von 22. 4. bis 5. 5. 1969. Während derselben wurden die Eier den verschiedenen in der Tab. 2 erwähnten tiefen Temperaturen in einer Serie von Kühlschränken, der Temperatur von 20 °C im Thermostat ausgesetzt. Bei der letzterwähnten Temperatur wurden dann die Eier bis zum Ausschlüpfen gehalten. Die Eier, welche keine Raupen ergaben, wurden seziert, um ihre Befruchtung nachzuweisen. In der Tab. 2 wird nur die Sterblichkeit der befruchteten Eier berücksichtigt.

2. *Operophthera brumata* (L.). Die Eier erhielt ich einerseits von Weibchen, welche Herr Ing. Sitko bei Lednice (Südmähren) Anfang November 1969 gesammelt hat. Die Population dieser Art befand sich dort in der Kulmination einer Übervermehrung, bei starkem Lichtfrass bis Kahlfrass der Raupen und mehreren Hunderten Weibchen je Baum. Sobald es in den Petrischalen zwischen die Schichten der Zellstoffwatte zur Eiablage gekommen war, wurde mir das Material gesandt und bis zum Beginn der Versuche im April 1970 in einem Kühlschrank aufbewahrt. Anderseits stammten die Eier von den Weibchen, die ich im Spätherbst 1970 in spezielle Fallen in der Umgebung der Stadt Zvolen (Mittelslowakei) gefangen habe. Die Population des Schädlings befand sich dort in der Gradationsphase der Akkreszenz. Auch diese Eier wurden bis zum Beginn der Versuche im März 1971 in einem Kühlschrank bei 5 °C aufbewahrt. Nur befruchtete, rötlich gefärbte Eier wurden in Versuche aufgenommen. Die Behandlung der Eier während der Versuche entsprach der bei der vorigen Art. Die Wirkung des Temperaturwechsels wurde ausserdem im Apparat „Feutron" untersucht.

3. *Lymantria dispar* (L.). Die Versuche führte ich mit Eiern verschiedener Herkunft aus. Ein Teil davon (in der Tab. 5 als Herkunft „A" bezeichnet) wurde im März 1969 und 1970 in einem Eichenwald bei Kráľovský Chlumec (Südostslowakei) gesammelt. Die Population befand sich dort in der Phase der Akkreszenz bei der durchschnittlichen Zahl von 7 Eigelegen je 100 Stamm. Das andere Material stammte von der Zucht (wobei sich die ursprüngliche Population in der Latenz befand) und zwar von einer Freilandzucht in einer Eichenkrone im Sack (Herkunft „B") bzw. Laborzucht mit der Eiche (Herkunft „C") und *Cornus sanguinea* (Herkunft „D").

Fur die Versuche im März 1972 benützte ich Eier, die im Herbst 1971 bei Pata, nahe Levice (Südwestslowakei), Gradationsphase Akkreszenz, gesammelt wurden. Sie werden als Herkunft „E" bezeichnet.

Für die Versuche im März 1973 stammte das Material der im Herbst 1972 in der Südwestslowakei gesammelten Eier von folgenden Populationen (Tab. 1):

Tabelle 1. Charakteristik des Materials fur die Versuche mit *Lymantria dispar* im März 1973

Herkunft	Lokalitat	Durchschn. Gewicht emes Eigeleges	Gradationphase
"F"	Sazdice	860,5 mg	Akkreszenz
"G"	Pata	381,7 mg	Eruption
"H"	Pata	179,9 mg	Eruption
"I"	Pata	77,0 mg	Eruption

Die einzelnen Proben (Tab. 1) differeiorten untereinander im Gewicht der Eigelege bedeutend, was für eine gute Ernährung (Herkunft „F") bzw. progressiv steigende Unterernahrung (Herkunft „G" bis „I") der vorgehenden Generation zeugte.

Die Eier wurden bis zu den Versuchen wiederum in 5 °C aufbewahrt. Bei jeder Herkunft wurden dieselben vermischt einzeln abgerechnet, in den Einzelfallen (Tab. 6) ganze Teile der Eigelege im Versuch genommen. Die Sicherung der einzelnen Temperaturen (Tab. 5—8) sowie der standigen rel. Luftfauchtigkeit (80—85 %) in Schalen nach Zwolfer (1931) geschah ähnlich wie bei den vorigen Arten.

4. Verschiedene Noctuiden (Tab. 9—13). Die Weibchen der einzelnen Arten, welche schon begattet waren, fing ich im April 1969 in eine Lichtfalle. Bei Futterung mit Zuckerlosung erzielte ich leicht die Eiablage in Glasbehältern mit Zellstoffwatte. Bis zu den Versuchen in April, Anf. Mai 1969 wurden die Eier bei 5 °C gehalten. Die Behandlung wahrend der Versuche war ähnlich wie bei den vorigen. Die ungeschlüpften Eier wurden an Befruchtung untersucht und nur die befruchteten in Betracht genommen.

Bei allen Arten wurden die abgerechneten Einzeleier oder Eigruppen in Glasrohrchen, die an beiden Enden mit Verbandzeugwatte verstoppt wurden, den betreffenden Temperaturen ausgesetzt. Die relative Luftfeuchtigkeit von 80—85 % wurde in den Schalen nach Zwölfer (1931), nur im „Feutron" direkt, vorbereitet.

RESULTATE

1. *Archips crataegana* (Hb.). Die Ergebnisse der Einzelversuche sind in der Tab. 2 zusammengefasst. Aus dieser geht hervor, dass die tiefen negativen Temperaturen (—3 bis —7 °C) bei den Eiern von *Archips crataegana* mit fortgeschrittener Embryonalentwicklung eine hohe (mehr als 50%tige) Mortalität erst dann herbeiführen, wenn sie längere Zeit (wenigstens 2—3 Tage wirken. Übertragung der Eier — bevor sie den tiefen Temperaturen ausgesetzt wurden — in 20 °C, wodurch deren Embryonalentwicklung weiterhin fortschreitet, scheint mit keinen grösseren Sterblichkeitsveränderungen verbunden zu sein. Daraus geht hervor, dass im Rahmen der vorausgeschrittenen Embryonalentwicklung (die Raupen von den im Kühlschrank bei 5 °C aufbewahrten Eiern schlüpften bei 20 °C in 5 Tagen) ist es wohl nicht allzu wichtig, in welcher Phase die Eier durch tiefe Temperaturen betroffen werden. Es hat sich weiter gezeigt, dass die Dauer der Einwirkung tiefer Temperaturen wichtiger als ihre Höhe war. So war die Sterblichkeit bei dreitägiger Wirkung von —3 °C höher als bei eintägiger Wirkung von —7 °C. Die einzelnen Resultate wechseln ziemlich, was verschiedene Resistenz der einzelnen Eigruppen beweist. Auch waren die einzelnen Proben wohl nicht ausreichend gross, um überzeugende Resultate zu geben.

108

Tabelle 2. Einfluss tiefer Temperaturen auf die Eier von *Archips crataegana* (Hb).

Ver- such Nr.	Aussetzung der Eier den Temperaturen während	Insge- samt	Zahl der Eier Nicht befruchtet	Befruchtet nicht ge- schlüpft	ge- schlüpft	Sterblich- keit der befruchteten Eier in %
1	3 Tage 20 °C, 2 Tage −7 °C, 1 Tag 10 °C	60	3	48	9	84,2
2	3 Tage 20 °C, 2 Tage −3 °C, 1 Tag 10 °C	58	3	8	47	14,5
3	3 Tage 20 °C, 2 Tage −1 °C 1 Tag 10 °C	58	2	3	53	5,4
4	1 Tag 20 °C, 2 Tage −7 °C	51	1	3	47	6,0
5	1 Tag 20 °C, 1 Tag −7 °C	47	3	9	35	20,4
6	2 Tage 20 °C, 1 Tag −7 °C	40	3	10	27	37,0
7	2 Tage 20 °C, 2 Tage −7 °C	61	8	48	5	90,6
8	1 Tag 20 °C, 2 Tage −3 °C	96	6	3	87	3,3
9	2 Tage 20 °C, 1 Tag −3 °C	49	—	5	44	10,2
10	3 Tage −7 °C	66	5	31	30	50,8
11	3 Tage −3 °C	55	2	40	13	75,5
12	3 Tage 0 °C	51	7	24	20	54,5
13	6 Tage −3 °C	67	6	61	0	100,0
14	1 Tag 20 °C, 6 Tage −3 °C	47	4	38	5	88,4
15	6 Tage −7 °C	60	6	32	22	59,3
16	2 Tage 20 °C, 6 Tage −7 °C	53	5	39	9	81,2
17	3 Tage 20 °C, 3 Tage −7 °C	46	0	21	25	45,7
18	Kontrolle − stets 20 °C	51	1	2	48	2,0
19	Kontrolle − stets 20 °C	38	0	2	36	5,3

Die Spätfröste liegen in der Slowakei selten so tief und besonders selten dauern sie so lange, um die Population von *A. crataegana* direkt ernster bedrohen zu können. Die Angaben verschiedener meteorologischer Stationen in der Mittel- und Südslowakei haben gezeigt, dass es seit 1952 keine solche April- oder Maitemperaturen gab. Manchmal traten jedoch solche im März auf, zuweilen nach der recht milden Wintertemperatur, wie es, besonders in den letzten Jahren, mehrmals der Fall war.

2. *Operophthera brumata* (L.). Resultate der Versuche sind in den Tab. 3 und 4 enthalten. Die Ergennisse mit der Population, welche sich in der fortge- schrittenen Gradationsphase befand, schwankten auffallend und bewiesen, dass es sich um stark heterogenes Material gehandelt hat. Manche Proben ertrugen extrem tiefe (−16 °C) oder relativ lang dauernde (3 Tage von −8 °C) Temperaturen ohne merkliche Verluste, andere wiesen hohe Mortalität auch unter anscheinend optimalen Verhältnissen (16 °C) auf. Wahrscheinlich war die Ursache der Sterblichkeit eine andere, als direkte Wirkung tiefer Tem- peraturen, da auch parallele Versuche verschiedenartige Resultate lieferten. Das beweisen auch die Versuche mit der Population in der Phase der Akkre- szenz (Tab. 4). Allgemein scheinen die wechselnden Temperaturen mit ge- ringerer Sterblichkeit als die ständigen (und besonders tieferen) verbunden zu sein. Viele Resultate (Tab. 3, Versuch Nr. 1, 2, 5, 8—12) zeugen, dass die Eier dieser Art auch in der fortgeschrittenen Gradationsphase gegen die direkte Wirkung der Spätfröste im Frühling sehr resistent sind.
Die Ergebnisse mit der Population in der Gradationsphase der Akkreszenz zeigen eindeutig die grosse Resistenz der Eier der *Operophtera brumata* gegen

Tabelle 3. Einfluss verschiedener Temperaturen auf die Eier von *Operophthera brumata* (L.), Gradationsphase Kulmination, von Lednice, Südmähren.

Ver- such Nr.	Aussetzung der Eier den Temperaturen während	Insgesamt	Zahl der Eier Nicht geschlüpft	Geschlüpft	Sterblichkeit in %
1	7 Tage 12 Stunden 8 °C, 12 Stunden 16 °C, weitere	30	2	28	6,6
2	7 Tage 12 Stunden − 5 °C, 12 Stunden − 16 °C abwechselnd	35	0	35	0
3	6 Tage 20 °C; dann 7 Tage je 12 Stund.	30	7	23	23,3
4	0 °C und 12 Stunden − 5 °C abwechselnd	30	7	23	23,3
5	3 Tage 20 °C, 1 Tag − 4 °C	30	0	30	0
6	3 Tage 20 °C, 3 Tage − 4 °C	30	17	13	56,7
7	3 Tage 20 °C, 1 Tag − 8 °C	30	30	0	100,0
8	3 Tage 20 °C, 3 Tage − 8 °C	30	8	22	26,7
9	6 Tage 20 °C, 1 Tag − 4 °C	30	7	23	23,3
10	6 Tage 20 °C, 3 Tage − 4 °C	30	10	20	33,3
11	6 Tage 20 °C, 1 Tag − 8 °C	30	2	28	6,6
12	6 Tage 20 °C, 3 Tage − 8 °C	30	0	30	0
13	Stets 16 °C	30	3	27	10,0
14	Stets 16 °C	30	13	17	43,3
15	Stets 16 °C	30	1	29	3,3
16	Kontrolle — stets 20 °C	30	4	26	13,3
17	Kontrolle — stets 20 °C	30	9	21	30,0
18	Kontrolle — stets 20 °C	30	12	18	40,0
19	Stets 25 °C	30	9	21	30,0
20	Stets 25 °C	30	16	14	53,3
21	Stets 25 °C	30	11	19	36,7

die Spätfröste und zwar ohne Rücksicht auf den Fortschritt der Embryonalentwicklung. Die Eier, welche vor dem Versuch 8 Tage bei 22 °C gehalten wurden, befanden sich schon vorwiegend vor dem Schlüpfen. Auch die Dauer der tiefen Temperaturen beeinflusste kaum die Sterblichkeit.

3. *Lymantria dispar* (L.). Die Resultate der Versuche sind in den Tab. 5—8 zusammengefasst. Die Eier von *Lymantria dispar* können wohl

Tabelle 4. Einfluss wechselnder tiefer Temperaturen in „Feutron" auf die Eier von *Operophthera brumata* (L.), Gradationsphase Akkreszenz, von der Umgebung von Zvolen (Mittelslowakei). In jeder Probe befanden sich 50 Eier.

Vor dem Versuch Aufenthalt der Proben in 22 °C für	Abwechselnd den Temperaturen von − 3 und − 8 °C ausgesetzt für						Kontrolle. dauernd in 22 °C 4 Wiederholungen	
	1 Tag		4 Tage Mortalität:		7 Tage			
	Stück	%	Stück	%	Stück	%	Stück	%
2 Tage	1	2	12	24	10	20	1:10	20
4 Tage	10	20	10	20	11	22	2:11	22
6 Tage	7	14	13	26	5	10	3: 1	2
8 Tage	13	26	6	12	9	18	4: 7	14

Tabelle 5. Einfluss tiefer Temperaturen auf die Eier von *Lymantria dispar* (L.), Gradationsphase Akkreszenz, von Královský Chlumec, Sudostslowakei.

Ver-such Nr.	Herkunft des Mate-riales	Aussetzung der Eier den Temperaturen während	Insge samt	Zahl der Eier Nicht ge schlupft	Ge-schlupft	Sterblich-keit in %
1	A	1 Tag 20 °C. 1 Tag −7 °C	51	3	48	5,9
2	A	2 Tage 20 °C, 1 Tag −7 °C	50	1	49	2,0
3	A	1 Tag 20 °C, 1 Tag −3 °C	51	2	49	3,9
4	A	2 Tage 20 °C, 1 Tag −3 °C	50	7	43	14,0
5	A	Kontrolle — stets 20 °C	50	5	45	10,0

im Frühling auch nach der Erwärmung (nach welcher es zur Aktivierung der schon vollentwickelten Raupe im Ei kommt) kurzer (1—7 Tage) dauernde mässige bis mittelstarke (bis −7 °C) Fröste ohne grössere Verluste ertragen (Tab. 5, 7). Temperaturen von −15 bis −16 °C überleben sie allgemein nur, wenn diese kürzer (12 Stunden) dauern. Bei der geschwächten Population

Tabelle 6 Einfluss tiefer Temperaturen auf die Populationen von *Lymantria dispar* von der Zucht.

Ver-such Nr.	Herkunft des Mate-riales	Aussetzung der Eier den Temperaturen während	Insge samt	Zahl der Eier Nicht ge schlupft	Ge-schlupft	Sterblich-keit in %
1	C	7 Tage· 12 Stunden 8° C,	50	8	42	16
2	C	12 Stunden 16 °C abwechselnd.	50	6	44	12
3	B	Weitere 7 Tage: 12 Stunden	50	8	42	16
4	B	−5 °C, weitere 12 Stunden	50	19	31	38
5	D	−16 °C abwechselnd	30	2	28	6,7
6	C	Kontrolle	50	13	37	26
7	B	Stets 20 °C	50	14	36	28
8	D		50	38	12	76
9	B	Stets 25 °C	100	14	86	14
10	C	Einzel· 20 °C 3 Tage, dann −15 °C 3 Tage	50	50	0	100
11	C	eier 20 °C 6 Tage, dann −15 °C 6 Tage	50	50	0	100
12	C	20 °C 9 Tage, dann −15 °C 9 Tage	50	49	1	98
13	C	20 °C 9 Tage, dann −15 °C 6 Tage	50	50	0	100
14	C	Teile 20 °C 3 Tage, dann −15 °C 3 Tage	73	73	0	100
15	C	der 20 °C 3 Tage, dann Eige- −15 °C 6 Tage	48	48	0	100
16	C	lege 20 °C 9 Tage, dann −15 °C 9 Tage	66	66	0	100
17	C	20 °C 9 Tage, dann −15 °C 6 Tage	65	65	0	100

Tabelle 7. Einfluss wechselnder tiefer Temperaturen auf die Eier von *Lymantria dispar* (L.), Gradationsphase Akkreszenz, von der Sudwestslowakei. In jeder Probe befanden sich 50 Eier.

Vor dem Versuch Aufenthalt der Proben in 22 °C für	Abwechselnd den Temperaturen von −3 °C −8 °C ausgesetzt für						Kontrolle, dauernd in 22 °C. 4 Wiederholungen	
	1 Tag		4 Tag		7 Tage			
				Mortalität				
	Stuck	%	Stuck	°₀	Stuck	°₀	Stuck	%
2 Tage	1	2	0	0	1	2	1 : 0	0
4 Tage	0	0	1	2	2	4	2 : 0	0
8 Tage	0	0	2	4	1	2	3 : 0	0
12 Tage	1	2	0	0	2	4	4 : 0	0
16 Tage	1	2	1	2	2	4		

„D" stellte man bei der wechselnden, z.T. auch negativen Temperatur (−5 und −16 °C während 12 Stunden) sogar eine viel niedrigere Mortalität als bei der stängigen (von 20 °C) fest (Tab. 6). Es handelte sich jedoch dabei um eine unausreichend grosse Probe (30 Stück).

Aus der Tab. 8. geht hervor, dass die Population der Herkunft „F" durch die Länge des Aufenthaltes in tiefen Temperaturen nicht beeinflusst wurde, ebenso die der Herkunft „G" nur wenig. Die Populationen der Herkunft „H" und „I", die in der vorigen Generation stark gehungert haben und deshalb geschwächt und wenig fruchtbar sind, scheinen gegen die verwendeten tiefen Temperaturen weniger resistent zu sein, obzwar die Höhe der Mortalität nicht proportional zur Verlängerung der Exposition angewachsen ist Diese Versuchsserie zeigt also, dass stärkere Spätfröste (−8 °C) einer unterernährten Population der *L. dispar* im Eistadium bestimmte Verluste herbeifuhren können. Diese Tabelle zeigt gleichzeitig, dass sich die Eigruppen der einzelnen Herkünfte untereinander auch durch das Gewicht der Einzeleier deutlich unterscheiden (die Analyse der Zerstreuung hat gezeigt, dass die Unterschiede zwischen „G" und „H" einerseits, „F" und „I" anderseits eine 99%tige und höhere Bedeutung aufweisen) Die Zeitspanne, welche bei 20 °C zum Schlüpfbegin notwendig war, schwankte zimlich, ohne jedoch eine bestimmte Abhängigkeit von den verfolgten Einflüssen (Grad der Unterernährung, Lange der Aktivierung und des Aufenthaltes in den tiefen Temperaturen) aufzuweisen. Ebenso die Schlüpfdauer der einzelnen Proben schwankte stark (7 − 22 Tage), am schnellsten verlief im allgemeinen das Schlüpfen der Probe der Herkunft „F".

Extreme Bedingungen, die in den Versuchen Nr. 10 − 17 der Tab. 6 herrschten, könnten im Freien nur ausnahmsweise auftreten (starke Erwarmung mitten im Winter, durch eine Welle tiefer Fröste gefolgt). Die Resultate scheinen zu beweisen, dass die direkte Wirkung der Spätfröste auf die Eier von *L. dispar* (vielleicht mit Ausnahme einer stark geschwachten Population der fortgeschrittenen Gradationsphase) keinen wichtigen Sterblickeitsfaktor vorstellt.

Während unsere Versuche die Frostresistenz der Schwammspinnereier nach der Beendigung der Winterdiapause untersuchten, gibt es mehrere

112

Tabelle 8. Einfluss tiefer Temperaturen auf die Eier von *Lymantria dispar* (L.) verschiedener Herkunft (vgl. Tab. 1). In jeder Probe befanden sich 50 Eier.

Ausgesetzt den Bedingungen während der Zeit	Herkunft	Gewicht von 50 Stück von Eiern in mg	In 20 °C bis zum Schlüpfbegin-Tage	Schlüpfzeit der Probe-Tage	Mortalität	
					Stück	%
Dauernd bei 22 °C	"F"	40,0	17	13	2	4
	"G"	36,9	17	16	6	12
	"H"	37,2	20	12	5	10
	"T"	34,8	17	22	5	10
	"F"	40,1	17	7	0	0
	"G"	37,1	17	18	10	20
	"H"	36,2	18	15	5	10
	"T"	35,0	20	10	24	48
	"F"	41,3	18	7	0	0
	"G"	36,6	13	16	2	4
	"H"	38,1	18	14	11	22
	"T"	35,0	18	14	24	48
	"F"	41,0	21	8	0	0
	"G"	36,8	14	13	7	14
	"H"	36,8	19	16	12	24
	"T"	34,0	15	17	7	14

Dann bis zum Schlüpfen bei 20 °C.

7 Tage   5 Tage   3 Tage

während:
3 Tage bei 20 °C, dann - 8 °C

113

Tabelle 9. Einflus tiefers Temperaturen auf die Eier von *Orthosia gothica* (L.).

Ver-such Nr.	Aussetzung der Eier den Temperaturen während	Insge-samt	Zahl der Eier		Ge-schlüpft	Sterblichkeit in %
			Nicht befruch-tet	Nicht ge-schlüpft		
1	3 Tage 20 °C, 7 Tage 10 °C	41	0	0	41	0
2	3 Tage 20 °C, 1 Nacht −1 °C 2 Tage 3 °C	50	0	0	50	0
3	2 Tage 20 °C, 10 Tage 10 °C, 5 Tage −7 °C	174	0	0	174	0
4	1 Tag 20 °C, 12 Tage 7 °C 8 Stunden −3 °C	133	3	0	130	0
5	1 Tage 20 °C, 12 Tage 7 °C, 1 Tag −3 °C	68	0	0	68	0

Angaben über den Einfluss tiefer Temperaturen auf die Eier dieser Art inner-halb derselben. Die Frostresistenz dieser Eier war deutlich höher.

Nach Summers (1922) überleben keine Eier erst die Temperatur von −25 °F (= −31,7 °C). Nach Maksimović (1958) brachte −25 °C während eines Tages eine 21.9%tige, − 2 Tage 61,4%tige, − 3 Tage 92,9%tige Sterblichkeit. Sullivan und Wallace (1972) verglichen die Frostresistenz zweier Populationen dieser in Amerika eingeschleppten Art — einer südlicheren von Masschusetts und einer nördlicheren von Quebec. Sie fanden *keine merklicheren Unter*schiede, also keine Anzeichen einer Naturselektion einer frostharteren Population im Norden. Dagegen fand Pantjuchov (1964) bei den Populationen vom ursprünglichen Verbreitungsgebiet dieser Art in Eurasien deutlichere solche Unterschiede. In der Slowakei, wo die klimatischen Bedingungen im Schadgebiet von *L. dispar* ziemlich einheitlich sind, kämen solche Unterschiede kaum in Betracht. Interessanter schienen in dieser Hinsicht die einzelnen Gradationsphasen zu sein, deshalb wurden diese in meine Versuche einbezogen. Pantjuchov stellte ferner im Spätherbst und Vorfrühling eine höhere Froststerblichkeit fest als mitten im Winter; er erklärt auch das Mechanismus der Frostresistenz auf biochemischphysiologischer Grundlage.

4. Eier der Noctuiden, die im zeitigen Frühling abgelegt werden. Die Resultate, welche mit den einzelnen Arten (*Orthosia gothica* (L.), *O. munda* (Den. et Schiff.) und *Eupsilia transversa* (Hufn.) erzielt wurden, sind aus den Tab. 9—13 zu ersehen.

Sie zeugen dafür, dass die Eier der erwähnten Verteter der Familie Noctui-dae kurzdauernde tiefe Temperaturen, die während der Spätfröste im April und Mai auftreten, ohne grössere Verluste ertragen können. Manche Arten

Tabelle 10. Einfluss tiefer Temperaturen auf die Eier von *Orthosia munda* (Den. et Schiff.).

Ver-such Nr.	Aussetzung der Eier den Temperaturen während (T = Tag, Tage)	Insge-samt	Zahl der Eier		Ge-schlüpft	Sterblichkeit in %
			Nicht befruch-tet	Nicht ge-schlüpft		
1	2 T 20 °C, 7 T 10 °C, 1 T 6 °C	228	0	0	228	0
2	2 T 20 °C, 7 T 10 °C, 5 T −3 °C	72	5	27	40	36,4
3	1 T 20 °C, 10 T 20 °C, 5 T −7 °C	169	10	115	44	72,3
4	1 T 20 °C, 8 T 7 °C, 2 T −1 °C	33	0	0	33	0

Tabellen 11—13. Einfluss tiefer Temperaturen auf die Eier verschiedener Noctuiden: Tab. 11. *Orthosia stabilis* (Den. et Schiff.), Tab. 12. *Conistra erythrocephala* (Den. et Schiff.), Tab. 13. *Eupsilia transversa* (Hufn.).

Tab. 11

| Ver-such Nr. | Aussetzung der Eier den Temperaturen während (T = Tag, Tage) | Zahl der Eier | | | | Sterblichkeit in % |
		Insge-samt	Nicht befruch-tet	Nicht ge-schlüpft	Ge-schlüpft	
1	2 T 20°, 7 T 10°, 1 T 20°, 1 T 6 °C	68	0	1	67	1,5
2	2 T 20°, 7 T 10°, 1 T 20°, 4 T −3°C	114	3	111	0	100,0
3	2 T 20°, 7 T 10°, 6 T −3 °C	98	8	88	2	97,8
4	2 T 20°, 7 T 10°, 1 T 20°, 6 T 0 °C	47	0	20	27	42,5
5	2 T 20°, 7 T 10 °C	108	2	0	106	0
6	1 T 20°, 7 T 10°, 1 T 20°, 6 T 0 °C	69	4	37	28	63,1
7	7 T 10°, 6 T −3 °C	112	4	108	0	100,0
8	2 T 20°, 10 T 10 °C	344	10	3	331	0,9
9	Kontrolle − stets 20 °C	122	5	26	91	22,2
10	3 T 20°, 10 T 10°, 3 T −7 °C	154	8	146	0	100,0
11	2 T 20°, 10 T 10°, 1 T −7 °C	225	2	25	198	11,2
12	2 T 20°, 10 T 10°, 1 T −5 °C	195	5	12	178	6,3
13	10 T 7 °C, 8 Stunden −7 °C	41	0	0	41	0
14	Kontrolle − stets 20° C	73	3	2	68	2,9

Tab. 12

1	2 T 20°, 10 T 10°, 5 T −7 °C	127	4	7	116	5,7
2	2 T 20°, 10 T 10°, 5 T −3 °C	89	3	3	83	3,5
3	2 T 20°, 10 T 10°, 13 T −7 °C	58	3	25	30	50,9

Tab. 13

1	3 T 20°, 10 T 10°, 5 T −7 °C	46	0	5	41	10,9

wie *O. gothica* und *E. transversa* sind auch gegen langdauernde Fröste stark resistent (bei −7 °C während 5 Tage keine bezw. 10,9%tige Sterblichkeit), andere, wie *C. erythrocephala*, *O. munda*, *O. stabilis* weisen unter diesen Bedingungen bereits eine hohe (50,9, 72,3 bezw. 100%tige) Mortalität auf.

Spätfröste, die in der Mittel- und Südslowakei im April und Mai verzeichnet wurden, würden die betreffenden (auch weniger resistenten) Arten direkt kaum bedeutend beeinflussen. Da die Eier dieser Arten − praktisch ohne Verluste − den 14-tägigen Aufenthalt bei 5 °C ertrugen, kann man annehmen, dass auch im Freien eine Welle kalter Witterung keine bedeutende Eimortalität mit sich bringt.

DISKUSSION

Die Resultate unserer früheren Arbeiten (Patočka, Čapek, Charvát, 1963; Patočka. Čapek, 1971) haben enge Beziehungen zwischen der Abundanzdynamik verschiedener Eichenlepidopteren und dem Auftreten der

Spätfröste im April und Mai bewiesen. Eine Möglichkeit der Tätigkeitsmechanik der Spätfröste könnte die direkte Wirkung derselben auf die Eier der betreffenden Arten vorstellen. Die Eier derselben kommen zu dieser Zeit im Freien vor und es verlaufen in ihnen gleichzeitig rege physiologische Prozesse der Embryonalentwicklung. Dabei handelt es sich zum Teil um Eier, deren Embryonalentwicklung — soweit es die Temperaturbedingungen erlauben — auch während der Winterzeit allmählich vor sich geht und durch das Auftreten der wärmeren Frühlingswitterung beschleunigt wird — *Archips crataegana* und *Operophthera brumata* (Hochmut, 1964; Mrkva, 1968). Bei anderen wird die Embryonalentwicklung schon im vorigen Jahre praktisch beendet, es folgt eine Diapause, nach welcher es — nach dem Genuss einer entsprechenden Thermalsumme- zum Schlüpfen kommt — *Lymantria dispar* (Schedl, 1936; Maksimović, 1958 u.a.). Bei der letzten Gruppe kommt es erst im Frühling zur Eiablage, nach welcher gleich eine intensive Embryonalentwicklung verläuft, welche unter Bedingungen im Freien nur etwa 10 bis 20 Tage dauert — die *Orthosia-*, *Conistra-* und *Eupsilia-* Arten (Patočka, 1950 u.a.). Vertreter dieser drei Hauptgruppen wurden in die obenerwahnten Versuche einbezogen, in welchen die tiefen Temperaturen während der Spätfröste im Labor nachgeahmt wurden. Obzwar das untersuchte Material und wohl auch die Zahl der Versuche für die endgültige Klärung dieser Frage nicht ausreichen, kann man trotzdem resultieren, dass die Spätfröste im April und Mai in der Mittel- und Südslowakei durch ihre direkte Wirkung auf die Eier kaum einen bedeutsamen Faktor der Abundanzdynamik der Eichenschmetterlinge vorstellen. Es ist dabei nicht ausgeschlossen, dass ihr Einfluss auf die degenerierte, unterernährte Population in der fortgeschrittenen Gradationsphase einerseits, unter ausserordentlichen, extremen Witterungsbedingungen auf manche empfindlichere Arten anderseits, stärker zum Ausdruck kommt. Meistens aber soll man für die Wirkung der Spätfröste und nasskalter Witterung im April und Mai auf die Populationsdynamik der Eichenschmetterlinge eine andere, indirekte Erklärung suchen; möglicherweise durch Störung der Koinzidenz zwischen dem Schlüpfen der Raupen un dem Treiben der Nährpflanze gemäss der Vermutung von Schutte (1957) bezw. durch Beeinflussung der Resistenz der Nahrpflanze und deren biochemischer Eigenschaften als Nahrung für die empfindlichen Jungraupen durch die Witterungseinflüsse.

ZUSAMMENFASSUNG

Laborversuche mit den Eiern des Wicklers *Archips crataegana* (Hb.), des Spanners *Operophthera brumata* (L.), des Schwammspinners *Lymantria dispar* (L.) und mehrerer Moctuiden — Arten zeugen dafür, dass tiefe Temperaturen (bis —8 °C), welche in der Mittel- und Südslowakei wahrend der Spätfröste auftreten, durch ihre direkte Wirkung meistens kein Massensterben der zu dieser Zeit vorkommenden Eier der Eichenschmetterlinge herbeiführen. Zu grösseren Verlusten kann in dieser Weise nur bei extrem tiefen und vor allem langdauernden Temperaturen, sowie anscheinend bei der geschwächten, degenerierten Population bei fortgeschrittenen Phasen der Gradation kommen.

LITERATUR

Hochmut R., 1964: A contribution to the knowledge of the embryogenesis of the roller Archips crataegana Hb. *Acta Soc. ent. čechoslov.*, **61** : 201—209.

Maksimović M., 1958: Experimental research on the effect of temperature on development and on population dynamics of Lymantria dispar. *Poseb. izd. Biol. Inst. N. R. Srb.* Beograd, **3** : 1—115.

Mrkva R., 1968: Bionomie pídalky podzimní (Operophthera brumata L.) — motýl a vajíčko. *Acta Univ. agric. fac. sylvicult. Brno C*, **37** : 223—246.

Pantjuchov G. A., 1964: Vlijanie otricateľnych temperatur na različnyje populjacii zlatoguzki Euproctis chrysorrhoea L. i neparnogo šelkoprjada Lymantria dispar. L. *Ent. obzor.*, **43** : 94 — 111.

Patočka J., 1950: Ekologické poznámky o můrách z rodu Taeniocampa. Komplexní žír housenek. *Ent. listy*, Brno, **13** : 41—45.

Patočka J., M. Čapek, K. Charvát, 1962: Príspevok k poznaniu korunovej fauny článkovcov na duboch Slovenska, predovšetkým so zreteľom na rád Lepidoptera. *Biol. práce SAV.* Bratislava, **7**, 5 : 1—155.

Patočka J., M. Čapek, 1971: Population changes of certain oak defoliators (Lepidoptera) in Slovakia. *Acta Inst. forest. Zvolen.*, **2** : 461—485.

Schedl K. E., 1936: Der Schwammspinner (Porthetria dispar L.) in Euroasien, Afrika und Neuengland. *Monogr. angew. Ent.*, Berlin, **12** : 1—242.

Schütte F., 1957: Untersuchungen über die Populationsdynamik des Eichenwicklers (Tortrix viridana L.). *Z. angew. Ent.*, **40** : 283—331.

Sullivan C. R., D. R. Wallace, 1972: The potential northern dispersal of the gypsy moth Porthetria dispar (Lepidoptera, Lymantriidae). *Can. Ent.*, **104** : 1349—1355.

Summers J. N., 1922: Effect of low temperatures on the hatching of gypsy moth eggs. *USDA Bull.* 1080, Washington, 1—54.

Zwölfer W., 1931: Studien zur Ökologie und Epidemiologie der Insekten. I. Die Kieferneule Panrolis flammea Schiff. *Z. angew. Ent.*, **17** : 475—562.

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CONTRIBUTION TO THE KNOWLEDGE OF THE DISTRIBUTION OF HELMINTHS IN THE INTESTINAL TRACT OF THE COMMON MOLE (TALPA EUROPAEA L.) IN THE AUSTRIAN ALPS

JAN PROKOPIČ & Ivo GRULICH

Abstract: Helminthological inspection of a total of 141 specimens of *Talpa europaea* L., trapped in 8 localities of the Austrian Alps in altitudes from 480—2,100 m above sea level, disclosed a total of 12 helminth species recovered from 88 moles (Fig. 1, Table 1). The most frequent helminth species were these: *Spirura talpae* (54 cases), *Soboliphyme hirundiniformis* (12 cases), *Capillaria talpae* (11 cases); of the larval stages recovered from *Talpa europaea*, the most frequent were those of the genus *Porrocaecum*. Up to altitudes of 1,600 m above sea level, we found 6 species. Of zoogeographical interest is the finding of the trematode *Plagiorchis* (*Multiglandularis*) *macrobursatum*, and of the nematode *Soboliphyme hirundiniformis*, which, until now, have been reported only from *Talpa caeca* from the Caucasus. Helminths were found in 20% of subadult females, 33.3% of subadult males, in 55.9% of adult females, and in 75.7% of adult males. In original, undisturbed areas, the incidence of infection of the mole was considerably higher than that in areas greatly changed by man-made activity.

Literary data are scarce on the distribution of helminths in the intestinal tract of the common mole (*Talpa europaea* L.) from Austria. In June 1967, Doc. Dr. Ing. Ivo Grulich, CSc. captured 141 specimens of *T. europaea* in the Austrian Alps. After teriological examination, the material was fixed in a weak formalin solution and sent for parasitological evaluation to the Institute of Parasitology, Czechoslovak Academy of Sciences, Prague.

MATERIAL AND METHODS

We examined in postmortem 141 specimens of *Talpa europaea* captured in 8 localities (Fig. 1, Table 1).

1. Pack-Sattel-Gurktaler Alpen (flysh belt) heavily pastured grass belts along spruce forests.
2. Stampf Pack-Stausee (Gurktaler Alpen), alder-tree stands along the edges of pine forests on the banks of a brook.
3. Vellach (Karavanken), mainly from Devonian limestone reefs in continuous alder-tree stands on a wide cirque with a rich herbal layer.
4. Geseldorfsee (Hohe Tauern) flysch rock with a crystallic nucleus. Moist, grassy edges of pine trees along the shore of a lake.
5. Innerkrems (Gurktaler Alpen), flysch-mountain rock-, mountain meadows and pastures, often on heavily pastured meadows in larchtree forests.
6. Kremsbrücke (Gurktaler Alpen), flysch -narrow strips of alder-tree stands and other deciduous woodplants along mountain brooks.
7. Kleinsölk (Hohe Tauern) flysh with a crystallic nucleus, piedmont meadows deeply wedged among mountain stands of autochthonous spruce.
8. Stein (Hohe Tauern), flysh with a crystallic nucleus, valley meadows along the river Enns, partly in alder-tree forests.
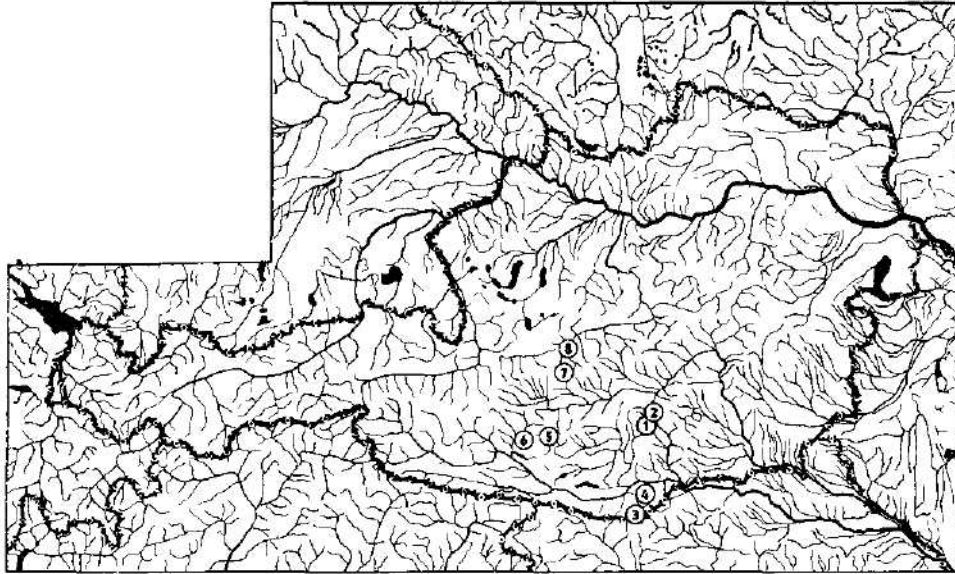
Fig. 1. Map showing the sites of collection.
Explanation: the numerals in the circles are identical with the numerals in Table 1 referring to the individual localities.

The method employed for the identification of the age of the moles has been given in an earlier paper (Grulich, 1967a).
The helminths were examined and evaluated in material fixed with 4% formalin. Trematodes and cestodes were stained with boraxcarmine, nematodes cleared with lactic acid. The helminth species identified in this material are listed and described in the text.

SYSTEMATICAL AND FAUNISTICAL SURVEY OF THE HELMINT SPECIES

I. Trematoda

1. *Plagiorchis (Multiglandularis) macrobursatum* Čertkova, Rodonaja, 1965
Description. Body pear-shaped (Fig. 2). Average body length 0.8 mm, width 0.3 mm. Oral sucker circular, average size 0.056 mm. Praepharynx 0.018 mm in diameter, pharynx 0.030 mm. Ventral sucker oval, size 0.018 mm. Intestinal bifurcation starting from ventral sucker downwards and extending of body (both branches). Sexual organs open close below pharynx. Cirrus to end sack encircles ventral sucker, its posterior end is extended to posterior edge of testes. Length of cirrus sack 0.310 mm, width 0.070 mm. Testes in posterior half of body, diameter from 0.110—0.120 mm. Ovary between testes (to the right of ventral sucker); it attains up to 0.070 mm in diameter. Vitelline glands composed of numerous follicles, extended along both sides of posterior body portion and merge in a medical line in anterior half of body. Uterus with eggs situated at caudal side of ventral sucker. Measurements of eggs from 0.030 to 0.034 mm × 0.017—0.020 mm.

This trematode species was found in the small intestine of one of the 141 specimens examined.

Locality: Gösseldorfsee (Kärnten) altitude 480 m above sea level.

119

Čertkova and Rodonaja (1965) described this species from *Talpa* sp. trapped at altitudes from 800—1,200 m above sea level in the Georgian S.S.R. This is the second finding of this trematode, and the first finding outside the territory of the Caucasus and, evidently, also the first finding in *Talpa europaea* L.
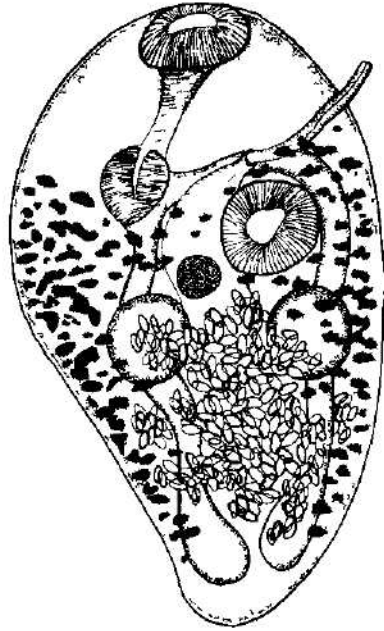

Fig 2 *Plagiorchis multiglandularis.*   Fig. 3. *Dilepis undula.*
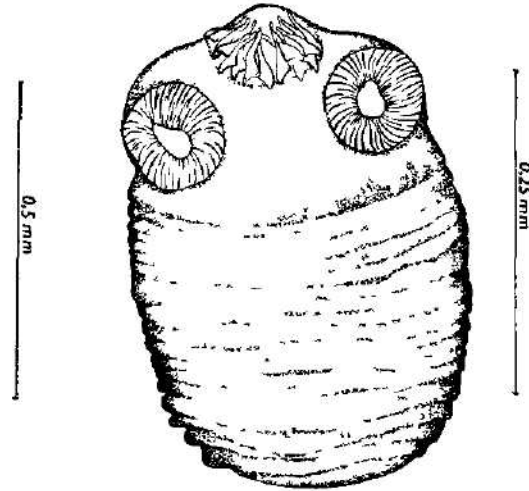
II. Cestoidea

1 *Rodentotaenia filamentosa* (Goeze, 1782)

A species parasitic in members of the genus *Talpa* in the Palaearctic region. We found it in the small intestine of 5 moles (out of a total of 141 moles examined).

Localities: Pack-Sattel, 112 m above sea level; Kremsbrucke, 960 m above sea level.

This species was recovered from moles by Prokopič (1959) (1 3%), by Genov and Dimitrova (1966) (12 0%), by Prokopič and Genov (1973) (1.4%) and (12%).

2. *Dilepis undula* (Schrank, 1788)

A typical parasite of passeriform birds from the Palaearctic region. It develops in *Lumbricidae* representing a major component in the mole's food; this accounts for frequent finding of immature forms of this cestode in the mole. We recovered 8 specimens from the small intestine of one mole (Fig. 3).

Locality: Gesseldorfsee, altitude 480 m above sea level.

120

Prokopič (1959) found this cestode species in *Neomys fodiens, Sorex alpinus* and *Crocidura suaveolens*. Andreyko (1969) recovered it from the common mole (6.25%) of Moldavia, Morozov (1958) from moles (7.35%) of Belorussia, Merkusheva (1969) from moles 3.5% of Belorussia, Prokopič and Genov (1973) from Czechoslovakia (1.2%).

III. Nematoda

1. *Spirura talpae* (Gmelin, 1790)

A parasite of the common mole, domestic cat, and common fox of the Palaearctic region; it was obtained also from rats with artificial infection. We recovered this nematode from the stomach of 54 moles (out of a total of 141 moles examined).

Localities: Vellach, 1,050 m above sea level; Gesseldorfsee, 480 m above sea level; Innerkrems, 1,600 m above sea level; Kremsbrücke, 960 m above sea level, Kleinsölk, 1,400—1,600 m above sea level; Stem, 850 m above sea level.

Prokopič (1959) found this species in 4% of moles from Czechoslovakia; Stammer (1959) in 11 moles out of a total of 19 moles from the German Federal Republic; Janchev (1965) in the common mole from Bulgaria; Furmaga (1959) in Poland; Merkusheva (1969) and Morozov (1958) in Belorussia, Chiriac and Hamar (1966) in Rumania.

2. *Morganiella talpae* (Morgan, 1928)

A parasite of the small intestine of the common mole from the Palaearctic region. We recovered it from 5 out of a total of 141 moles.

Localities: Gesseldorfsee, altitude 480 m; Innerkrems, 1,600 m; Innerkrems, 2,100 m.

Prokopič (1959) recorded this species in 13.6% of moles from Czechoslovakia. Stammer (1955) found it in 9 out of a total of 19 common moles from the German Federal Republic; Andreyko (1968) in the same host from Moldavia; Furmaga (1959) in Poland; Merkusheva (1969) in 38.4% of moles from the White Russian S.S.R.

3. *Tricholinstowia linstowi* (Travassos, 1918)

A parasite of the common mole, common shrew, and water shrew from the Palaearctic region. Out of a total of 141 common moles we found it in 3 moles.

Localities: Pack-Sattel, altitude 1,125 m; Pack-Stausee, 800 m.

Stammer found this species in 7 out of a total of 19 specimens of the common mole from the German Federal Republic, Prokopič (1959) in the water shrew from Czechoslovakia.

4. *Capillaria capillaris* (Linstow, 1882)

A parasite of the urinary bladder of the common mole and other insectivores of the Palaearctic region. We recovered it from one of the 141 specimens of the common mole examined.

Locality: Stampf, altitude 800 m above sea level.

Stammer (1955) recorded this species from 4 of the 19 specimens of *Talpa europaea*; Prokopič and Genov (1972) from the same host (8%) in Bulgaria. Morozov (1958), Grygorev (1963), Merkusheva (1969), Karasev (1966) recorded findings from Belorussia, Soltys (1954) from Poland, Prokopič (1959) found this species in *Sorex araneus, S. minutus* and *Neomys fodiens* from Czechoslovakia.

5. *Capillaria talpae* (Siebold, 1850)

A parasite in the intestine of the common mole from the Palaearctic region. We found it in 11 specimens of *T. europaea* (out of a total of 141 specimens examined).

Localities: Pack-Sattel, altitude 1,125 m; Pack-Stausee, 800 m; Vellach, 1,050 m; Gesseldorfsee, 480 m; Innerkrems, 1,600 m; Kremsbrucke, 960 m; Kleinsolk, 1,400—1,600 m.

This species was recovered from *T. europaea* by Sovinov (1960) in the Kalinin district of the U.S.S.R., by Karasev (1966) and Merkusheva (1969) from Belorussia, by Furmaga (1959) from Poland, by Prokopič (1959) from Czechoslovakia, and by Prokopič and Genov (1972) from Bulgaria (4%) and Czechoslovakia (0.8%).

6. *Parastrongyloides winschesi* Morgan, 1928

A parasite of the small intestine of the common mole and other insectivores from the Palaearctic region. We recovered it from 5 out of a total of 141 common moles

Localities: Kleinsolk, altitude 1,400—1,600 m above sea level, Kremsbrucke, 960 m above sea level; Gesseldorfsee, 480 m above sea level; Pack-Stausee, 800 m above sea level, Stein, 850 m above sea level.

Stammer (1955) recorded findings of this species from the German Federal Republic, Vasilev (1949) from the surroundings of Leningrad, Mustafayev (1964) from the Transcaucasus, Morozov (1958) and Merkusheva (1969) from Belorussia, Prokopič (1959) from Czechoslovakia, and Prokopič and Genov (1972) from Bulgaria and Czechoslovakia.

7. *Soboliphyme hirundiniformis* Kirschenblatt, 1946

Kirschenblatt's (1946) original description of this species is from *Talpa caeca orientalis* Ognev from Abkhazia (Georgian S.S.R.) and, until the present, it has not been found elsewhere. In view of the scarcity of this species, we are giving a description of our finding.

Large oval nematodes with a typical sucker on the anterior body end (Fig. 5). Length of male 22—24 mm, width 0.40—0.55 mm. Diameter of sucker 1.100—1.140 mm. Length of oesophagus 3.4—3.6 mm, width 0.76 to 0.77 mm. Posterior ending of male's body obtuse. Bursa copulatrix typically bell-shaped, closed, in direction towards the ventral side, width 900—940 u. Spicule (one, Fig. 6.) 2.300—2.350 mm long. Length of female 27—30 mm, width 0.85—0.90 mm. Diameter of sucker 1.550 to 1.750 mm Oesophagus length 3.3—4.7 mm, width 0.500—0 550 mm. Vulva situated in anterior third of body, approximately at 5.8 to 6.3 mm from proximal margin. Uterus and ovary formed by a simple, long tube. Eggs lemon-shaped (Fig. 5), size 66—70 × 38—42 μm. Distal end of body obtuse. Anal pore at 0.34 – 0.35 mm from distal body end.

We found this species in the stomach Fig. 4. of 12 specimens of the common mole (out of a total of 141 specimens examined).

8. *Julinea* sp.

Minute, oval worms attenuated at both ends. Oesophagus terminates in small bulbus. Oral cavity bears 3 lips. Cuticle on proximal body part with transverse striation. Length of male 0.9—1.0 mm, width 0.045—0.050 mm. Diameter of head 20—24 μm. Length of oesophagus 0.160—0.170 mm. Diameter of bulbus 0.025—0.030 mm. Nerve ring at 0 080—0.084 mm from proximal end of body. Intestine straight, elarged below the bulbus, later attenuated. Spicules 0.051—0.055 mm. Overall length of female 0.95—1.500 mm, width 0.050—0.06 mm. Diameter of head 0.020—0.025 mm. Length of oesophagus 0.170—0.190 mm. Diameter of bulbus 0.028—0.032 mm. Nerve ring at 0.085—0.090 mm from anterior body end. Intestine enlarged below the bulbus, then attenuated. Anal pore at 0.036—0.040 mm from distal body end. Vulva approximately in mid body. Eggs irregularly oval, size 0.040 to 0.041 mm × 0.018 — 0.024 mm. Body ending conical tail. The species was obtained from the stomach of 4 specimens of the common mole out of a total of 141 animals examined.

We recovered this species from the stomach only. In view of the atypical location of oxyurids in the stomach, and of the fact that none of the members of the family Blattophilidae Klos, 1960 are known to parasitize the common mole, or other mammals, it is possible that the phenomenon involved was not true parasites. The stomach of the moles contained frequently remnants of various insect species and milipedes, from which these nematodes could have been released and than survived in the stomach of the common mole for a certain period. We observed frequently similar cases in members of the genus *Sorex* (unpublished).

9. *Porrocaecum* sp. (larva)

Adults of the genus *Porrocaecum* parasitize birds. Larvae of this genus found in the common mole belonged to various species, e.g. *P. depressum*, *P. ensicaudatum*, *P. talpae*. *Porrocaecum* larvae are generally difficult to identify. Insectivores, the common mole inclusive, are reservoir hosts of these parasites; Lumbricidae, which are ingested by the reservoir hosts are utilized as the intermediate hosts. The larvae penetrate the wall of the intestinal tract of the reservoir host and encyst on its outer wall. Frequently, a large number of larvae (up to several hundred) cumulate in the abdominal cavity of the common mole. If a carnivore feeds on a common mole (or other insectivores) infected with these larvae, it is utilized by the adult worm as its definitive host.

In the complementary host, larvae of the genus *Porrocaecum* encyst on the outer wall of the stomach and intestine, in the abdominal cavity, the liver and, in several instances, on the surface of the genitalia (testes). We found

123

Table 1 Survey of the age and sex of the moles, of the localities and date of trapping

Locality	Date - June 1967	Altitude	No. of examined moles	No of positive moles	%
Pack - Sattel — 1	13—14	1125	40	15	37 5
Stampf Pack - Stausee — 2	14	800	5	2	40.0
Vellach — 3	15—16	900—1000	17	7	41.2
Gesseldorfsee — 4	17—18	480	20	11	55 0
Innerkrems — 5	19—20	1600	21	17	80.9
Kremsbrucke — 6	21—23	960	23	20	86.9
Kleinsolk — 7	24—25	1200—1500	9	9	100.0
Stein — 8	26	850	6	6	100.0
Total	13—26	480—1600	141	88	62.4

them in 39 specimens of common moles (out of a total of 141 specimens examined).

Localities. Pack-Sattel, 1,125 m above sea level; Pack-Stausee, 800 m above sea level; Vellach, 1,050 m above sea level; Gesseldorfsee, 480 m above sea level; Innerkrems, 1,600 m above sea level; Kremsbrücke, 960 m above sea level; Kleinsolk, 1,400 —1,600 m above sea level; Stein, 850 m above sea level.

ECOLOGICAL AND GEOGRAPHICAL REMARKS

According to the data available, *Talpa europaea* L. is parasitized by 5 species of trematodes, 11 species of cestodes, 25 species of nematodes and 4 species of acanthocephalans. We found a total of 12 species in our material. Of the 45 helminth species recorded from *Talpa europaea*, 13 species (28%) were at the larval stage. These we are mainly parasites of beasts of prey and carnivores; the common mole is utilized as the intermediate host by, e.g , *Hydatigera taeniaeformis, Taenia tenuicollis, T. crassiceps*, etc., or as the reservoir host, by e g *Alaria alata, Spirocerca lupi, Physocephalus sexalatus, Ascarops strongylina*, etc. Other larvae recorded from the common mole are those of the cestode *Dilepis undula, Amoebotaenia lumbrici*; these develop in Lumbricidae, their definitive hosts are passeriform birds. They occur with considerable frequency in *Talpa europaea*, generally in the immature stage in the intestine. An exceptional finding was that of the oxyurid worm *Julinea* sp., which, apparently, had been released from an arthropod ingested by the common mole and survived for a certain period in its digestive tract.

124

| ♂♂ | | | | ♀♀ | | | | ♂♂ | | ♀♀ | | ad | | sd | |
| adult | | subadult | | adult | | subadult | | ad + sd | | ad + sd | | ♂♂ + ♀♀ | | ♂♂ + ♀♀ | |
No. of examined	No. of positive	No. of examined	No. of positive	No. of examined	No. of positive	No. of examined	No. of positive	No. of examined	No. of positive	No. of examined	No. of positive	No. of examined	No. of positive	No. of examined	No. of positive
12	9	15	—	10	6	3	—	27	9	13	6	22	15	18	—
2	2	—	—	1	—	2	—	2	2	3	-	3	2	2	—
11	4	3	3	2	—	1	—	14	7	3	—	13	4	4	3
6	5	4	1	8	5	2	—	10	6	10	5	14	10	6	1
16	13	1	1	3	2	1	1	17	14	4	3	19	15	2	2
14	11	3	3	6	6	—	—	17	14	6	6	20	17	3	3
4	4	1	1	3	3	1	1	5	5	4	4	7	7	2	2
5	5	—	—	1	1	—	—	5	5	1	1	6	6	—	—
70	53	27	9	34	19	10	2	97	62	44	25	104	76	37	11

In our material from the Austrian Alps, the most frequent parasite of the common mole was the nematode *Spirura talpae*. Merkusheva (1963) found *S. talpae* in approximately 0.5% of specimens from the Belorussian S.S.R. Moles living in high altitudes are, evidently, more frequently attacked by biohelminths which require the presence of an intermediate host.

Morgeniella talpae, *Tricholinstowia linstowi*, *Capillaria talpae* appear to be distributed over the areas inhabited by *Talpa europaea*.

The trematode *Plagiorchis (Multiglandularis) macrobursatum* was found in altitudes up to 480 m above sea level in the Austrian Alps, the cestode *Rodentotaenia filamentosa* in areas from 480—1,125 m above sea level, the species *Spirura talpae*, *Morganiella talpae*, *Capillaria talpae*, *Parastrongyloides winchesi*, *Soboliphyme hirundiniformis*, *Julinea* sp., *Porrocaecum* sp. were distributed in areas up to 1,600 m above sea level. The only two species found at an altitude of 2,100 m above sea level, were *Spirura talpae* and *Morganiella talpae*.

The locality with the lowest incidence of infected specimens of *T. europaea* was Pack-Sattel. In this highly exploited agricultural area, the moles settled only temporarily on intensively cultivated meadows and pastures, and along the edge of spruce forests pastured occasionaly. A higher degree of parasitation was found in waterlogged areas near Pack-Stausee and Vellach. The incidence of helminth infection reached up to 55% along the edge of spruce cultures and ploughed moist meadows near Gesseldorfsee. An extremely high incidence of infection, close to or reaching a 100%, occured near Kremsbrücke,

lnnerkrems, Kleinsölk, and in the vicinity of the village Stein in the valley of the river Enns. Evidently, in these natural and relatively undisturbed areas, the diversity of species and their numbers are larger, and *T. europaea* feeding on these species, acquires infection more readily than in areas disturbed by man-made activity in which both the diversity and number of species on which the mole feeds are lower. This confirms the rule laid down by Prokopič (1972). the number of species attacking a host is bigger in less disturbed biogeocenoses with optimal conditions, than in disturbed biogeocenoses.

Reproduction of *Talpa europaea* occurs once a year in central Europe (Grulich, 1959). Young individuals constituting approximately 70% of populations inhabiting the High Tatra Mts., the Beskydy and Jeseníky Mts, were found from the first days of June in the hunting tunnels of the mole (Grulich, 1969). The situation was similar in the Austrian Alps. The period of postnidal life (after changing from mother milk to adult food) has, evidently, a considerable effect on both the intensity and incidence of infection (Table 1). In samples from various populations of *T. europaea* from the Austrian Alps, young specimens feeding on adult food were present for 30 days only; adults. however, are known to fed on this food for 13 months at the minimum, 49 months at the maximum. Of the 10 subadult females examined, two specimens only were positive (20%), of the 27 subadult females, 9 specimens (33.3%) were positive, of the 34 adult females examined, 19 specimens (55.9%) were positive, of the 70 adult males examined, 53 specimens (75.7%) were positive.

This survey indicates that the incidence of helminth infection is very different in adult and subadult moles. Helminthological postmortem inspection of 104 adults of the common mole disclosed positivity in 76 cases (73.1%), while in the 37 subadult male and female specimens, positivity was found in 11 specimens only (29.7%).

A considerable difference in the incidence of infection was observed between males and females. Of the 97 adult and subadult males in our material from the Austrian Alps, 62 specimens, i.e , 63.9%, were positive, while of the 44 females (adults and subadults) 25 specimens only (56.8%) were positive. In our opinion, the higher incidence of infection in the male may be due to the fact (Grulich, 1967b) that the intake of food of the male is bigger than that of the female and, hence, the male ingests more infected individuals harbouring larval helminth stages. The average weight of the male is 17.1% higher than that of the female. This difference, stipulated by secondary sexual dimorphism. is reflected also in subadult males and females. Also the homing range of the males is wider that of the females, and they are considerably more mobile. These facts are reflected in the representation of the individual sexes in the catches. (Grulich, 1969).

The seasonal incidence of the individual helminth species could not be estimated from our material.

LITERATURE

Edelényi B , 1965: Saugwürmer in einheimischen Kleinsäugern II. *Ann. Hist Nat. Mus. Nat. Hung.*, **57** : 217—221.

Furmaga S., 1959: Internal parasites of the mole (Talpa europaea L.) in the Lublin environment. *Acta Parasitol. Pol.*, **7** : 203—214.

Genov T., E. Dimitrova, 1966: Km chelmintofaunata na nasekomojadnite bozajnici v Blgarija. *Izv. Centr. Chelm. Lab.*, 11 : 125—159.

Grulich I., 1959: Wühltätigkeit des Maulwurfs (Talpa europaea) in der ČSR. *Práce brněnské základny ČSAV*, 31/3—386/ : 157—216.

Grulich I., 1967a: Zur Methodik der Altersbestimmung des Maulwurfs (Talpa europaea L., m der Periode seiner selbstständiger Lebensweise. *Zool. listy*, 16 : 41—59.

Grulich I., 1967b: Die Variabilität der taxonomischen Merkmale des Maulwurfs (T. europaea L., Insectivora) im Zusammenhang mit Alter und Geschlecht. *Zool. listy*, 16 : 125—144.

Grulich I., 1969: Kritische Populationsanalyse von Talpa europaea L., aus den West-Karpaten Mammalia). *Přírodovědné práce ústavů ČSAV v Brně*, III. N. S., (4) : 1—54.

Grygorev P. P., 1963: Nekotoryje endo- i ektoparazity krotov v Belorusii. *Izv. AN BSSR ser. biol.*, 3 : 121—124.

Chiriac E., M. Hamar, 1966: Contribution à la connaissance des helminthes des petits mamifères (Rongeurs et Insectivores) de la Roumanie. *Acta Parasit. Polon.*, 14 : 61—72.

Jančev J., 1965: Izučvanija varchu chelmintofaunata na grizačite i nasekomojadnite bozajnici v Trakija. *Izv. BAN*: 51—81.

Lukasiak J., 1939: Badania nad fauna helmintologiczna Polski. *Fragm. faun. Zool. Pol.*, 4 : : 93—106.

Karasev N. F., 1966: Gelminty mlekopitajuščich Berezinskovo zapovednika. Autoref.

Macaberidze G. V., 1967: Materialy k izučeniju gelmintofauny nasekomojadnych vostočnoj Gruzii. *Mecniereba*: 59—71.

Morgan D. O., 1928a: Parastrongyloides winchesi gen. et sp. nov. A remarkable new Nematode parasite of the mole and the shrew. *J. Helminth,*, 6 : 79—86.

Morgan D. O., 1928b: A new nematode species of the genus Viania from the mole (Talpa europaea) *J. Helmith.*, 6 : 199—204.

Morozov J. F., 1957: K gelmintofauně krotov Gorkovskoj oblasti. *Uč. zap. Gorkovs. Gos. ped. in-ta im. Gorkogo*, 19 : 27—29.

Morozov J. F., 1958: Materialy po gelmintofaune gryzunov i nasekomojadnych Bialowežskoj pušči (Materials of the helminth fauna of rodents and insectivores of the Bialoweža Reservation). *Tr. zap. ochot. choz. Belowežskaja pušča*, 1 : 151—175 (in Russian).

Mustafajev J. Š., 1967: Gelmintofauna nasekomojadnych, zajceobraznych i gryzunov centralnogo sektora euroazijskoj subarktiki. (Helminth fauna of Insectivora, Lagomorpha and Rodentia from the central parts of the Euro- Asian Subarctic). Autoref. Kanad. Diss. 27 pp, (in Russian).

Osche G., 1955: Über Entwicklung, Zwischenwirt und Bau von Porrocaecum talpae, Porrocaecum ensicaudatum und Habronema mansioni (Nematoda) *Z. Parasitenkunde*, 17 (8) : 114 bis 164.

Petrov A. M., A. N. Čertkova, 1959: K izučeniju gelmintofauny krotov v SSSR. *Tr. VIGIS*, 6 : 167—176.

Petrov A. M., V. A. Savinov, 1956: Gelmintofauna krotov Vologodskoj oblasti. *Sb. rabot Vologd. naučnoissled. opyt. stancii*, 3 : 107—115.

Petrov A. M., V. A. Savinov, 1959: K gelmintofaune krotov (Talpa europaea L.) Kalininskoj oblasti. *Tr. VIGIS*, 6 : 160—166.

Prokopič J., 1957: Systematické zpracování cizopasných červů krtka obecného a srovnání invase cizopasných červů u jednotlivých rodů hmyzožravců na území ČSR. *Zool. listy*, 6 : : 331—340.

Prokopič J., 1959: Cizopasní červi našich hmyzožravců. *Čs. Parasitologie*, 7 (2) : 87—134.

Prokopič J., I. Genov, 1974: Distribution of helminths of micromamals (Insectivora and Rodentia) under different ecological and geographical conditions Studie ČSAV 9 : 1—159.

Prokopič J., I. Genov, J. Jančev, I. Karapčanski, 1974: Ekologičeski analis na chelmintofaunata na drebni bozojnici v različni biotopi z različni rajoni na Evropa. *Izv. BAN*, 17 : 119—144.

The plates (Figs. 4, 5, 6) will be found at the end of this issue.

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GENETIC ANALYSIS OF RESISTANCE FACTORS IN A WILD STRAIN OF THE HOUSE FLY (MUSCA DOMESTICA) RESISTANT TO DDT AND SOME ORGANO-PHOSPHOROUS INSECTICIDES

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Abstract: A genetic analysis of resistance factors was made in a DDT and organophosphate resistant strain of the house fly captured in Czechoslovakia in 1973. The resistance to DDT was strongly synergized by Warf-antiresistant and F-DMC, and mildly by sesamex and TBTP. Resistance to trichlorfon was largely reduced by sesamex and removed by TBTP. Resistance factors were determined only on chromosome II and III. On chromosome III the factor allelic with gene Pen was present, enhancig in the interaction the effects of the factors on chromosome II. On chromosome II the gene DDT-asa present which cause the greatest part of resistance to DDT and least two factors for resistance to organophosphates. These factors can be separated by a crossover process of which one is synergized by sesamex and the other by TBTP. Both contribute to a certain extent to DDT resistance.

Resistance to organophosphates in the house fly was ascertained in Czechoslovakia in 1973 in an area where Nexion (active substance bromophos-ethyl) had been used for a number of years (Rupeš and Pinterová, 1973). Of the strains captured in this area the greatest resistance was found in the strain O which was also a considerable resistant to analogues of juvenile hormones (Rupeš, Žďárek, Švandová, Pinterová, 1975) and whose genetic analysis of resistance factors is presented.

MATERIAL AND METHODS

Strains of house fly used: the resistant wild strain O, captured in a relatively isolated locality not far from Brno in January 1973. For the last four years before its capture Nexion had been used for its control. In the laboratory it was not selected, genetical experiments were started in the generation F_5 and resistance of the strain O remained unchanged from the beginning until the end of the experiments.

The susceptible multimarker strain ac; ar; bwb; ocra (designated below as aabo) with recessive morphological markers upen chromosome I, II, III and V. The strain had been received from Prof. Milani, University of Pavia, Italy.

The larvae of the flies were cultivated on a medium composed of dried yeast, dried milk, agar and water (Sawicki, 1964). Adults 3—10 days of age, fed an sugar at a temperature of 26° C, were used for the experiments. Insecticides and synegists were applied topically under ether anesthesic, in an amount of 1 µl acetone solution. Synergists were applied 0.5—2 hours before the application of insecticide on the abdomen tip. The insecticides were applied on the dorsal thorax. Mortahty was read after 24 hours, the experiment with each concentration was repeated 2—4 times, always with 15 individuals.

LD_{50} and LD_{90} values were estimated by the graphic probit analysis according to Lichtfield and Wilcoxon (ex Roth, Josífko, Malý, Trčka, 1962).

The following insecticides were used: pp'-DDT (designated below as DDT, recrystallized from, alcohol, produced by Spolana Neratovice), trichlorfon (produced by Spolana, Neratovice),
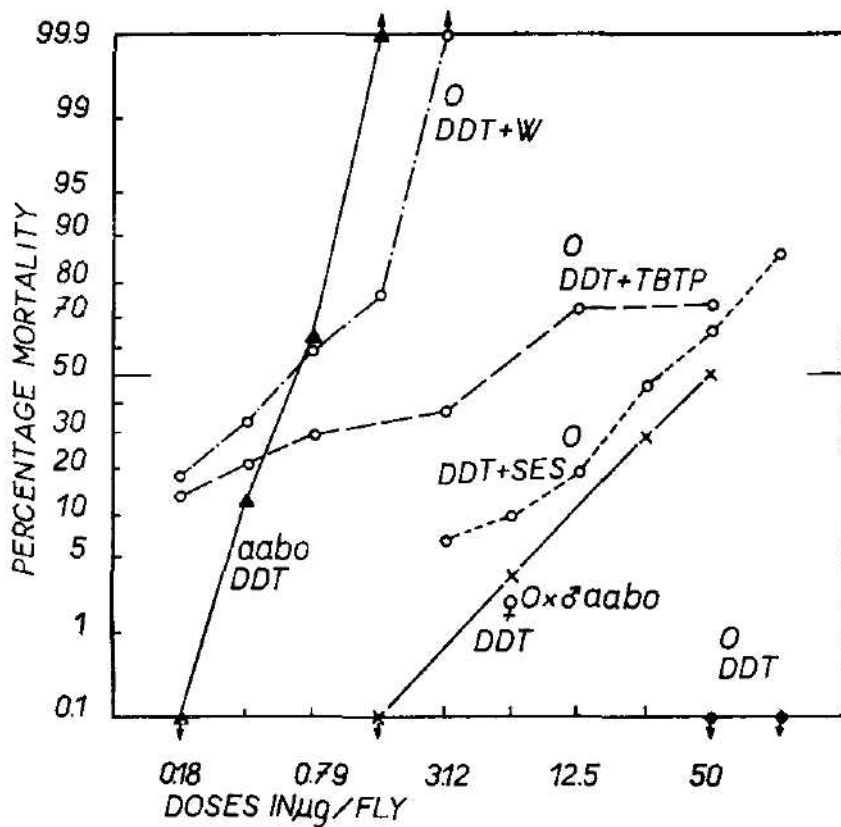
Fig. 1. Mortality lines of females of strain O after treatment with DDT alone and with DDT and synergists. (W = WARF-antiresistant in a dose of 5 µg/fly, SES — sesamex in a dose of 2 µg/fly, TBTP in a dose of 1.25 µg/fly).

bromophos-ethyl (Cela, Ingelheim), fenitrothion (Chemical Plants J. Dimitrov in Bratislava), dichlorvos (Bayer), dimethoate (Germet, GDR), fenitroxon, TBTO (= tributhyltinoxide). TBTA (= tributhyltinacetate), as well as the following synegists: WARF-antiresistant (= N,N--di-n-buthyl-chlorobenzenesulphonamide), F-DMC (= bis -(p-chlorophenyltrifluoromethyl carbinol), TBTP (= S,S,S-tributhyl phosphorotrithionate) and sesamex. Except DDT, all substances were used without further purification and treatment.

In the mass cresses 100 virgin females and the same number of males were used, for single pair crossing the modified method described by Sawicki and Fernham (1968) was used.

RESULTS

Resistance of strain O to various insecticides is presented in Table 1 and to DDT in Fig. 1. Sesamex reduced substantially resistance to trichlorfon and to DDT, and eliminated it entirely to fenitroxon. WARF-antiresistant eliminated almost completely the resistance to DDT, TBTP removed resistance to trichlorfon and reduced it considerably to DDT.

Resistance to DDT and to bromophos-ethyl of F_1 generation reciprocal crosses O × aabo was very similar. Table 5 and fig. 1 demonstrate the re-

Tab. 1. Insecticide resistance in strain 0

insecticide synergist	Sex	Susceptibility of strain aabo		Factor of resistance*** of strain 0 at	
		LD_{50} in µg/fly	LD_{90} in µg/fly	LD_{50}	LD_{90}
bromophos-ethyl	♀	0.019	0.063	60	74
	♂	0.006	0.015	55	65
trichlorfon	♀	0.12	0.20	75	85
	♂	0.06	0.084	125	167
trichlorfon + sesamex*	♀	—	—	14	13
	♂	—	—	13	14
trichlorfon + TBTP**	♀	—	—	< 0.1	< 0.1
	♂	—	—	< 0.1	< 0.1
fenitrothion	♀	0.042	0.06	18	22
	♂	0.015	0.032	19	23
fenitroxon	♀	0.19	0.6	13	15
	♂	0.12	0.26	10	17
fenitroxon + sesamex*	♀	—	—	0.5	1
	♂	—	—	0.5	0.6
dichlorvos	♀	0.0005	0.0014	19	22
	♂	0.0004	0.0045	8	17
dimethoate	♀	0.004	0.008	8	10
	♂	0.0012	0.0028	7	10

* sesamex in dose of 2 µg/fly
** TBTP in dose of 1.25 µg/fly
*** factors of reistance were estimated by relating to susceptible aabo strain in all tables

sistance of the offsprings of the coss ♀ O × ♂ aabo which may be regarded as intermediary.

In the females and males of the offsprings of the back-cross ♀ aabo × × ♂ (♂O × ♀ aabo) all markers were at expected frequency, indicating normal segregation and the absence of the M (III) factor. Similar segregation was observed in the offsprings ♀ aabo × ♂ (♀O × ♂ aabo). From this progeny,

Tab. 2. Susceptibility (in µg/fly) of females of substrain O—I and O—V

Insecticide	O—I		O—V	
	LD_{50}	LD_{90}	LD_{50}	LD_{90}
bromophos-ethyl	0.017	0.022	0.017	0.024
trichlorfon	0.007	0.017	0.08	0.11
fenitrothion	—	—	0.007	0.017
DDT	0.18	0.39	0.07	0.13

Tab. 3. Susceptibility (in µg/fly) and resistance in substrain O—II

| Insecticide | Sex | Insecticide alone | | factors of resistance at | | Pretreatment with | | | |
| | | | | | | sesamex* | | TBTP** | |
		LD_{50}	LD_{90}	LD_{50}	LD_{90}	LD_{50}	LD_{90}	LD_{50}	LD_{90}
bromophos-ethyl	♀	0 6	1 1	30	18	0.73	1 4	0.012	0.022
	♂	0.3	0 6	50	40	0.37	0.8	0 004	0.007
trichlorfon	♀	1 6	3 7	12	19	0 023	0 06	0 005	0.012
	♂	1.3	2 7	21	30	0 011	0 03	0 003	0.008
fenitrothion	♀	0 39	0 9	9	15	—	—	0 012	0 023
	♂	0.09	0.5	6	15	—	—	0.005	0.011

* sesamex in dose of 2 µg/fly
** TBTP in dose of 1.25 µg/fly

using the process described by Sawicki and Farnham (1969), 4 types of substrains were raised each, of which carried in the homozygous stage only one autosome of strain O, whereas the other autosomes were derived from the susceptible strain aabo. Chromosome IV was disregarded in this connection.

The susceptibility of the substrain carrying the homozygous stage chromosome I of strain O, designated O-I, was very similar to or higher than the susceptibility of the strain aabo (Tab. 2) from which it may be assumed that chromosome I does not carry resistance factors.

The situation was similar in the substrain O-V, carrying in the homozygous stage chromosome V. This chromosome, too, has no resistance factors which was borne out by fact that the progeny of the phenotype ac; ar; bwb crossing ♀ aabo × ♂ (♀ O × ♂ aabo) was massreared for three following generation whereby individuals of ocra were eliminated in each generation. The susceptibility of the flies ocra[+] of all three generations resembled closely that of the substrain O-V and the mortality line was straight. Mortality O-100% was

Tab. 4. Susceptibility (in µg/flx) and resistance of substrain O—III

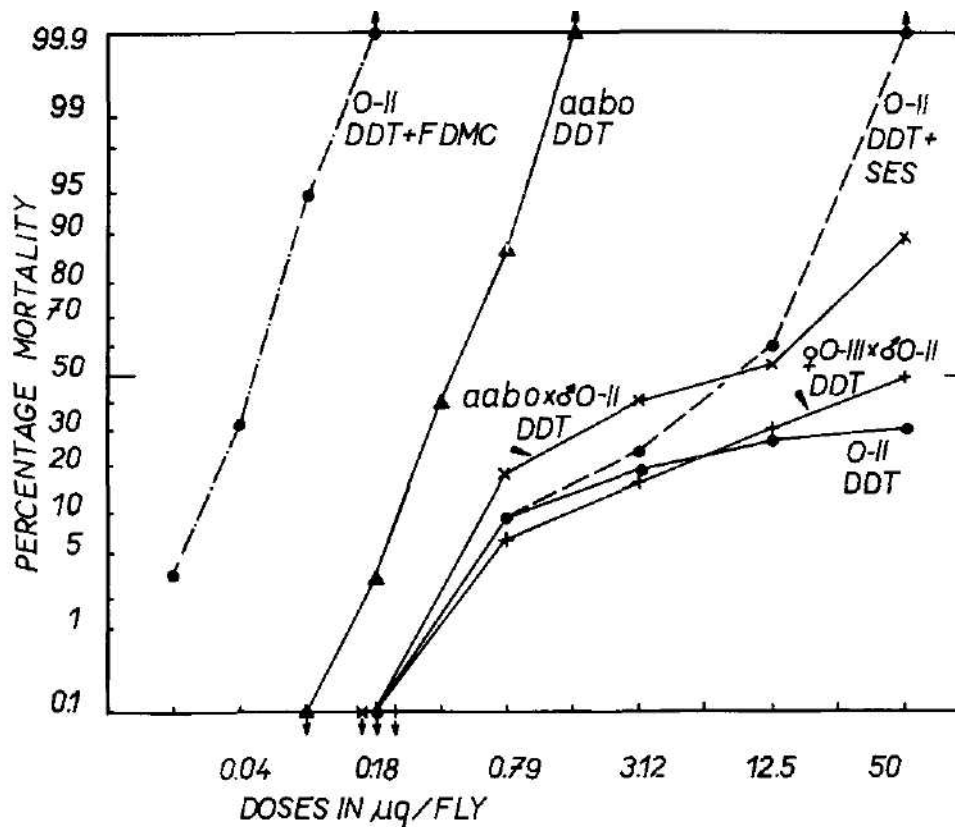| Insecticides | Sex | LD_{50} | LD_{90} | Factor of resistance at | |
				LD_{50}	LD_{90}
bromophos-ethyl	♀	0.03	0.052	1.6	0.8
	♂	0.018	0.025	3	1 6
trichlorfon	♀	0.026	0.042	< 0.5	< 0.5
	♂	0.011	0 020	< 0.5	< 0.5
fenitrothion	♀	0.011	0.018	< 0.5	< 0.5
	♂	0.01	0.017	0.6	0.5
DDT	♀	0.14	0.26	< 0.5	< 0.5
	♂	0.034	0.08	< 0.5	< 0 5

Fig. 2. Mortality lines of females of substrain O-II and progeny from cross O-II with aabo and with O-III after treatment with DDT alone and DDT with sesamex and F-DMC. (SES = sesamex in a dose of 2 µg/fly, F-DMC in a dose of 0.625 µg/fly.)

caused by doses of 0.005—0.035 µg/fly of bromophos-ethyl, 0.002-0.039 µg/fly of trichlorfon and 0.04-1.56 µg/fly of DDT.

We further reared 2 substrains carrying in the homozygous stage chromosome II of strain O. Their susceptibility to bromophos ethyl and to DDT was very much alike, the more fertile substrain was selected for further experiments and designated O-II. LD_{50} and LD_{90} values of the second substrain for bromphos-ethyl were 0.56 and 1.3 µg/fly for the female and 0.36 and 0.72 µg/fly for the male.

Table 3 shows the resistance of the substrain O-II to organophosphates. In no case did their level of resistance achieve the value of strain O, the difference was largest at fenitrothion. TBTP eliminated completely resistance to all organophosphates tested, sesamex suppressed it entirely to trichlorfon, but was inffective to bromophos-ethyl.

Resistance to DDT was also lower than in strain O and was completely eliminated by F-DMC. Sesamex increased substantially the steepness of the mortality lines. The situation in females is illustrated in Fig. 2, in males the

132

Tab. 5. Susceptibility (in µg/fly) and resistance in crosses of O × aabo, O–II × aabo, O–III × O–II and O–III × O–V.

Cross backcross	Sex	bromophos-ethyl		factors of resistance at		Trichlorfon		factors of resistance at	
		LD_{50}	LD_{90}	LD_{50}	LD_{90}	LD_{50}	LD_{90}	LD_{50}	LD_{90}
♀ O × ♂ aabo	♀	0.6	1.3	31	21	—	—		
	♂	0.31	0.7	51	46	—	—		
♀ O–II × ♂ aabo	♀	0.26	0.78	13	12	0.16	0.45	1.3	2.2
	♂	0.14	0.22	23	14	—	—		
♀ aabo × ♂ (♀ aabo × ♂ O–II)	♀ar⁺	0.29	0.66	15	15	—	—		
	♀ar	0.02	0.1	1	1.6	—	—		
♀ aabo × ♂ O–II	♀	0.23	0.75	12	12	0.14	0.37	1.1	1.6
♀ O–III × ♂ O–II	♀	0.46	1.1	24	17	1.1	2.5	10	15
	♂	0.32	0.63	53	42	—	—		
♀ O–II × ♂ O–V	♀	0.020	0.055	1.2	0.9	0.036	0.043	0.5	0.5

results were similar. All these results indicate the presence of a further resistance factor on chromosome III.

The substrain O-III carrying chromosome III of strain O in the homozygous stage was maderately resistant to bromophos-ethyl and DDT, however, not to trichlorfon and fenitrothion (Table 4).

In the progeny of reciprocal crosses O-II × aabo resistance to bromophos-ethyl was intermediary, to trichlorfon recessive. (Table 5). Resistance to DDT was almost dominant (Fig. 2). In the progeny of the back cross ♀ aabo × ♂ (♀ aabo × ♂ O-II) only the individuals ar⁺ were resistant to bromophos ethyl and DDT, the flies ar were susceptible (in Table 5 and Fig. 3 only females are given). On the other hand the mortality line of females ar from the back cross ♀ (♀ aabo × ♂ O-II) × ♂ aabo showed at the application of DDT a distinct plateau in mortality of 80% between doses of 0.18–3.12 µg/fly.

Tab. 6. Resistance of females to TBTO and TBTA

Strain substrain cross	TBTO factors of resistance at*		TBTA factors of resistance a**	
	LD_{50}	LD_{90}	LD_{50}	LD_{90}
O	2.7	4.5	1.8	2.7
O–II	1.4	1.6	—	—
O–III	1.7	2.2		1.1
♀ O–II × ♂ O–III	1.7	2.2	—	—

* LD_{50} and LD_{90} for females of aabo (in µg/fly) 0.3 and 0.4 respectively
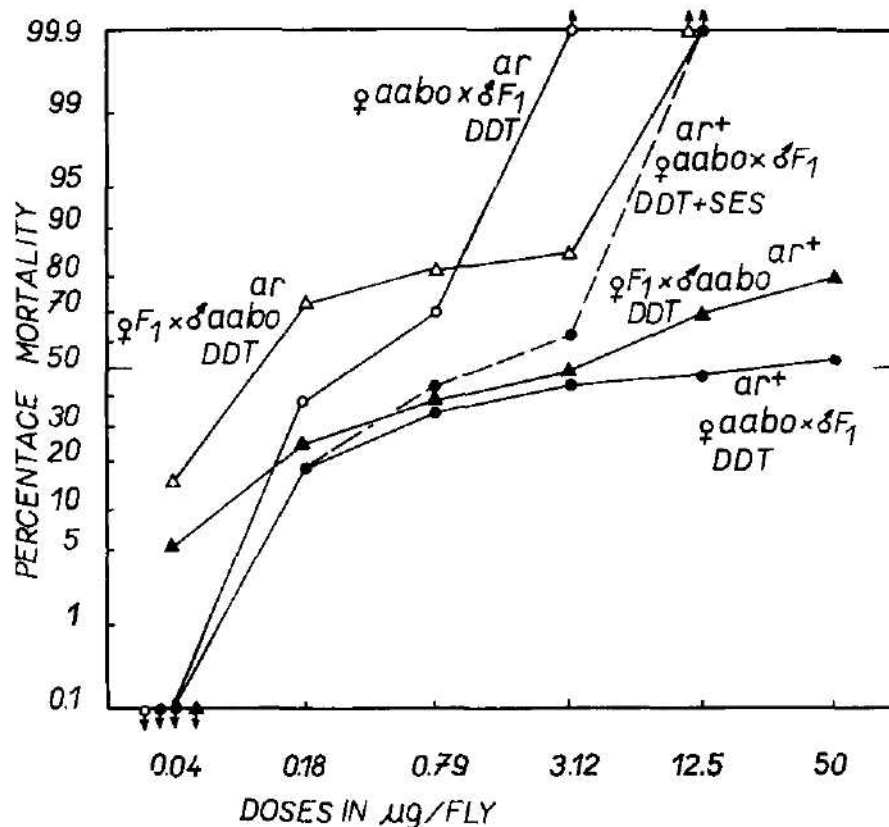** LD_{50} and LD_{90} for females of aabo (in µg/fly) 0.5 and 0.9 respectively

Fig. 3. Mortality lines of females ar and ar+ of reciprocal crosses (♀ O-II × ♂ aabo) × aabo after treatment with DDT alone and DDT with sesamex. (SES = sesamex in a dose of 2 µg/fly)

In females ar+ the mortality rate was higher than in females of the F₁ generation from cross O-II × aabo. This indicates a 20% crossing over between resistance factors to DDT and the marker ar (Fig. 3).

In the F₁ generation of the cross ♀ O-III × ♂ O-II the interaction of factors of chromosome II and III in the heterozygous stage manifested itself distinctly in an increased resistance to all insecticides tested (Table 5, Fig. 2.). The F₁ generation of cross ♀ O III × ♂ O-V was not resistant to the insecticides tested (Table 5 only. bromphos-ethyl and trichlorfon are given).

Since results indicated the presence of gene Pen (Sawicki, Farnham, 1969) on chromosome III, susceptibility to TBTO and TBTA was tested (Table 6). Resistance of strain O to both chemicals was weak and was enhanced by factors of chromosome II and III.

In another experiment the adults of ar from cross ♀ (♀ aabo × ♂ O-II) × × ♂ aabo were selected by a dose of bromophos-ethyl which induced a 100% mortality in flies of strain aabo. Females were applied a dose of 0.3 µg/fly, males 0.15 µg/fly. Less than 10% males and females survived the selection. Of 7 pairs formed only one was fertille. Its offspring, substrain 3, tested from the F₄ generation showed almost an identical resistance to bromophos-ethyl as the substrain O-II, while susceptibility to DDT and trichlorfon resembled

134

closely the susceptibility of the strain aabo. Thus it is probable that the cross over process separated resistance factors to DDT and trichlorfon from resistance to bromophos (Fig. 4 and 5).

DISCUSSION

From the above results follows that in the wild strain O the factors of resistance to insecticides are on chromosome II and III. Upon chromosome III is probably factor alelic gene Pen (= Organotin-R) (Sawicki, Farnham,
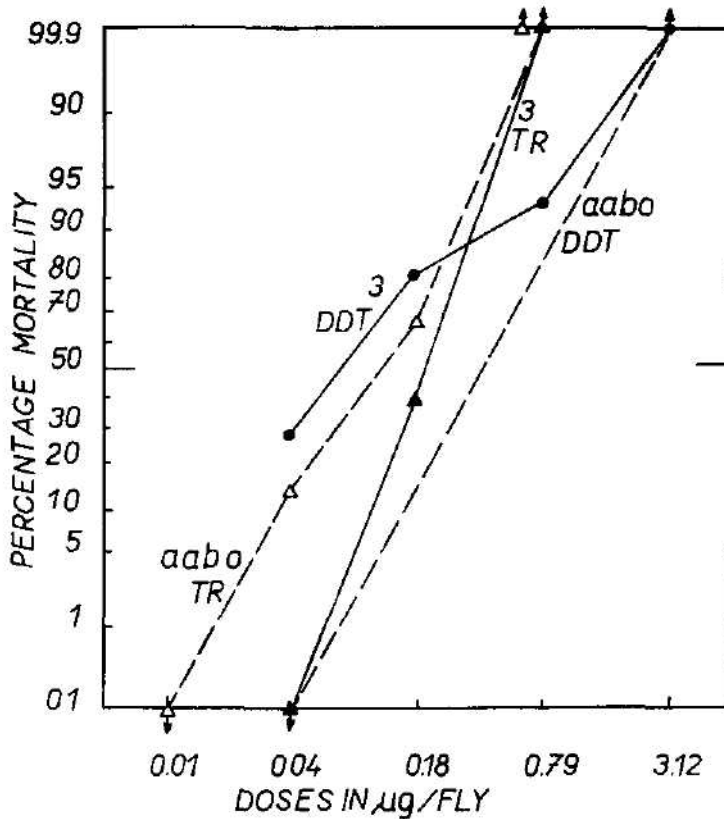
Fig. 4. Mortality lines of females of substrain 3 (for detailes see text) after treatment with DDT and trichlorfon (TR = trichlorfon).

1969; Hoyer, Plapp, 1968) which in itself induces weak resistance to bromophos-ethyl and to TBTO, but not to DDT, trichlorfon and TBTA. It manifests itself more clearly in the interaction with the other factors, even in the case of insecticides to which it does not induce resistance by itself.

On chromosome II the situation is more complicated. Apparently the gene DDT-ase for dehydrochlorinase of DDT present, being responsible for the greater part of resistance to DDT. Its persistence in the population which at least for four years had not been contreled with DDT, is remarkable.
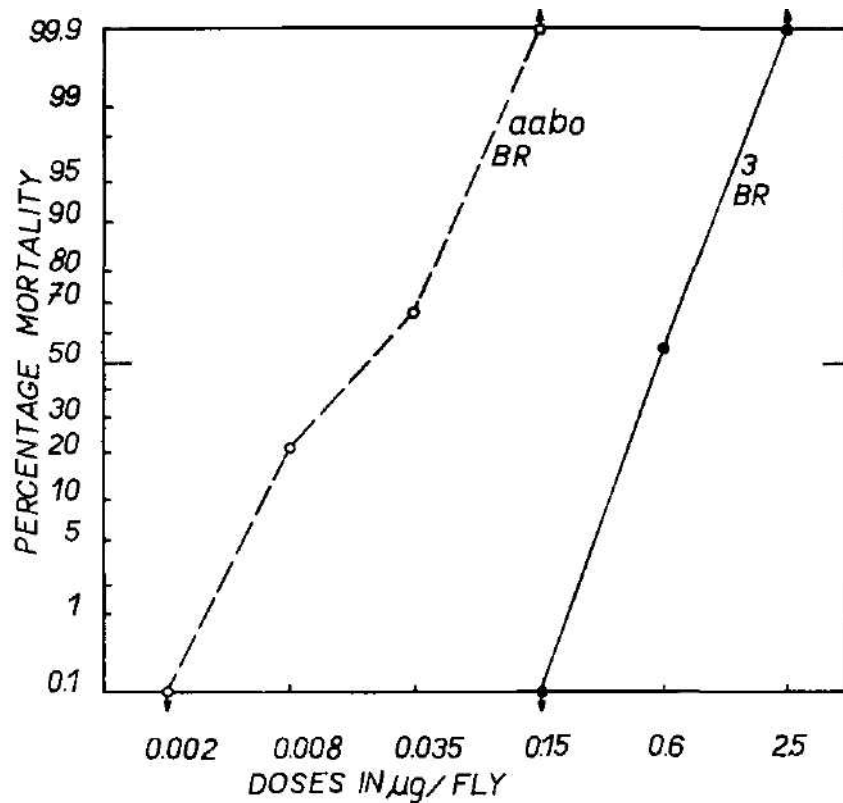
135

Fig. 5. Mortality lines of females of substrain 3 (for details see text) after tretment with bromo-phos-ethyl (BR = bromophos-ethyl)

At least two factors present account for resistance to organophosphorous insecticides that can be separated by a crossover process of which one, synergized by sesamex, is probably the gene Ox^2 (Khan et al., 1973). The apparent influence of sesamex on the resistance to DDT may be ascribed to a certain ability of the gene Ox^2 to induce resistance to this substance, too, or to unspecific effect of sesamex. TBTP synergizes, at least in strain SKA, the effects of the gene a (van Asperen, Openoorth, 1960) as the effects of gene g (Oppenoorth et al., 1972) for glutathion transferase (Lewis, Sawicki, 1972). On the basis of the experiments it cannot be desided which of the two genes is present, or exclude the presence of both. The substantial effect of TBTP on the resistance of strain O to DDT indicates the participation of glutathion-dependet water soluble enzymes for the degradation of organophosphates on resistance to DDT, as stated by Motoyama and Dauterman (1974).

Resistance to trichlorfon in strain O and substrain O-II is more strongly synergized by TBTP than by sesamex. Resistance to bromophos-ethyl is synergized to a lesser degree by TBTP than resistance to trichlorfon. At the same time resistance to bromophos-ethyl is intermediary in the heterozygous

136

stage, while to trichlorfon it is almost recessive. This can be interpreted to the effect that resistance to bromophos, i.e. a substance with selected resistance, is caused by at least two factors which interact in the heterozygous stage. Resistance to trichlorfon is, at least to a greater extent, caused by only of these factors, the effect of which is eliminated by TBTP. The simultaneous separation of resistance to DDT and to trichlorfon may be explained by the localisation of both factors on the chromosome.

It was not possible to make a more detailed study of individual factors due to the relatively low resistance and to the considerable overlapping of the mortality curves. The results show the state of resistance factors at a time when, as a consequence of resistance, the insecticide used ceased to be effective in field applications.

LITERATURE

Asperen van K., F. J. Oppenoorth, 1960: The interaction between organophosphorus insecticides and esterases in homogenates of organophosphorus susceptible and resistant houseflies. *Ent. Exp. Appl.*, 3 : 68—75.

Hoyer R. F., F. W. Plapp, 1968: Insectide resistance in the house fly: Identification of a gene that confers resistance to organotin insecticides and acts as an intensifier of parathion resistance. *J. econ. Entomol.*, 61 1269—1276.

Khan M., A., Q., R. I. Mirimoto, J. P. Bederka, J. M. Runels, 1973: Control of the microsomal mixed-function oxidase by Ox² and Ox⁵ genes in houseflies. *Biochem. Genetics*, 10 : : 243—252.

Lewis J. B., R. M. Sawicki, 1972: Characterization of the resistance mechanisms to diazinon, parathion and diazoxon in the organophosphorus-resistant SKA strain of house flies (Musca domestica L.). *Pesticide Biochem. Physiol.*, 1 : 275—285.

Motoyama N , W. C. Dauterman, 1974: The role of nonoxidative metabolism in organophosphorus resistance. *J. Agr. Food. Chem.*, 22 : 350—356.

Oppenoorth F. J., V. Rupeš, S. ElBashir, N. W. H. Houx, S. Voerman, 1972: Glutathione--dependent degradation of parathion and its significance for resistance in the housefly. *Pesticide Biochem. Physiol.*, 2 262—269.

Roth Z., K. Josífko, L. Malý, F. Trčka (1962): Statistické metody v experimentální medicině, Praha.

Rupeš V., J. Žďárek, E. Švandová, J. Pinterová, 1975: Cross-resistance to a juvenile hormone analogue in wild strains of the housefly. *Ent. Exp. Appl.*, (in press).

Sawicki R. M., 1964: Some general consideration on housefly rearing techniques. *Bull. Wld. Hlt. Org.*, 31 : 535—537.

Sawicki R. M., A. W. Farnham, 1968: Genetics of resistance to insecticides of the strain SKA of Musca domestica. III. Location and isolation of the factors of resistance to dieldrin *Ent. Exp. Appl.*, 11 : 133—142.

Sawicki R. M., A. W. Farnham, 1969: Examination of the isolated autosomes of the SKA strain of house-flies (Musca domestica L.) for resistance to several insecticides with and without pretreatment with sesamex and TBTP. *Bull. Ent. Appl*, 59 : 409—421.

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Bezirksmuseum Tachov

DER SEXUELLE DIMORPHISMUS UND DIE ABHÄNGIGKEIT DER RELATIVEN GRÖSSE DER PLASTISCHEN MERKMALE VON DER KÖRPERLÄNGE DER ELRITZE (PHOXINUS PHOXINUS — CYPRINIDAE) AN VERSCHIEDENEN ORTEN IHRES VERBREITUNGSAREALS

PAVEL ŘEPA

Eingegangen am 17. Februar 1975

In memoriam Doz. Dr. Walter Černý gewidmet

Abstrakt: Der Verfasser verglich bei 25 plastischen Merkmalen der Elritzen aus einigen europäischen Lokalitäten die Unterschiede zwischen den beiden Geschlechtern, und die Abhängigkeit ihrer relativen Grösse von der Körperlänge. Bei der Mehrzahl der untersuchten Merkmale wurden im sexuellen Dimorphismus und in der Tendenz der Änderungen der relativen Grösse an allen verfolgten Lokalitäten gleiche Unterschiede festgestellt. Der Verfasser ist der Meinung, dass bei einigen plastischen Merkmalen der Elritze eine gewisse geographische Variabilität der Abhängigkeit ihrer relativen Grösse von der Körperlänge vorhanden sei.

EINLEITUNG

Die Elritze weist bei einigen plastischen Merkmalen bedeutende Unterschiede zwischen den beiden Geschlechtern auf (Vladykov, 1927; Oliva, 1952; Lohniský, 1964). Bei der eingehenden Analyse von 25 plastischen Merkmalen der Elritze aus Südwestböhmen (Stromgebiet der Elbe) habe ich nachweisbare Unterschiede zwischen den Geschlechtern bei einer ganzen Reihe dieser Merkmale festgestellt (Řepa, 1970). Auch habe ich bei einzelnen Merkmalen eine Abhängigkeit ihrer relativen Grösse von der wachsenden Körperlänge registriert. Da es mir in den letzten Zeit möglich war die Messungen an einer ziemlich grossen Zahl der Elritzen aus verschiedenen Lokalitäten der ČSSR und an einer gewissen Menge dieser Fische aus weiteren europäischen Fundorten vorzunehmen, verfolgte ich die obenerwähnten Erscheinungen auch an diesem Komplex. Das Ziel der Arbeit war festzustellen, ob sich der sexuelle Dimorphismus und die Abhängigkeit der relativen Grösse der plastischen Merkmale von der Körperlänge immer auf gleiche Weise offenbart, oder ob in dieser Hinsicht bei den Elritzen aus verschiedenen Orten ihrer Verbreitungsareals Unterschiede vorhanden seien.

MATERIAL UND METHODIK

Es wurde folgendes Material verwendet:

Britische Inseln: 1 Ex. aus Fluss Severn in der Graftschaft Montgomery 1946, 6 Ex aus Llynbenguilin in Wales, 1864, 4 Ex aus Buchana-See, Pertshire, Schottland, 1925, 6 Ex. aus dem Fluss Roding in Essex 1971, 1 Ex. aus dem Fluss Wye, Gloucestershire 1960 (das gesamte Material stammt aus den Sammlungen des Britischen Museums London — weiter nur BML).

Spanien 3 Ex aus Pyrenäen (us den Sammlungen des Naturhistorischen Museums in Wien, weiter nur NMW, Kat Nr 51243), 3 Ex aus Arrigoriaga bei Bilbao (NMW Kat Nr 51270). Stromgebiet des Rheins 4 Ex aus Waiblingen, Würtemberg, 2 Ex. aus dem Fluss Main, 3 Ex. aus dem Rhein bei Strassburg (alles BML), 5 Ex aus dem Main (Sammlungen des Natur Museums und Forschungsinstitutes Senckennberg in Frankfurt M , weiter nur SMF - - Kat. Nr. 899), 4 Ex. aus Salzbach bei Salzwog (SMF 4824), 4 Ex , aus Horbach, Zieglertal 1959 (SMF 4825), 4 Ex. von Pirmasens, Rodalbe 1963 (SMF 6127), 1 Ex aus Horbach zw. Kaltenbech und Hauenstein 1963 (SMF 6128), 1 Ex aus Walhalbe, Kneipersmühle 1963 (SMF 6129), 3 Ex. aus Gaisbach bei Schonau 1963 (SMF 6130), 2 Ex. aus Wieslauter bei Bruchweiler 1963 (SMF 6130)

Stromgebiet der Weser 38 juv Ex. aus der Edertalsperre 1963 (SMF 6644 u 6647).

Stromgebiet der Elbe· 180 Ex aus dem Fluss Mže bei Tachov (die Ergebnisse aus der Arbeit Řepa 1970 übernommen)

Stromgebiet der Donau 84 Ex aus dem Fluss Kysuca (Zufluss der Waag) 1957 (aus den Sammlungen des Nationalmuseums in Bratislava, weiter nur NMB Kat. Nr. 720 u 721)

42 Ex aus dem Fluss Bečva (Zufluss der March) 1957, 1958, 1960 (aus den Sammlungen des Mährischen Museums in Brno, weiter jen MMB, Kat Nr 704, 840A, 844A, 1244A). 75 Ex aus dem Bach Javsanský (Zufluss der Theiss) 1960 (NMB 1421).

Stromgebiet der Weichsel. 80 Ex aus dem Fluss Poprad 1958, 1959 MMB 985A, 1027, 1034, 1088A)

Skandinavien 3 Ex aus dem Fluss Iwald (Finnland), 6 Ex aus dem Wenern-See (Schweden), 3 Ex aus Glomia (Norwegen alles aus BML).

Zur Bewertung habe ich das Material in einige Gruppen aufgeteilt Zumeist bewertete ich zusammen das Material aus dem Stromgebiet eines Flusses (des Rheins, der Elbe, der Weichsel, der Weser) Material aus dem Donaugebiet war zahlenmässig so umfangreich, dass ich die Komplexe aus den Zuflussen der Waag, der March und der Theiss getrennt bewerten musste. Dagegen war ich bei dem Material aus den Britischen Inseln, Spanien und Skandinavien, infolge der kleinen Anzahl der vorhandenen Exemplare gezwungen, das gesamte Material aus grossen Gebieten zusammen zu bewerten Daher rechne ich bei Bewertung auch mit der Tatsache, dass das Material nicht gleich homogen ist

Bei den Messungen habe ich dasselbe System angewendet wie in meiner vorherigen Arbeit (Řepa, 1970) Es wurden folgende Ausmasse festgestellt·

Longitudo corporis (weiter nur 1), longitudo capitis (lc), distantia praeanalis (dA), dist praedorsalis (dD), dist praeventralis (dV), altitudo corporis (acr), latitudo corporis (lacr), minima altitudo corporis (mac), long pedunculi caudae (lpc), alt pedunculi caudae (apc) dist. pareorbitalis (dO), dist postorbitalis (dpO), dist interorbitalis (diO), diameter oculi (doc), dist, praenasalis (dN), dist internasalis (diN), alt capitis (ac), lat capitis (lac), long maxillae (lmax). long pinnae dorsalis (lD), long pinnae analis (lA), alt pinnae dorsalis (aD), alt pinnae analis (aA), long pinnae pectoralis (lP), long pinnae ventralis (lV), distantia inter P et V (P-V), dist inter V et A (V A)

Die Unterschiede wurden mittels t-Tests (Turček, 1956) und des CD Koeffizientes (Hubbs, Hubbs, 1953) ausgewertet Als genügend unterschiedlich wurden die Werte $CD \geq 1$ genommen, die ich als „nachweisbar" bezeichne

Danksagung

ERGEBNISSE

A. Die Abhangigkeit der relativen Grösse der plastischen Merkmale von der wachsenden Körperlänge

An allen Proben des Materials habe ich zuerst für ein jedes Merkmal dessen Abhangigkeit von der wachsenden Körperlange nachgepruft. Für

Tab. 1. Die Tendenz der Änderungen der relativen Grösse der plastischen Merkmale in Abhängigkeit von der Körperlänge bei den Elritzenaus verschiedenen Orten ihres Verbreitungsareals

Lokalität	Brit. Inseln	Rhein	Weser	Weser+Rhein+Ems	Elbe	Elbe	Elbe	Oder	Oder	Skandinavien	Donau	Marcha	Waag	Theiss	Weichsel
Verfasser	eigene Ergebnisse	eigene Ergebnisse	Weser	Tack 1943	eigene Ergebn.	Lohnus-ký 1964	Tuček 1964	Lohnus-ký 1964	Tuček 1964	eigene Ergebn.	Tuček 1964		eigene Ergebnisse		
Zahl der Ex.	5+13	22+18	24+12	569	105+70	5+12	97	25+56	85	5+7	9?	15+27	29+44	34+43	31+44
lacr v %	-?	??	+?	?	+?					-?	??	??	??	++	++
mac v % lpo	-+	-+	+?		-?	++	?	++	?	??	?+	?+	++	+++	+?
ape v % lpe	++	++	+?		??					??		-+?	++?	++	??
dO v % le	+?	++	++	+	??	++				-+		-++	++?	+++	++?
dpO v % le	?	-?	??		??					++		??	?+	+++	-+
ao v % le	??	??	++		++	++				++		??	?-+	+++	??
lac v % le	-?	-?	-?	-	+-?					+?		++	+-+	??	??
lc v % l	+?	--	--		--	--				--		??	?-	?-?	--
dV v % l	-?	??	-?	?	??					-?		-+	?-?	++?	??
doe v % le	--	--	--	-	--			I		--	I	--	--	--	-?
diN v % le	--	--	??	-	??		I		I	+?		??	??	??	-+
la V % l	--	-?	-?		??					??		??	-?	??	-?
aA v % l	--	-?	-?		-?					-?		-?	-?	-?	+?
lC v % l	-?	-?	??		??					+?		??	?-	??	?-
dN v % le	+?	+?	??	+	??					+?		??	??	??	?-+
lD v % l	-?	?+	??		??					??		??	??	??	??
aD v % l	?-	??	+?		??					??	-	?-	-?	-?	-?
IP v % P-V	+-	-?	+++	+	??	??		??		???		-?	-?	?-?	-?
IV v % V-A	++	??	+?		??	??		??		??	-?	??	-?	??	?-
lA v % l	?-	+?	-?	++	--					+?		?+	-+?	++-	?-+
dD v % l	??	-?	??	+	-?	++				?-+		-?	-+?	-?	++?
diO v % le	?+	--	-?	-	??					+?		??	-+?	-?	++?
lpe v % l	++	??	?+	++	???		?	+		++	++	-+	-+	-?	-?
lmax v % le	-+	++	??	+	--	++	+		+?	--		+?	??	??	--
acr v % l	-?	??	-?	+	-?		?		?	-?	+?	?+	?-+	-+	-+

Erklärungen: Bei der Zahl der Exemplare bedeutet die erste Nummer Männchen, die zweite Weibchen; ebenfalls das erste Zeichen ist für Männchen, das zweite für Weibchen.
+ = relative Grösse mit wachsender Körperlänge steigend
— = relative Grösse mit wachsender Körperlänge sinkend
? = relative Grösse von wachsender Körperlänge unabhängig

Tab 2 Nachprüfung der Unterschiede zwischen den Durchschnittswerten einzelner Merkmale bei den kleineren und grösseren Elritzen mit Hilfe des Koeffizients CD.

Merkmal	Verfolgtes Stromgebiet	Männchen verfolgte Längenkategorien		Weibchen verfolgte Längenkategorien	Koef. CD
le v % l	Elbe	50—55 × 65—70	0,14	50—55 × 65—70	0,66
dA v % l	Elbe	50—55 × 65—70	0,06	50—55 × 65—70	0,59
	Theiss	40—50 × 60—70	0,68	30—40 × 60—70	0,75
dD v % l	Elbe	50—55 × 65—70	0,87	50—55 × 65—70	0,51
	Theiss	40—50 × 60—70	0,30	30—40 × 60—70	0,55
dV v % l	Elbe	50—55 × 60—70	0,22	50—55 × 65—70	0,44
acr v % l	Elbe	50—55 × 65—70	0,37	50—55 × 65—70	0,38
lacr v % l	Elbe	50—55 × 65—70	0,21	50—55 × 65—70	0,34
lpc v % l	Theiss	40—50 × 60—70	0,12	30—40 × 60—70	1,34
apc v % lpc	Theiss	50—60 × 60—70	0,58	40—50 × 60—70	1,06
mac v % lpc	Theiss	50—60 × 60—70	0,52	40—50 × 60—70	0,50
dO v % le	Elbe	55—60 × 65—70	0,45	55—60 × 65—70	0,12
dpO v % le	Waag	55—60 × 65—70	0,28	55—60 × 65—70	1,98
doc v % le	Theiss	50—60 × 60—70	0,25	40—50 × 60—70	0,22
dlO v % le	Elbe	50—55 × 65—70	0,57	55—60 × 65—70	0,44
	Theiss	50—60 × 60—70	0,43	40—50 × 60—70	0,32
dN v % le	Elbe	50—60 × 65—70	0,28	55—60 × 65—70	0,39
dlN v % le	Weichsel	50—60 × 60—70	0,15	60—70 × 70—80	0,27
ac v % le	Elbe	50—55 × 65—70	0,10	50—55 × 65—70	0,76
lac v % le	Theiss	50—60 × 60—70	0,33	50—60 × 70—80	0,33
lmax v % le	Rhein	40—50 × 60—70	0,65	50—60 × 60—70	0,88
	Weichsel	50—60 × 60—70	0,47	50—60 × 70—80	0,47
lD v % l	Elbe	50—55 × 60—65	0,05	55—60 × 65—70	0,12
aD v % l	Elbe	50—55 × 60—75	0,10	55—60 × 65—70	0,18
lA v % l	Weichsel	50—60 × 60—70	0,51	60—70 × 70—80	0,07
aA v % l	Weichsel	50—60 × 60—70	0,76	60—70 × 70—80	0,21
le v % l	Elbe	50—55 × 60—65	0,49	55—60 × 65—70	0,06
lp v % P V	Elbe	50—55 × 60—65	0,28	55—60 × 65—70	0,68
lV v % V A	Elbe	50—55 × 60—65 mm	0,58	55—60 × 65—70 mm	0,42

jede Probe entstand eine Übersicht, die mit der Tabelle 1 aus meiner vorherigen Arbeit (Řepa, 1970) identisch ist. Einzelne Tabelle führe ich hier der Ramersparung wegen nicht an, bloss die Summe der Ergebnisse, welche in der Tab. 1 zu dieser Arbeit enthalten ist. Bei jeder Probe habe ich für ein jedes Merkmal *(getrennt für beide Geschlechter) angegeben, ob sich seine relative Grösse mit der wachsender Körperlänge vergrössert, oder vermindert, oder ob die Abhängigkeit von der Körperlänge nicht zu ersehen ist.* Weil in anderen Arbeiten über Elritze analogische Angaben zu finden sind (Tack, 1943; Lohnický, 1964; Tuček, 1964) habe ich sie ebenfalls in der Tab. 1 in die Übersicht einbezogen. Aus den Tabellen ergeben sich folgende Schlüsse:

1. Es gab keine Fälle der entgegensetzeten Tendenz der Änderungen in der *relativen Grösse desselben Merkmals bei Männchen und Weibchen aus der* gleichen Probe. Einige vereinzelte Ausnahmen (in Proben aus England, Skandinavien und aus der March) betrachte ich als Abweichungen, die auf individuelle Variabilität zurückzuführen sind (es handelt sich durchwegs um weniger umfangreiche und nicht homogene Proben).

2. Ich habe mich bemüht festzustellen, ob die Änderungen der relativen Grösse desselben plastischen Merkmals, welche von der Körperlänge abhängig sind, auf allen verfolgten Lokalitäten die gleiche Tendenz haben.

a) Bei laer, mac, ape, dO, dpO, ae und lac weisen die meisten Proben eine Zunahme dieser Grösse auf, welche im Zusammenhang mit der wachsenden Körperlänge steht. Weniger zahlreich sind die Fälle, wo sich die relative Grösse des Merkmals nicht ändert; ausnahmsweise gibt es auch Fälle, wo sie sinkt. Mit einer gewissen Wahrscheinlichkeit kann man annehmen, dass diese Ausnahmen auf zufällige Einflüsse der individuellen Variabilität zurückzuführen sind. Grundsätzlich kann man sagen, dass an allen Orten des Verbreitungsareals bei allen obenerwähnten plastischen Merkmalen ihre steigende relative Grösse mit der wachsenden Körperlänge gut ersichtlich ist.

b) Bei lc, doe, dV, diN, lA, aA und lC ist die Situation ähnlich, doch mit dem Unterschied, dass eine Tendenz zur Verminderung der relativen Grösse der Merkmale mit der wachsenden Körperlänge zu ersehen ist.

c) Bei dN, lD, aD, lP, lV überwiegen die Fälle, wo sich ihre relative Grösse mit der wachsenden Körperlänge nicht ändert, oder ohne klare Tendenz schwankt. Nur vereinzelt ist bei ihnen eine Tendenz zur Steigerung oder Verminderung der relativen Grösse zu verzeichnen. Ich bin daher der Ansicht, *dass die relative Grösse dieser letzgenannten Merkmale an allen Lokalitäten* von der wachsenden Körperlänge unabhängig ist.

d) Die relative Grösse der verbleibenden plastischen Merkmale (acr, dA, dD, lpe, diO und lmax) hat in einigen Proben sinkende Tendenz, in anderen steigt sie, und in noch weiteren schwankt sie ohne Abhängigkeit von der wachsenden Körperlänge.

Bei der Verfolgung dieses Problems habe ich zum Schluss, mit Hilfe des Koeffizients CD (Mayr, Linsley, Usinger, 1953) die Unterschiede zwischen den Durchschnittswerten einzelner Merkmale in verschiedenen Längekategorien der Elritzen nachgeprüft. Die Koeffizientausrechnung habe ich an der zahlenmässig stärksten Probe aus dem Stromgebiet der Elbe durchgeführt. Bei den Merkmalen, wo in dieser Probe keine deutliche Tendenz der Änderungen *in relativer Grösse hervortrat, habe ich zur Ausrechnung noch Proben* aus anderen Lokalitäten benützt. Zum Vergleich wählte ich solche Längekategorien, die der Periode der Geschlechtsreife entsprechen, wo etwaiger

Aufstieg oder Rückgang der relativen Grösse mässiger ist als bei den juvenilen Individuen. Die Ergebnisse (Tab. 2.) zeigen, dass der Koeffizient CD einen genügenden Unterschied zwischen den grösseren und kleineren Elritzen nur bei lpc und dpO, und dazu noch nur bei den Weibchen andeutet. Bei keinem anderen Merkmal waren die Änderungen der relativen Grösse der adulten Individuen so deutlich, dass man den Unterschied nach dem Koeffizient CD als nachweisbar betrachten könnte.

B. Der sexuelle Dimorphismus

Mit Rücksicht auf die Änderungen der relativen Grösse der plastischen Merkmale im Zusammenhang mit der wachsenden Körperlänge, welche wir hier festgestellt haben, ist es beim Vergleichen der durchschnittlichen Körperlänge der Geschlechter unbedingt notwendig nur die Fische einer bestimmten Länge in Betracht zu ziehen. Hier habe ich 40—65 cm lange Stücke verwendet Für alle Merkmale habe ich durchschnittliche und andere statistische Werte ausgerechnet, und die Unterschiede zwischen den Durchschnitten bei Männchen und Weibchen habe ich durch t-Test (Turček, 1956) ermittelt. Statistische Grundwerte sind in der Tab. 3, die t-Werte in der Tab. 4 enthalten.

Die Merkmale kann man in einige Gruppen aufteilen:

1. An allen verfolgten Lokalitäten ist ein gleicher, statistisch nachweisbarer Unterschied in der durchschnittlichen Grösse des Merkmals bei Männchen und Weibchen zu verzeichnen. Es handelt sich um lP und lV, welche immer bei den Männchen grösser sind als bei den Weibchen.

2. An den meisten Lokalitäten (nur 1 — 2, höchstens 3 Ausnahmen) ist ein gleicher, statistisch nachweisbarer Unterschied zwischen den Geschlechtern zu verzeichnen. Dabei ist dV und dA bei den Weibchen immer grösser als bei den Männchen, dD ist grösser bei den Männchen. Weil die statistisch nicht nachweisbaren Unterschiede hauptsächlich nur bei zahlenmässig kleineren Proben (Spanien, Skandinavien) vorkommen, neige ich zur Ansicht, dass beim Vorhandensein eines umfangreiches Materials auch diese Merkmale den sexuellen Dimorphismus klar auftreten lassen wurden.

3. Bei der absoluten Mehrheit der Proben (5 von den 9 verfolgten) ist ein gleicher, statistisch nachweisbarer Unterschied zwischen der durchschnittlichen Merkmalgrösse bei den beiden Geschlechtern zu verzeichnen; bei den anderen ist der Unterschied nicht klar nachweisbar.
Dabei hat lpc einen grösseren Durchschnittswert bei den Männchen, dD und diO bei den Weibchen.

Auch bei diesen Merkmalen kann man also mit Wahrschenlichkeit einen gewissen Einklang im sexuellen Dimorphismus an verschiedenen Orten des Verbreitungsareals voraussetzen.

4. Bloss bei 4,3 oder sogar nur bei 2 Proben von den 9 verfolgten sind identische nachweisbare Unterschiede zwischen den Geschlechtern vorhanden. Die übrigen Proben entbehren sie. Bei lD und aA ergeben sich höhere Durchschnitte bei den Männchen, bei lac, acr, apc, doc diN bieten die Weibchen höhere Werte. Es handelt sich um Andeutungen kleinerer Unterschiede zwischen den Geschlechtern, die nur hier und da als nachweisbar erscheinen.

5. Bei dO, dpO, dN, ac, lmax, lA und lC findet man an 2—3 Lokalitäten nachweisbare Unterschiede. Aber immer ergibt sich bei demselben Merkmal

Tab. 3. Durchschnittliche und andere statistisch wichtige Werte der plastischen Merkmale der Elritzen (Körperlänge 40 – 65 mm) aus verschiedenen Orten des Verbreitungsareals. A) Männchen

	Britische Inseln			Spanien			Rhein			Elbe			Maroh		
	$\bar{x}$	s	$s\bar{x}$	$\bar{x}$	s	$s\bar{x}$	$\bar{x}$	s	$s\bar{x}$	$\bar{x}$	s	$s\bar{x}$	$\bar{x}$	s	$s\bar{x}$
Zahl der Ex.	5			3			20			104			14		
le v %l	26,4	1,33	0,593	25,9	0,61	0,352	25,5	1,27	0,284	24,5	1,52	0,147	23,8	1,52	0,422
dA v %l	64,4	2,42	1,090	62,6	1,34	0,774	61,2	2,56	0,568	59,6	2,16	0,209	61,9	1,05	0,323
dD v %l	53,3	0,80	0,360	54,2	2,10	1,215	55,2	2,16	0,485	53,5	1,75	0,168	53,6	1,61	0,429
dV v %l	48,0	0,66	0,297	47,0	1,59	0,900	45,9	1,94	0,434	45,5	1,98	0,191	45,0	1,01	0,269
acr v %l	19,8	2,01	0,905	19,1	0,90	0,520	20,6	1,82	0,408	17,4	1,55	0,149	20,6	1,48	0,394
lacr v %l	11,9	1,06	0,477	9,3	0,63	0,364	13,3	1,79	0,401	12,9	1,07	0,103	14,1	1,17	0,314
lpc v %l	26,4	1,95	0,878	26,2	1,46	0,844	27,0	2,22	0,475	26,8	1,72	0,165	27,6	1,16	0,309
mae v % lpc	27,4	3,06	1,362	33,7	1,70	0,983	32,1	4,35	0,971	28,2	2,47	0,242	29,8	2,02	0,538
apc v % lpc	39,0	1,43	0,611	47,2	3,68	2,121	41,5	4,05	0,950	36,9	2,26	0,220	41,8	2,62	0,701
do v % le	30,2	3,56	1,590	27,9	0,77	0,456	28,1	2,28	0,505	30,6	2,94	0,288	30,5	3,28	0,874
dpO v % le	44,0	3,10	1,382	42,7	2,48	1,433	46,1	3,72	0,822	47,9	3,89	0,374	46,9	2,46	0,656
doe v % le	25,0	2,74	1,234	26,2	2,40	1,385	25,1	2,31	0,518	23,0	2,14	0,207	24,8	1,93	0,514
diO v % le	27,7	1,62	0,729	25,7	1,03	0,595	28,7	3,62	0,811	29,8	2,32	0,223	29,2	7,70	0,720
dN v % le	20,1	1,09	0,487	13,2	1,20	0,695	18,6	2,27	0,505	21,4	2,73	0,267	19,3	3,70	0,987
diN v % le	16,0	1,18	0,531	13,2	4,30	2,500	16,0	1,55	0,347	15,7	2,14	0,205	19,0	0,94	0,250
ac v % le	64,5	1,57	0,706	59,2	4,55	2,640	64,1	4,85	1,087	59,4	3,78	0,363	58,9	3,91	1,042
iac v % la	48,6	5,74	2,590	47,2	3,89	2,290	50,7	3,94	0,882	49,9	4,03	0,387	50,2	2,98	0,794
lmax v % lo	28,0	1,85	0,833	26,6	3,01	1,738	28,2	2,78	0,623	26,8	2,70	0,259	27,4	2,50	0,666
lD v %l	12,7	0,95	0,425	11,0	1,26	0,693	11,6	0,93	0,206	12,7	0,99	0,097	11,5	0,98	0,261
aD v %l	21,6	0,63	0,284	18,8	0,96	0,558	20,0	1,34	0,300	20,0	1,33	0,128	20,9	1,33	0,354
lA v %l	11,8	0,97	0,423	9,7	0,40	0,225	10,5	0,75	0,167	12,0	0,80	0,078	10,8	0,51	0,136
aA v %l	20,5	1,09	0,491	19,2	0,68	0,396	19,5	1,43	0,321	19,4	2,17	0,208	18,8	1,52	0,410
lC v %l	19,7	2,95	1,315	20,1	4,00	2,215	20,9	3,20	0,710	20,6	2,72	0,267	19,8	1,81	0,482
lP v % P-V	85,9	4,39	1,977	83,4	10,4	6,011	85,4	7,20	1,614	89,1	6,28	0,604	84,4	7,90	0,261
lV v % V-A	92,7	12,0	5,450	88,7	0,01	0,527	92,1	11,7	2,627	88,1	7,19	0,691	84,5	7,65	2,060

144

Tab. 3. Durchschnittliche und andere statistisch wichtige Werte der plastischen Merkmale der Elritzen (Körperlänge 40—65 mm) aus verschiedenen Orten des Verbreitungsareals. A) Männchen-Fortsetzung

	Waag			Theiss			Weichsel			Skandinavien		
	$\overline{X}$	s	s_x	$\overline{X}$	s	s_x	$\overline{X}$	s	s_x	$\overline{X}$	s	s_x
	37			26			31			4		
le v % l	25,0	0,98	0,161	24,6	1,04	0,209	23,9	0,82	0,149	25,2	0,18	0,080
dA v % l	61,9	1,44	0,236	62,3	1,51	0,296	62,6	1,55	0,282	61,2	1,98	0,990
dD v % l	54,9	1,93	0,316	53,9	1,47	0,288	54,2	1,42	0,254	53,1	1,77	0,885
dV v % l	47,0	1,18	0,193	46,0	1,72	1,234	45,2	1,62	0,288	45,8	1,25	0,625
acr v % l	19,8	1,74	0,285	21,7	1,59	0,312	20,3	1,20	0,216	18,7	1,24	0,620
lacr v % l	14,9	1,56	0,256	13,3	1,14	0,223	13,9	1,13	0,202	12,0	0,77	0,385
lpc v % l	28,2	1,60	0,262	27,3	1,89	0,370	27,6	1,17	0,209	28,3	0,72	0,360
rmac v % lpc	31,3	3,22	0,526	35,3	3,01	0,590	30,8	2,32	0,378	22,6	1,48	0,740
apc v % lpc	39,4	4,04	0,670	44,1	3,28	0,643	42,1	3,39	0,605	32,1	4,42	2,200
dO v % lc	31,9	2,12	0,441	29,2	2,25	0,441	29,2	1,75	0,313	30,0	1,98	0,980
dpO v % lc	46,2	3,06	0,502	46,4	2,35	0,461	45,9	2,46	0,439	45,0	1,24	0,620
doc v % lc	23,2	2,46	0,403	25,2	2,12	0,415	25,9	2,30	0,411	27,2	1,97	0,985
diO v % lc	30,8	1,72	0,282	29,5	2,84	0,557	30,4	2,76	0,493	29,5	1,25	0,625
dN v % lc	22,0	2,24	0,367	19,7	1,65	0,323	20,8	1,72	0,307	18,6	2,34	1,178
diN v % lc	18,4	1,47	0,241	18,4	1,89	0,370	18,5	1,81	0,336	16,5	2,11	1,060
ac v % lc	65,0	3,45	0,565	61,5	4,30	0,843	58,7	3,20	0,257	61,3	1,10	0,555
lac v % lc	52,4	3,76	0,616	51,4	4,18	0,820	49,6	4,41	0,787	50,0	5,62	2,810
lmax v % lc	30,2	2,06	0,336	28,7	2,76	0,522	26,4	2,46	0,439	28,1	2,71	1,355
lD v % l	11,2	1,00	0,164	12,1	0,79	0,155	11,5	0,71	0,127	11,6	0,55	0,245
aD v % l	20,0	1,24	0,203	22,3	2,24	0,439	20,8	1,09	0,195	19,5	1,46	0,730
lA v % l	10,9	0,82	0,134	10,9	1,18	0,229	10,9	0,98	0,175	10,8	0,31	0,155
aA v % l	18,6	1,01	0,169	20,7	1,42	0,278	19,3	1,11	0,198	19,7	0,69	0,295
lC v % l	20,3	1,92	0,318	21,0	1,85	0,363	20,2	1,46	0,261	16,0	1,95	0,975
lP v % P-V	83,1	4,92	0,866	90,4	6,42	1,259	82,0	5,20	0,932	93,9	3,46	1,730
lV v % V-A	89,5	6,75	1,161	90,3	9,30	1,823	93,4	8,55	1,526	90,2	6,90	2,95

Tab. 3. Durchschnittliche und andere statistisch wichtige Werte der plastischen Merkmale der Elritzen (Körperlänge 40—65 mm) aus verschiedenen Orten des Verbreitungsareals. B) Weibchen

	Britische Inseln			Spanien			Rhein			Elbe			March		
	$\bar{X}$	s	s$\bar{x}$	$\bar{X}$	s	s$\bar{x}$	$\bar{X}$	s	s$\bar{x}$	$\bar{X}$	s	s$\bar{x}$	$\bar{X}$	s	s$\bar{x}$
Zahl der Ex.	2			3			9			63			25		
le v % l	26,8	0,31	0,227	23,7	0,65	0,376	23,8	0,63	0,210	24,1	1,60	0,202	24,2	0,88	0,176
dA v % l	67,0	0,77	0,547	65,7	2,62	1,512	62,8	1,46	0,487	62,7	2,47	0,312	63,1	2,68	0,536
dD v % l	56,5	0,71	0,503	55,0	1,37	0,790	71,3	1,69	0,563	54,8	2,07	0,262	53,5	1,72	0,344
dV v % l	50,7	0,35	0,248	50,2	3,46	2,000	48,9	2,22	0,740	46,8	2,10	0,265	45,8	1,46	0,292
aor v % l	18,9	2,61	1,851	19,5	1,22	0,705	20,9	2,85	0,950	19,2	2,04	0,357	21,6	1,57	0,314
laor v % l	12,9	2,61	1,851	9,6	0,57	0,328	15,8	2,89	0,963	14,2	1,47	0,185	15,2	1,23	0,246
lpe v % l	25,6	1,30	0,922	24,6	1,29	0,745	26,0	1,35	0,450	25,8	1,71	0,215	26,7	2,72	0,544
mae v % lpe	23,2	1,64	1,163	37,3	3,18	1,842	31,4	2,29	0,763	29,2	2,81	0,352	32,0	3,12	0,624
apo v % lpe	38,1	3,10	2,198	47,4	3,78	2,190	40,9	2,02	0,673	42,8	2,02	0,673	44,4	4,32	0,864
dO v % le	30,0	3,14	2,226	31,8	1,88	1,085	28,5	1,99	0,663	31,6	2,46	0,310	29,9	2,86	0,572
dpO v % le	48,4	2,60	1,844	45,2	2,00	1,155	45,9	2,29	0,763	48,2	3,72	0,469	45,7	3,08	0,601
doe v % le	28,8	1,83	1,302	26,4	4,55	2,622	25,9	4,05	1,350	24,9	2,25	0,284	24,3	3,08	0,596
diO v % le	29,3	1,64	1,164	30,1	1,32	0,767	33,1	3,82	1,273	33,8	2,44	0,308	30,0	2,52	0,504
dN v % le	20,7	2,68	0,744	16,9	1,92	1,124	19,3	2,50	0,833	22,5	3,02	0,384	20,9	2,16	0,432
dlN v % le	19,6	1,44	0,402	15,7	1,79	1,065	17,1	3,10	1,033	17,6	1,77	0,223	19,2	2,61	0,522
aoe v % le	62,1	1,90	1,345	64,3	3,06	2,290	63,8	3,80	1,226	56,9	3,90	0,479	58,8	4,28	0,856
lae v % le	51,4	0,40	0,284	53,7	6,70	3,860	54,0	3,36	1,120	53,2	4,37	0,551	53,2	4,60	0,920
hmax v % le	23,3	0,65	0,462	29,5	3,86	2,320	29,7	5,68	1,893	30,6	2,81	0,354	28,0	2,18	0,436
lD v % l	11,5	0,93	0,620	10,9	1,05	0,630	11,0	1,29	0,430	12,3	0,95	0,122	11,7	0,79	0,158
aD v % l	21,5	0,50	0,354	19,0	2,16	1,255	19,0	1,42	0,473	17,9	2,10	0,265	19,6	1,47	0,294
lA v % l	11,2	0,97	0,670	9,9	0,26	0,150	10,6	1,01	0,337	11,8	0,98	0,123	10,5	0,73	0,146
aA v % l	20,7	0,30	0,270	18,6	0,95	0,549	16,7	1,41	0,470	17,9	1,84	0,232	18,3	1,05	0,201
lC v % l	20,3	0,30	0,270	18,9	1,18	0,682	18,4	2,12	0,706	19,3	1,94	0,246	18,9	1,72	0,344
lP v % P-V	72,1	2,90	2,060	64,7	4,21	2,440	66,2	5,95	1,983	71,9	6,76	0,852	71,3	6,00	1,200
lV v % V-A	78,0	0,00	0,000	80,8	4,22	2,440	72,8	10,7	3,560	73,3	7,50	0,945	76,9	6,52	1,310

Tab. 3. Durchschnittliche und andere statistisch wichtige Werte der plastischen Merkmale der Elritzen (40—65 mm Körperlänge) aus verschiedenen Orten des Verbreitungsareals. B) Weibchen-Fortsetzung

...massgebende Werte der plastischen Merkmale der Eirinxen (40—65 mm Körperlänge) aus verschiedenen Orten des Verbreitungsareals. B) Weibchen-Fortsetzung

	Waag			Theiss			Weichsel			Skandinavien		
	X̄	S	s̄x	X̄	S	sx	X̄	S	s̄x	X̄	S	s̄x
Zahl der Ex.	36			26			23			5		
le v %1	24,7	1,47	0,244	24,8	1,17	0,229	24,7	1,16	0,242	24,7	0,86	0,375
dA v %1	63,8	1,50	0,250	63,1	1,61	0,296	63,9	1,20	0,250	64,3	1,12	0,500
dD v %1	55,4	2,29	0,382	54,7	1,94	0,380	54,3	1,94	0,404	55,6	1,73	0,772
dV v %1	48,0	1,96	0,327	47,1	1,63	0,320	46,7	1,09	0,227	46,6	3,10	1,384
acr v %1	20,7	2,02	0,345	21,7	1,53	0,300	20,7	1,03	0,215	19,7	0,97	0,433
lacr v %1	15,6	1,60	0,266	13,9	1,37	0,268	14,0	1,13	0,235	10,8	0,90	0,402
lpc v %1	25,8	1,33	0,222	25,9	1,58	0,310	26,7	1,33	0,277	26,8	0,60	0,267
mac v % lpc	33,2	2,94	0,490	35,3	3,56	0,692	30,2	2,52	0,525	27,0	2,96	1,342
apc v % lpc	44,5	4,05	0,680	43,9	4,06	0,800	41,6	3,18	0,662	34,3	3,42	1,525
dO v % lc	32,0	2,66	0,443	29,8	2,24	0,439	29,0	1,90	0,396	26,5	2,46	1,095
dpO v % lc	45,8	3,20	0,533	46,0	2,95	0,578	45,3	2,41	0,500	42,5	2,07	0,924
doc v % lc	23,1	1,99	0,332	26,6	1,70	0,333	25,2	2,10	0,439	30,7	2,50	1,113
dtO v % lc	32,6	2,82	0,470	31,3	2,83	0,555	29,8	2,50	0,520	27,4	2,20	0,982
dN v % lc	22,0	2,20	0,367	19,4	2,18	0,427	19,6	2,33	0,467	17,7	1,46	0,652
dtN v % lc	19,4	1,51	0,332	18,1	2,22	0,435	19,0	2,14	0,446	15,8	2,60	1,160
dtN v % lc	19,4	1,51	0,332	18,1	2,22	0,435	19,0	2,14	0,446	15,8	2,60	1,160
acr v % lc	66,4	4,71	0,785	59,2	3,42	0,670	55,7	2,95	0,614	58,7	1,14	0,508
lac v % lc	54,3	4,81	0,802	52,4	4,01	0,786	48,5	3,10	0,646	49,1	4,30	1,920
lmax v % lc	31,2	2,86	0,477	29,9	2,74	0,637	27,4	2,29	0,477	30,7	3,58	1,595
lD v %1	11,5	0,98	0,163	11,7	0,95	0,186	11,3	0,69	0,147	10,8	1,05	0,482
aD v %1	19,0	1,41	0,235	21,1	1,45	0,284	19,9	1,16	0,242	17,6	0,81	0,362
lA v %1	10,6	0,95	0,158	11,3	0,88	0,172	10,6	0,99	0,206	10,5	1,01	0,451
aA v %1	17,7	0,90	0,150	19,9	0,91	0,180	19,3	1,12	0,232	18,7	1,04	0,464
IC v %1	20,0	1,66	0,277	20,2	1,29	0,261	20,1	2,22	0,465	20,2	3,74	1,670
IP v % P-V	68,7	5,30	0,883	75,8	5,78	1,133	74,5	5,85	1,218	66,1	5,45	2,440
IV v % V A	78,5	6,40	1,666	84,7	6,21	1,220	80,6	6,86	1,422	79,1	5,36	2,395

Erklärungen: X̄ — Durchschnitt   S — massgebende Abweichung   s̄x — mittlere Fehler des Durchschnitts

Tab. 4. Die Unterschiede in den Durchschnittswerten der plastischen Merkmale zwischen beiden Geschlechtern an verschiedenen Orten nach ihrer Bewertung durch t-Test

Zahl der Feststufen	Britische Inseln 5	Spanien 7	Rhein 27	Elbe 165	March 37	Waag 71	Theiss 50	Weichsel 52	Skandinavien 8	t-Test bedeutsamer
lc v %	-0,64	+2,55 ??	+4,85 !!	+1,09 ?	-0,89	+1,04	-0,65	-2,88 !!	+1,31 !	4
dA v %	-2,16 ?	-0,76	-2,13 !	-8,61 !!	-1,93 ?	-5,59 !!	-1,90 ?	-3,44 !!	-2,79 !	8
dD v %	-5,15 !!	-0,55	-2,75 !!	-4,20 !!	+0,18	-1,01	-1,67 ?	-0,21	-,13 ?	5
dV v %	-7,10 !!	-1,45 !	-3,57 !!	-4,08 !!	-2,05 !	-2,62 !	-2,39 !	-4,06 !!	-0,54	8
aer v %	+0,44	-0,45	-0,28	-6,00 ?!	-2,00 !	-2,00 ?	0,00	-1,31	-1,31	3
lacr v %	-0,52	-0,61	-2,40 !	-6,20	-2,75 !!	-1,90 ?	-1,78	-0,32	+2,18 ?	5
lpo v %	+0,63	+1,41	+1,54	+10,35 !!	+1,41	+7,06 !!	+2,98 !!	+2,64 !!	+3,42 !	5
mac v % lpo	+2,32 ?	-1,71	+0,57	-2,24 !	-2,65 !!	-2,64 !!	0,00	+0,92	-2,82 !	5
ape v %	+0,39	-0,06	+0,52	-12,20 !!	-2,34 !!	+0,20	+0,57	+0,57	-0,83	4
dO v % lc	-0,07	-3,39 !	-0,48	-2,38 !	+0,58	-0,18	+0,16	+0,50	+2,39 !	3
dpO v % lc	-1,91 ?	-1,36	+0,18	-0,49	+1,40	+0,54	+0,55	+0,90	+2,24 ?	2
doc v % lc	-2,11 !	-0,07	-0,14	-5,40 !!	0,63	+0,19	-2,64 !!	+1,16	-0,14	3
diO v % lc	-0,88	-4,85 !!	-3,01 !!	-10,51 !!	0,91	-3,28 !!	-2,29	+0,04	+1,81	5
dN v % lc	-0,67	-2,78 !	-0,78	-2,22 !	-1,49	0,00	+0,52	+2,14	+0,66	2
dhN v % lc	+5,45 !!	-0,92	-1,01	-6,10 !!	-0,36	-2,44 !!	+0,33	-0,89	+0,45	3
ae v % lc	-1,58	-2,46	+0,18	-4,16 !!	+0,07	-1,48	+2,15 !	+3,56 !!	+2,10 ?	7
lac v % lc	-1,07	+1,44	-2,32 !	-4,95 !!	-2,43 !	-1,87 ?	-0,88	+1,08	+0,26	4
lmax v % lc	+4,95 !!	-1,06	-0,76	-8,55 !!	0,76	-1,75	-1,67	+1,02	+1,45	2
lD v %	+2,55 !	+1,27	+0,10	+3,30 !!	-1,50	-1,30	+1,67 ?	+1,20	+1,45	3
aD v %	+0,22	+0,58	+1,73 ?	+7,48 !!	+1,09	+3,22 !!	+2,32 !	+2,90 !!	+2,32 !	6
lA v %	+1,07	-0,73	-0,27	+1,38	+1,50	+1,45	-1,44	+1,12	+0,62	0
aA v %	-0,36	-0,88	+5,00 !!	+4,42 !!	+1,09	+4,00 !!	+2,42 !	0,00	+1,85	4
lC v %	-0,46	+0,51	+2,50 !	+3,62 !!	+3,63 !!	+1,53	+0,71	+1,82 ?	-2,18 ?	4
lP v % P-V	+4,86 !!	+2,88 !	+7,60 !!	+16,50 !!	+5,42 !!	+12,40 !!	+8,70 !!	+4,80 !!	+9,30 !!	9
lV v % V-A	+2,69 !	+3,18 !	+4,45 !!	+12,60 !!	+3,10 !!	+5,50 !!	+,254 !	+6,13 !!	+2,90 !	9

Erklärungen: Zeichen + vor dem t-Wert bedeutet, dass der Durchschnittswert bei den Männchen höher ist als bei den Weibchen;
Zeichen — bedeutet höheren Durchschnittswert bei den Weibchen
! — Unterschied, der möglicherweise statistische Bedeutung hat   ! — statistisch bedeutsamer Unterschied
!! — statistisch hoch bedeutsamer Unterschied

148

Tab. 5. Die Unterschiede in den Durchschnittswerten der plastischen Merkmale zwischen beiden Geschlechtern an verschiedenen Orten nach ihrer Bewertung durch CD-Koeffizient.

	Rhein	Elbe	Waag	Theiss	Weichsel	March	CD 1
lc v % l	0,900	0,13	0,12	0,09	0,41	0,17	0
dA v % l	0,30	0,67	0,65	0,26	0,47	0,31	0
dD v % l	0,54	0,33	0,12	0,23	0,03	0,03	0
dV v % l	0,82	0,32	0,32	0,33	0,55	0,32	0
acr v % l	0,04	0,50	0,26	0,00	0,18	0,32	0
lacr v % l	0,53	0,71	0,22	0,24	0,04	0,46	0
lpc v % l	0,50	0,82	0,43	0,23	0,23	0,28	0
apc v % lpc	0,10	1,04	0,63	0,26	0,08	0,40	1
mac v % lpc	0,10	0,19	0,33	0,32	0,13	0,43	0
dO v % lc	0,09	0,18	0,02	0,02	0,05	0,10	0
dpO v % lc	0,03	0,04	0,06	0,07	0,12	0,22	0
doc v % lc	0,12	0,43	0,02	0,37	0,16	0,10	0
diO v % lc	0,59	0,83	0,40	0,31	0,11	0,15	0
dN v % lc	0,12	0,19	0,09	0,18	0,30	0,27	0
diN v % lc	0,24	0,49	0,50	0,08	0,12	0,08	0
ac v % lc	0,03	0,32	0,16	0,30	0,49	0,01	0
lac v % lc	0,45	0,39	0,22	0,12	0,14	0,40	0
lmax v % lc	0,18	0,69	0,20	0,22	0,21	0,13	0
lD v % lc	0,27	0,26	0,15	0,23	0,15	0,11	0
aD v % lc	0,36	0,61	0,38	0,32	0,40	0,14	0
lA v % l	0,06	0,11	0,17	0,19	0,15	0,24	0
aA v % l	0,98	0,37	0,47	0,33	0,00	0,19	0
lC v % l	0,47	0,28	0,08	0,25	0,23	0,35	0
lP v % P-V	1,46	1,32	1,72	1,20	0,68	0,94	4
lV v % V-A	0,86	1,01	0,83	0,36	0,83	0,53	1

an einer Lokalität ein höherer Durchschnitt bei dem einem Geschlecht, an anderen Lokalitäten bei dem anderen. Ich bin der Ansicht, dass bei diesen Merkmalen überhaupt keine Unterschiede im Sexualdimorphismus vorhanden seien.

6. Interessant ist die Situation bei lacr und mac, wo sich bedeutsame Unterschiede zwischen den Geschlechtern an 6 bzw. 5 Lokalitäten ergeben. Mac ist in fast allen diesen Fällen bei den Weibchen grösser: nur in der Probe aus England ist es höher bei den Männchen. Ähnlicherweise, fast alle Lokalitäten mit einem nachweisbaren Unterschied zeigen lacr grösser bei den Weibchen und nur die Probe aus Skandinavien bei den Männchen.

Für taxonomische Arbeit wird zur Bewertung der Unterschiede der Koeffizient CD empfohlen, der nicht nur Durchschnittswerte, sondern auch die gesamte Variabilität des Merkmals in Betracht zieht. Daher habe ich für zahlreichere Proben (Elbe, Rhein, Theiss, Weichsel, Waag, March) auch die Werte dieses Koeffizients angewendet, welche in der Tab. 5 angeführt sind. Es ist klar, dass bei Berücksichtigung der gesamten Variabilität die Unterschiede zwischen den Geschlechtern bedeutend kleiner sind. Nur bei lP entsprechen die Werte des Koeffizients CD einem im voraus erwählten „nachweisbaren" Unterschied; bei lV nähern sich diese Werte nur an einigen

Lokalitäten der „Nachweisbarkeit", und bei einigen weiteren Merkmalen (dA, lpc, apc) wurde eine solche Neigung zur „Nachweisbarkeit" wenigstens an zwei Lokalitäten festgestellt.

DISKUSSION

Wenn wir den Sexualdimorphismus an einer ausreichend grossen Probe der Elritzen aus einem Gebiet verfolgen (Oliva, 1952; Řepa, 1970), finden wir die Geschlechtsunterschiede bei zahlreichen plastischen Merkmalen. Falls wir aber von diesem Standpunkt aus mehrere Proben von den verschiedenen Orten des Verbreitungsareals in Betracht ziehen, sehen wir, dass sich die Zahl der Merkmale, welche identisch den Sexualdimorphismus zutage kommen lassen, bedeutend vermindert.

Ferner haben wir festgestellt, dass bei 6 Merkmalen die Tendenz der Änderungen ihrer relativen Grösse in Abhängigkeit von der Körperlänge von einer Lokalität zur anderen unterschiedlich war. Es gibt auch 2 Merkmale, bei welchen die nachweisbaren Unterschiede zwischen den Geschlechtern an vereinzelten Lokalitäten entgegesetzt waren, im Vergleich mit den übrigen Orten. Bereits Toporkova (1965) hat bei der Gattung *Rana* auf die Tatsache hingewiesen, dass nicht nur die Grösse der plastischen Merkmale der geographischen Variabilität unterliegen muss, sondern dass sich in Abhängigkeit von der geographischen Lage des Vorkommensortes auch die Unterschiede zwischen den Geschlechtern, oder die Tendenz der Änderungen der relativen Merkmalgrösse in Beziehung zur Körperlänge ändern kann. Unsere Beobachtung lassen auch auf eine solche Möglichkeit schliessen, nämlich auf die Wahrscheinlichkeit der geographischen Variabilität der obenerwähnten Erscheinung auch bei der Elritze.

Versuchen wir einen Nachweis bei der Tendenz der Änderungen der relativen Grösse der plastischen Merkmale zu bringen:

Aus der Tab. 1, wo die Lokalitäten nach der geographischen Länge geordnet sind, ist ersichtlich, dass bei dA und dD an westlicher gelegenen Lokalitäten ihre relative Grösse mit der wachsenden Körperlänge sinkt. Dagegen ist an östlicher gelegenen Orten eine Steigerung derselben zu verzeichnen. Umgekehrt ist es bei diO, lpc und lmax. Es gibt zwar auch Ausnahmen: Deutschland bei dA (Tack, 1943), Waag bei dD, und England bei lpc, das kann aber durch Representativitätsmängel der Proben oder durch ökologische Bedingungen verursacht werden. Im Ganzen bin ich der Ansicht, dass bei diesen Merkmalen eine fortschreitende Änderung der Tendenz der Abhängigkeit der relativen Merkmalgrösse von der Körperlänge, im Zusammenhang mit der sich ändernden geographischen Lage, vorhanden sei. Bei acr ändert sich diese Tendenz von einer Lokalität zur anderen, ohne Rücksicht auf die geographische Länge. Ich meine, dass es sich hier eher um Fluktuationen handelt, welche durch Unstabilität dieses Merkmals (Anfüllung der Verdauungsorgane, Reifegrad der Gonaden usw.) verursacht werden.

Bei den Abweichungen im Sexualdimorphismus (mac und lacr) ist die Lage anders. Nur eine von den verfolgten Lokalitäten unterscheidet sich von den übrigen; eine fortschreitende Änderung des Sexualdimorphismus von einer Lokalität zur anderen im Zusammenhang mit der sich ändernden geographischen Länge ist nicht ersichtlich. In beiden Fällen handelt es sich aber um Lokalitäten, welche von den übrigen in Richtung zur Arealsgrenze bedeutend

150

entfernt sind (England und Skandinavien), sodass auch hier die Möglichkeit vorliegt, dass mit der Änderung der geographischen Lage eine völlige Umkehrung der Unterschiede zwischen den Geschlechtern stattfindet. Bei diesen Merkmalen erscheint trotzdem die geographische Variabilität im Sexualdimorphismus nur als möglich; den Beweis könnte nur die Analyse der erwähnten Merkmale bei den Elritzen aus Lokalitäten, welche zwischen denjenigen, wo die Abweichung zerst auftrat, und der nächsten von der hier verfolgten gelegen sind.

Bei lacr möchte ich noch bemerken, dass es nicht nur von der Anfüllung der Verdauungsorgane und vom Reifegrad der Gonaden, sondern auch von der Länge des Konservierens des Fisches beeinflusst wird; beim älteren Material lässt sich manchmal lacr überhaupt nicht messen.

ZUSAMMENFASSUNG

An den Proben von Elritzen aus 9 europäischen Lokalitaten sind bei 25 plastischen Merkmalen Unterschiede zwischen Geschlechtern und die Abhängigkeit ihrer relativen Merkmalgrösse von der wachsenden Körperlänge verfolgt worden. Die Ergebnisse der Analysen kann man folgendermassen zusammenfassen:

1. a) Die Tendenz der Änderungen der relativen Grösse in Abhängigkeit von der wachsenden Körperlange ist bei 19 verfolgten plastischen Merkmalen in den Proben aus verschiedenen Orten des Verbreitungsareals der Elritze immer die gleiche. Bei sieben von ihnen (lacr, mac, apc, dO, dpO, ac und lac) ist Steigerung der Grösse mit der wachsenden Körperlänge zu verzeichnen, bei anderen sieben (Lc, doc, dV, diN, lA, aA und lC) sinkt sie, und bei 5 Merkmalen (dN, lD, aD, lP und lV) ist sie von der Körperlänge unabhängig.

b) Bei den verbleibenden 6 plastischen Merkmalen (dA, dV, acr, lpc, diO und lmax) ist die Tendenz der Abhängigkeit von der Körperlänge an verschiedenen Lokalitäten auch verschieden.

2. a) Die Unterschiede zwischen den beiden Geschlechtern der Elritze sind bei 8 plastischen Merkmalen praktisch an allen verfolgten Lokalitäten gleich. LP, lV und lpc sind grösser bei den Männchen, dA, dD, dV und diO bei Weibchen.

b) Lacr und mac weisen an meisten Lokalitäten ebenfalls einen statistisch bedeutsamen Sexualdimorphismus auf (sind durchwegs grösser bei Weibchen). Jeweils nur eine Lokalität (England bei mac und Skandinavien bei lacr) zeigt einen entgegensetzten Unterschied.

c) Bei weiteren Merkmalen gibt es wahrscheinlich auch Untershiede zwischen den Geschlechtern; sie sind aber so klein, dass sie nur an wenigen Lokalitäten als statistisch bedeutsam erscheinen (aA und lD grösser bei den Männchen, acr, apc, lac, doc, diN bei den Weibchen).

d) Bei den restlichen 8 Merkmalen gibt es zwischen den Geschlechtern überhaupt keine Unterschiede.

LITERATUR

Hubbs, C. L., C. Hubbs, 1953: An improved graphical analysis and comparison of series of samples. *Syst. Zool.*, 2 (2) : 49—57.

Lohniský, K., 1964: Příspěvek k systematice a k pohlavnímu dimorfismu střevle potoční (Phoxinus phoxinus Linnaeus 1758). *Acta mus. Reginaehr.*, ser A, 6 : 221—246.

Mayr, E., Linsley, E. G., R. L. Usinger, 1953: Methods and principles of systematic zoology
    N. York-Toronto-London : 142—150.
Řepa, P., 1970: Beitrag zur Kenntnis des Geschlechtdimorfismus der Elritze, Phoxinus phoxinus
    (Linnaeus, 1758). *Věst. čs. spol. zool.,* **35** : 126—131.
Tack, E., 1943: Die Elritze (Phoxinus laevis Ag.), eine monographische Bearbeitung. *Archiv
    f. Hydrobiol.,* **37** : 321—494.
Tuček, J., 1964: Systematika a růst střevle potoční (Phoxinus phoxinus) Diplomarbeit, Natur-
    wiss. Fak. KU Prag, nicht veröff.
Toporkova, L. J., 1965: Geografičeskaja izmenčivost allometričeskogo rosta u dvuch vidov
    roda Rana. Sbor.: Vnutrivid. izmenčivost nazem. pozvonočnych živ. Ural. otd. An SSSR,
    Sverdlovsk : 361—366.
Turček, F. J., 1956: Úvod do kvantitatívného výskumu populácii vtákov a cicavcov. SAV
    Bratislava, 124 pp.
Vladykov, V., 1927: Über den geschlechtlichen Dimorphismus bei Elritzen (Phoxinus phoxinus,
    Linné). *Zool. Anz.,* **74** : 322—328.

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STUDIES ON THE ORAL VALVES OF SOME INDIAN FRESHWATER TELEOSTS

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Abstract: The oral valves of *Bagarius bagarius* (Ham.) (Sisoridae), *Xenentodon cancila* (Ham.) (Belonidae), *Botia dario* (Ham.) (Cobitidae), *Colisa fasciata* (Bl. & Schn.) (Anabantidae) and *Chatoessus manminna* (Ham.) (Dorosomidae) have been studied. The maxillary and mandibular oral valves occur in *Bagarius bagarius*, *Xenentodon cancila* and *Chatoessus manminna*. Only maxillary oral valve is found in *Botia dario*, and mandibular one in *Colisa fasciata*. The oral valves of the fishes examined have mucous cells and taste buds in different intensity. The mucosal surface which comes into contact with food has many taste buds but a few mucous cells. The other mucosal surface has more mucous cells and no taste buds.

Oral valves are flaps of tissue, found just back of the upper or lower or both jaws, attached to its base and free at the posterior border. They are called maxillary or mandibular valves on the basis of their position. Both the valves or any of the two may be present in fishes.

There is little information available on the histology of oral valves of fishes. Kapoor (1957) reviewed the earlier works on oral valves particularly of Dahlgren (1898), Mitchell (1904) and Gudger (1946). Brief and stray accounts of these structure are available in the papers by Curry (1939), Al-Hussaini (1947), Girgis (1952), Al-Hussaini and Kholy (1953), Nagar and Khan (1958), Saxena (1958), Sarkar (1959), Ishida and Sato (1960), Chaudhary and Khandelwal (1961), Nagar, Ahmad and Khan (1961), Khanna (1962), Lal (1962), Lal, Bhatnagar and Kaili (1964) and Pasha (1964a, b, c).

This contribution has been attempted to provide collective information on the form, arrangement and histology of the oral valves from a comparative view point, an aspect so far neglected.

For histology, the valves were taken out from the live fishes and were fixed in Bouin's fluid and formalin. Longitudinal sections were cut at 7 μm stained with Delafield's haematoxylin and eosin.

OBSERVATION

In *Bagarius bagarius*, *Xenentodon cancila* and *Chatoessus manminna*, both the maxillary and mandibular valves are present and are of crescentic shape. In *Botia dario*, only the maxillary valve, while in *Colisa fasciata*, only the mandibular valve exists and both are U-schaped in outline. Development of top papillae in place of valve has not been found either in *Botia dario* or *Colisa fasciata* in which mandibular and maxillary valves are absent respectively. Longitudinal folds are observed on the upper surface of the maxillary

valve in *Botia dario*. The valvular surface of other fishes studied is quite smooth. Only the mandibular valve of *Chatoessus manminna* is pigmented.

Histologically, the maxillary and mandibular valves of all the fishes studied are composed of dorsal and ventral mucosae and an intermidiate submucosa. In *Bagarius bagarius* (Fig. 1) the maximum thickness of the mucosae of the maxillary valve is about 14 μm. It is composed of five to six layers of stratified epithelium having flat polygonal, spindle-shaped and columnar cells, all with central nuclei. The mucous cells are in plenty in the dorsal mucosa and scarce in the ventral mucosa. The taste buds are sufficiently present in the ventral mucosa. They are supported by sumbucosal papillae and flush with the outer margin. Each taste bud measures approximately 35 μm long and 28 μm wide. The dorsal mucosa is devoid of taste buds.

In *Xenentodon cancila* (Fig. 3) the thickness of the maxillary mucosa varies in between 28 to 35 μm and consists of polygonal, elongated and basal columnar cells. The mucous cells are fround along the periphery on both dorsal and ventral mucosae. A few taste buds are seen in the ventral mucosal surface. Each taste bud is about 21 μm long and 10 μm wide.

In *Chatoessus manminna* (Fig. 7) the thickness of maxillary mucosa ranges from 14 to 28 μm. Each mucosal surface comprises of five to six layers of stratified polygonal and basal columnar cells, all with central nuclei. The mucous cells are small in number in both mucosal layers. The taste buds are found on the ventral surface in small number. They are placed on submucosal papillae and flush with the outer margin. Some eosinophilic granular cells are found.

In the mandibular valves of *Bagarius bagarius* (Fig. 2), *Xenentodon cancila* (Fig. 4) and *Chatoessus manminna* (Fig. 8) the taste buds are present in dorsal mucosa which comes into direct contact with the food.

In *Botia dario* (Fig. 5) the dorsal layer of the maxillary valve is thin (21 μm), while the ventral on is thick (63 μm). The dorsal mucosa is composed of three to five and ventral of four to seven layers of stratified polygonal, oval and columnar cells. The mucous cells occur on both the surfaces of mucosa. They are in plenty on the dorsal and scarce on the ventral surface and are arranged along the periphery. The taste buds (about 49 × 21 μm) are profuse in the ventral mucosa. They are born on submucosal eminences and flush with the outer margin. They completely lack in the dorsal one. The mandibular valve is absent.

In *Colisa fasciata* the maxillary valve is absent. Both the ventral and dorsal mucosae of the mandibular valve are made up of about two to three layers of polygonal epithelial cells (Fig. 6). The mucous cells are in plenty in the dorsal mucosa and are arranged along the periphery. They are entirely absent in the ventral mucosa. A few taste buds are present in the mucosa of the dorsal surface which touches food. The ventral surface is completely destitute of taste buds.

The mucosa is separated from the submucosa by a thin basement membrane in all the fishes studied. In *Colisa fasciata* the basement membrane is not distinct.

In all the fishes studied the submucosa is composed of connective tissue fibres and the blood vessels traverse it. In *Xenentodon cancila* the submucosa is thin and consists of compactly arranged connective tissue fibres. In *Botia dario* the submucosa is folded. It consists of loosely dispersed connective

154

tissue fibres. In *Colisa fasciata* the submucosa is thick and is made up of a dense layer of connective tissue fibres. In *Chatoessus manminna* the submucosa is very thin.

DISCUSSION

In the fishes studied, both maxillary and mandibular valves are present in *Bagarius bagarius, Xenentodon cancila* and *Chatoessus manminna*. Similarly both the valves are reported in *Clarias lazera* (Al-Hussaini and Kholy, 1953), *Wallago attu, Gudusia chapra* (Kapoor, 1957), *Mastacembelus armatus* (Nagar and Khan, 1958), *Labeo rohita, Rita rita, Heteropneustes fossilis, Clarias batrachus, Ophicephalus striatus, Anabas testudineus* (Saxena, 1958), *Mystus seenghala* (Sarkar, 1959), *Parasilurus asotus* (Ishida and Sato, 1960), *Mugil corsula* (Nagar, Ahmad and Khan, 1961), *Rita rita, Mystus aor, Silondia silondia, Channa marulius, Harpodon neherius, Engraulis telera* (Khanna, 1962), *Magalops cyprinoides, Tilapia mossambica* and *Mystus gulio* (Pasha, 1964 a, b, c).

In *Botia dario,* only the maxillary valve occur. Similarly only the maxillary valve is present in *Campostoma anomalum* (Rogick, 1931), *Cyprinus carpio* (Curry, 1939), *Labeo horie* (Girgis, 1952), *Catla catla, Barbus stigma* (Kapoor, 1957), *Oreinus plagiostomus* (Chaudhary and Khandelwal, 1961), *Catla catla, Barbus sarana, Cirrhina mrigala, Hilsa ilisha* (Khanna, 1962), *Tor putitora* (Lal, 1962) and *Chagunius chagunius* (Lal, Bhatnagar and Kaile, 1964).

In *Colisa fasciata,* only the mandibular valve is found. On the basis of accessible literatura, it is assumed that no body has reported presence of only the mandibular valve in any fish up till now. Hence, the finding on the presence of only the mandibular valve in *Colisa fasciata* appears to be interesting.

Observations so far made on the histology of oral valves present a diversity. The mucous cells and the taste buds are present in different intensity in the oral valves of fishes examined. Similarly the taste buds and mucous cells are recorded in the oral valves of *Cyprinus carpio* (Curry, 1939), *Labeo horie* (Girgis, 1952), *Clarias lazera* (Al-Hussaini and Kholy, 1953), *Catla catla, Barbus stigma* (Kapoor, 1957), *Megalops cyprinoides, Tilapia mossambica* (Pasha, 1964a, b). The taste buds are completely absent in the oral valves of *Gudusia chapra* (Kapoor, 1957). The mucous cells, the club cells and a few taste buds are recorded in the oral valves of *Wallago attu* (Kapoor, 1957) and *Mystus seenghala* (Sarkar, 1959). Nagar, Ahmad and Khan (1961) reported absence of mucous cells in the maxillary valve of *Mugil corsula*.

The reported functions of the oral valves are that they prevent the reflux of respiratory stream and escape of food. They aid in the act of breathing. On the basis of the histological studies, it can be derived that they assist in gustation and lubrication of the food matter to a certain degree.

155

LITERATURE

Al-Hussaini A. H., 1947: The anatomy and histology of the alimentary tract of the plankton--feeder, Atherina forskali (Rupp.) *J. Morph.*, **80** : 251—286.

Al-Hussaini and A. A. Kholy, 1953: On the functional morphology of the alimentary tract of some omnivorous teleost fish. *Proc. Egypt. Acad. Sci.*, **9** : 17—39.

Chaudhary H. S. and O. P. Khandelwal, 1961: The anatomy and histology of the alimentary tract of Oreinus plagiostomus (Heckel). *Annot. Zool. Japon.*, **34** (3) : 139—152.

Curry E., 1939: The histology of the digestive tube of the carp (Cyprinus carpio communis). *J. Morph.*, **65** : 53—78.

Dahlgren U., 1898: The maxillary and mandibular breathing valves of teleost fishes. *Zool. Bull.*, **11** : 117—124.

Girgis S., 1952: The bucco-pharyngeal feeding mechanism in an herbivorous bottom-feeding cyprinoid, Labeo horie (Cuvier). *J. Morph.* **90** (2) : 281—315.

Gudger E. W., 1946: Oral breathing valves in fishes. *J. Morph.*, **79** (2) : 263—285.

Ishida J. and M. Sato, 1960: The anatomical and histological observations of the alimentary tract of a catfish, Parasilurus asotus (L.) *Sci. Rep. Hirosaki Univ.*, **7** (2) : 57—63.

Kapoor E. G., 1957: Oral valves of teleosts. *Jap. J. Ichthyol.*, **5** : 127—131.

Khanna S. S., 1962: A study of bucco-pharyngeal region in some fishes. *Ind. J. Zool.*, **3** : 21—48.

Lal M. B., 1962: Morphology of Tor putitora (Hamilton). *Agra Univ. J. Res. (Sci.)*, **11** : 167 to 172.

Lal M. B., A. N. Bhatnagar and R. K. Kaile, 1964: Studies on the morphology and histology of the digestive tract and associated structures of Chagunius chagunio (Hamilton). *Proc. Nat. Acad. Sci. India, B*, **34** : 160—172.

Mitchell E. G., 1904: Oral breathing valves of teleosts, their modifications and relation to the shape of the mouth. *Amer. Nat.*, **38** : 153—164.

Nagar S. K. and W. M. Khan, 1958: The anatomy and histology of the alimentary canal of Mastacembelus armatus (Lacep). *Proc. Nat. Acad. Sci., B*, **67** (3) : 173—187.

Nagar S. K., W. M. Khan and S. Ahmad, 1961: The anatomy and histology of the alimentary canal of the grey mullet Mugil corsula (Ham.). *Ann. Mus. Civ. Stor. Nat. Genova.*, **72** : 47—68.

Pasha S. M. K., 1964a: The anatomy and histology of the alimentary canal of a carnivorous fish Megalops cyprinoides (Brouss.). *Proc. Ind. Acad. Sci. B*, **59** : 107—115.

Pasha S. M. K., 1964b: The anatomy and histology of the alimentary canal of a herbivorous fish Tilapia mossambica (Peters.). *Proc. Ind. Acad. Sci. B*, **59** : 340—349.

Pasha S. M. K., 1964c: The anatomy and histology of the alimentary canal of an omnivorous fish Mystus (Macrones) gulio (Ham.). *Proc. Ind. Acad. Sci. B*, **59** : 211—221.

Rogick M. D., 1931: Studies on the comparative histology of the digestive tube of certain teleost fishes. II. A minnow (Compostoma anomalum). *J. Morph. and Physiol.*, **52** (1) : 1—25.

Sarkar H. L., 1959: Studied on the morpho-histology of the digestive system in relation to the food feeding habits in a siluroid fish Mystus (Osteobagrus) seenghala (Sykes). *Proc. Zool. Soc. Bengal.*, **17** (2) : 97—109.

Saxena D. B., 1958: Oral breathing valves in some fresh-water fishes of India. *Sci and Cult.*, **25** : 318—319.

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

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TO THE IDENTITY OF THE MICROSPORIDIA AFFECTING MAN

Jaroslav WEISER

Abstract: Microsporidia in mammals are divided into three groups: *Encephalitozoon cuniculi* with spores 2.5 μm, mononuclear *Nosema chagasi (connori)* with spores binuclear and ranging from 3 to 4 μm and *Thelohania apodemi* with octosporous pansporoblasts and spores 4 to 5 μm long. Only members from the *chagasi-connori* group are known from man. The inclusions in neural cells during disseminated sclerosis are dicussed.

A recent description of *Nosema connori* (Sprague, 1974) brought again to the scientific audience the problem of the plurality of microsporidian infections of man and of mammals in general. As discussed earlier (Weiser, 1965) several microsporidia have been reported from different mammals as members of the genera *Encephalitozoon*, *Nosema* and *Thelohania*. The descriptions are spread over the last 50 years and the details of descriptions are concentrated on different features. Some fundamental differences in ultrastructures of *Nosema* and *Encephalitozoon* were recognized recently and used for their differentiation. The different erudition of the authors of early descriptions reflects in the poor differentiation of mature spores and stages of sporogony. Sporonts and sporoblasts are usually larger than mature spores and a broad range of the indicated dimensions is caused by inclusion of the young stages into the calculation of spore size. Only the lower sizes should be taken for comparison. When arranged according the spore size, the microsporidia from mammals can be divided into three distinct groups (Tab. 1): In the first group there are organisms with minute broad pyriform spores not longer than 2.5 μm (2 — 2.5 × 1 — 1.5 μm). They are uninuclear, have the primary seat in the makrophagues and develop with vegetative stages in the cells of the kidney, the connective tissue and several other organs including the pankreas and ganglial cells of the brain (Fig. 1). Secondary cysts with mature spores are distributed in different organs of the body. The hosts are small mammals, mainly rodents, carnivors and herbivors. Most of them are synanthropic organisms.

The final group with spores 4—5 by 2—2.5 μm and with spores in groups of eight, is represented only by *Thelohania apodemi* (Doby et al., 1963) (Fig. 3). The occurrence is very rare or is their diagnostics made only on histological material from field collected rodents.

Between these two extreme groups we find a series of reports of microsporidia with a spore size 3—4 by 1.5 μm. This intermediary group includes *Encephalitozoon chagasi* (Torres, 1927), *E.* sp. Matsubayashi et al. (1959), *Nosema* sp. Seibold and Fussell (1973) and *Nosema connori* Sprague (1974) (Fig. 2). This group has in common the spore size (3—4 by 1.5 μm), and two nuclei connected in a diplokaryon, they occur in man or in primate hosts. They have some affinity to the gut and muscles, but they occur also in other tissues.

Tab. 1. Microsporidia occurring in mammals and man

	Name	Spore size μm	Tissue	Host	Author
I.	*Encephalitozoon cuniculi*	2.5 × 0.5 — 1	Br K L P Ct Ly	rabbit mouse	Levaditi et al., 1924
	Encephalitozoon rabiei	1 — 2	Sg Br	dog	Manouelian, Viala 1924
	Encephalitozoon negrii	1 — 2	Br Sg	dog	Manouelian, Viala 1927
	Glugea lyssae	2 × 1	Br	dog	Levaditi et al., 1924a
	Nosema muris	2,5 × 1	M Ct Ly	mouse	Weiser, 1965
II.	*Encephalitozoon chagasi*	3.5 × 1.5	M Br Ct	man	Torrez, 1927
	Encephalitozoon sp.	2.7 — 3 × 1,2 — 1.8	Br Sp	man	Matsubayashi et al., 1959
	Nosema sp. ex *Calicebus*	2 × 4	G Ly	primate	Seibold, Fusse, 1973
	Nosema connori	4 — 4,5 × 2 — 2.5	G Ly M	man	Sprague, 1974 Margileth et al., 1973
III.	*Thelohania apodemi*	4 — 5 × 2 — 2.5	Br	mouse	Doby et al., 1963
IV.	*Encephalitozoon brumpti*	2 — 6 × 1.5 — 3.5	Br	man	Coulon, 1924

Abbreviations: Br = brain, Ct = connective tissue, G = gut, K = kidney, L = lung, Ly = lymphocytes, M = muscles, Sg = salivary glands, Sp = spinal fluid, P = pancreas

Beside of this we find only the description of *E. brumpti* (Coulon, 1929) where the indicated size of the stages is variable in a large extent which is not common in microsporidia.

From the above data it is evident that at least 4 of the reported parasites have oval spores in the range of 3—4 by 1.5—2 μm. The case of the infection in man described by Matsubayashi et al. (1959) where the original slides are available, was slightly confused because mice were used for its isolation and an eventual cross-contamination with *E. cuniculi* could not be avoided. The organism re-isolated from experimental mice after intraperitoneal injection of the spinal fluid was again the larger type, with spores 3 to 3,5 by 2 to 2.8 μm. They can be identified with *E. cuniculi* only with difficulties and today we can understand the difference. The original smears of the spinal fluid were inspected by me during the 1st Congress of Parasitology in Rome, 1966 and could definitely be identified as microsporidian spores.

Sprague (1974) hesitated to accept the old taxon *E. chagasi* Torres and supported his decision with the citation of my statement (Weiser, 1965) of the impossibility of appraisal of *E. chagasi* because the original material has been lost. My statement reflected the status in 1965. In the case of rediscovery of a lost material in the same host under the same circumstances, with the same distribution in tissues and of the same general morphology, it is the use to take such material for the neotype and emendate the description. The material described by Margileth et al. (1973) most corresponds to the microsporidian *E. chagasi*. The discovery of two nuclei in each spore tentatively indicated by Sprague and documented on ultrathin sections

by Shadduck (1974), contributed in an essential way to the differentiation of both microsporidia.

If we take into consideration only the clean descriptions of microsporidia in human cases or in primates, we find that all belong to the *"chagasi"* group. There is no evidence yet of an infection with the *"cuniculi"* spore-type in man, on the other side. This fact does of course bring other implications to the conclusions of Chalupský & Vávra (1974), who discuss the negative skin-and immunofluorescent antigen tests with man. and *E. cuniculi* as antigen. Our experience (Kálalová and Weiser, 1973) is that microsporidia are species specific in immunofluorescent antigen tests. In this sense their negative findings do not exclude the eventual etiological connection of some cases of multiple sclerosis with microsporidian infections as it was discussed by Witing (1965) on basis of specific granulations appearing in brain ganglial cells (Fig. 4) in the regions which serve the functions destroyed during multiple sclerosis.

REFERENCES

Cali A., 1971: Morphogenesis in the genus Nosema. Proc. 4th Int. Coll. Insect Pathol., College Park, Md,: 431—438.

Coulon G., 1924: Présence d'un nouvel Encephalitozoon (Encephalitozoon brumpti n.sp.) dans le liquide cephalorachidien d'un sujet attaint de méningite suraigue. *Ann. Parasit.*, 7 :449—452.

Chalupský J., Vávra J., 1974: Personal communication.

Doby J. M., Jeannes A. and Rault B, 1963: Thelohania apodemi n.sp., première microsporidie du genre Thelohania observée chez un mammifère. *C. R. Acad. Sci.*, 257 : 248—251.

Kálalová S. and Weiser J., 1973: Identification of microsporidia by indirect fluorescent antibody tests. Proc. Vth. Int. Coll. Insect Pathol., Oxford, p. 111.

Levaditi C., Nicolau S. and Schoen R., 1924a: L'étiologie de l'encéphalite epizootique du lapin dans ses rapports avec l'étude experimentelle de l'encéphalite léthargique Encephalito zoon cuniculi (nov. spec.). *Ann. Inst. Pasteur*, 38 : 651—712.

Levaditi C., Nicolau S. and Schoen R., 1924b: La microsporidiose du lapin, ses relations avec la rage. *C. R. Acad. Sci.*, 178 : 256—258.

Manouelian Y. and Viala J., 1924: Encephalitozoon rabiei, parasite de la rage. *Ann. Inst. Pasteur*, 38 : 258—267.

Manouelian Y. and Viala J., 1927: Encephalitozoon Negrii, parasite de l'encéphalomyelite des jeunes chiens. *C. R. Acad. Sci.*, 184 : 630—632.

Margileth A. M., Strano A. J., Chandra R., Neafie R., Blum M. and McCully R. M., 1973: Disseminated nosematiosis in an immunologically compromesed infant. *Arch. Pathol.*, 95 : : 145—150.

Matsubayashi H., Koike T., Mikata I., Takei H. and Hagiwara S., 1959: A case of Encephalitozoon-like body infection in man. *Arch Pathol.*, 67 : 181—187.

Seibold H. R. and Fusse E. N., 1973: Intestinal microsporidiosis in Callicebus moloch. *Laboratory animal sci.*, 23 : 115—118.

Shadduck J. A., 1974: Mammalian microsporidioses. Proc. 3rd. Int. Congress of Parasitol., Munchen, III : 154.

Sprague V., 1974: Nosema connori sp.n., a microsporidian parasite of man. *Trans. Amer. Microscop. Soc.*, 93 : 400—403.

Torrez C. M., 1927: Encephalitozoon chagasi, n.sp., observé dans un cas de méningo encéphalo--myélite congénitale avec myosite et myocardite. *C. R. Soc. Biol.*, 97 : 1787—1790.

Weiser J., 1965: Nosema muris n.sp., a new microsporidian parasite of the white mouse (Mus musculus L.) *J. Protozool.*, 12 : 78—83.

Weiser J., 1966: Microsporidian infections in mammals and the genus Encephalitozoon. Trans. Inst. Int. Congress of parasitol., Roma: 445—446.

Witting A. I., 1965: (Contribution à létude de l'étiologie de la sclerose en plaques à la lumière des donnés de l'exploration morphologique du système nerveux central). (Russian, French summary). *Zhurnal neuropatologii i psichiatrii*, 65 : 1641—1645.

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† RNDr. JAROSLAVA KOŘÍNKOVÁ

June 23, 1938 — September 25, 1974

On 25th September 1974, Czechoslovak hydrobiology sustained a great loss through the untimely death of Jaroslava Kořínková, Senior Lecturer at the Department of Hydrobiology of the Charles University, Praha.

Jaroslava Kořínková was born in Praha on the 23rd June, 1938, and finished grammar school there in 1956. In the same year she began her studies at the Charles University and obtained her prom. biol. degree with honours (equivalent of MSc) in 1961. Her deep interest in the everchanging natural phenomena and an inborn delight in sports activities and physical training were the decisive factors in her selection of hydrobiology as a major object of her study. The intensive field work on fish ponds in the gentle Southwestern Bohemian landscape of melancholy beauty and the valuable results of her early studies fully satisfied her desire for a full life. She was concerned with problems of the spatial distribution of the bottom fauna and statistical evaluation of its quantitative sampling. Within a short time she acquired the affection of her fellow students and colleagues for her energy, inventiveness and brightness as well as for her cheerful disposition.

In 1961, she was appointed Lecturer in the Department of Hydrobiology of the Charles University, in 1964 she became Senior Lecturer. Her research activities were concentrated from the start on problems of the littoral fauna in fish ponds. The influence of fish on the density and biomass of animals living on and among submerged vegetation, relations between the density of the vegetation and species diversity of the macrofauna and its types of distribution were the main objects of her interest. She invented a new sampling method which was later included in the Handbook of methods for measuring the secondary productivity in freshwaters recommended in the International Biological Program. All new results in this field were profoundly treated in the manuscript of her PhD thesis, the publication of which was prevented by her death. ("A study of relations between submerged vegetation in a carp pond and its fauna". PhD Thesis, Praha, 1973).

Jaroslava Kořínková was a talented teacher, easily acquiring the confidence of her students. She lectured on the biology of the littoral and freshwater insects and gave laboratory and field courses in the identification of freshwater fauna. Some of her students were inspired by her enthusiastic study of the littoral fauna and later took their degrees in the same field under her supervision.

Dr. Jaroslava Kořínková eas an extremely conscientious, industrious and charming person, always ready to offer help to anyone who needed it. Her friendly, straightforward and honest character was invaluable in the team-work conducted in our department.

Her colleagues and friends will always remember her.

Jan Lellák

BIBLIOGRAPHY

Kořínková J., 1963: To the statistical evaluation of the pond bottom fauna sampling accuracy. *Věst. Čs. spol. zool.*, **27** (4) : 280—294.

Kořínková J., 1966: Submerged vegetation and its fauna. *Čs. rybářství*, **7** : 98—99 (in Czech).

Kořínková J., 1966: Biology of freshwater fauna. Trichoptera. Mimeographed, 132—138 (in Czech).

Kořínková J., 1967: Relations between predation pressure of carp, submerged plant development and littoral bottom fauna of pond Smyslov. *Rozpravy ČSAV, řada MPV*, **77** (11) : 35—62.

Kořínková J., Sigmund J. 1968: The colouring of bottom-fauna samples before sorting. *Věst. Čs. spol. zool.*, **32** (3) : 300—304.

Kořínková J., 1971: Quantitative relations between submerged macrophytes and populations of invertebrates in a carp pond. *Hidribiologia*, **12** : 377—382, Bucuresti.

Kořínková J., 1971: Sampling and distribution of animals in submerged vegetation. *Věst. Čs. spol. zool.*, **35** (3) : 209—221.
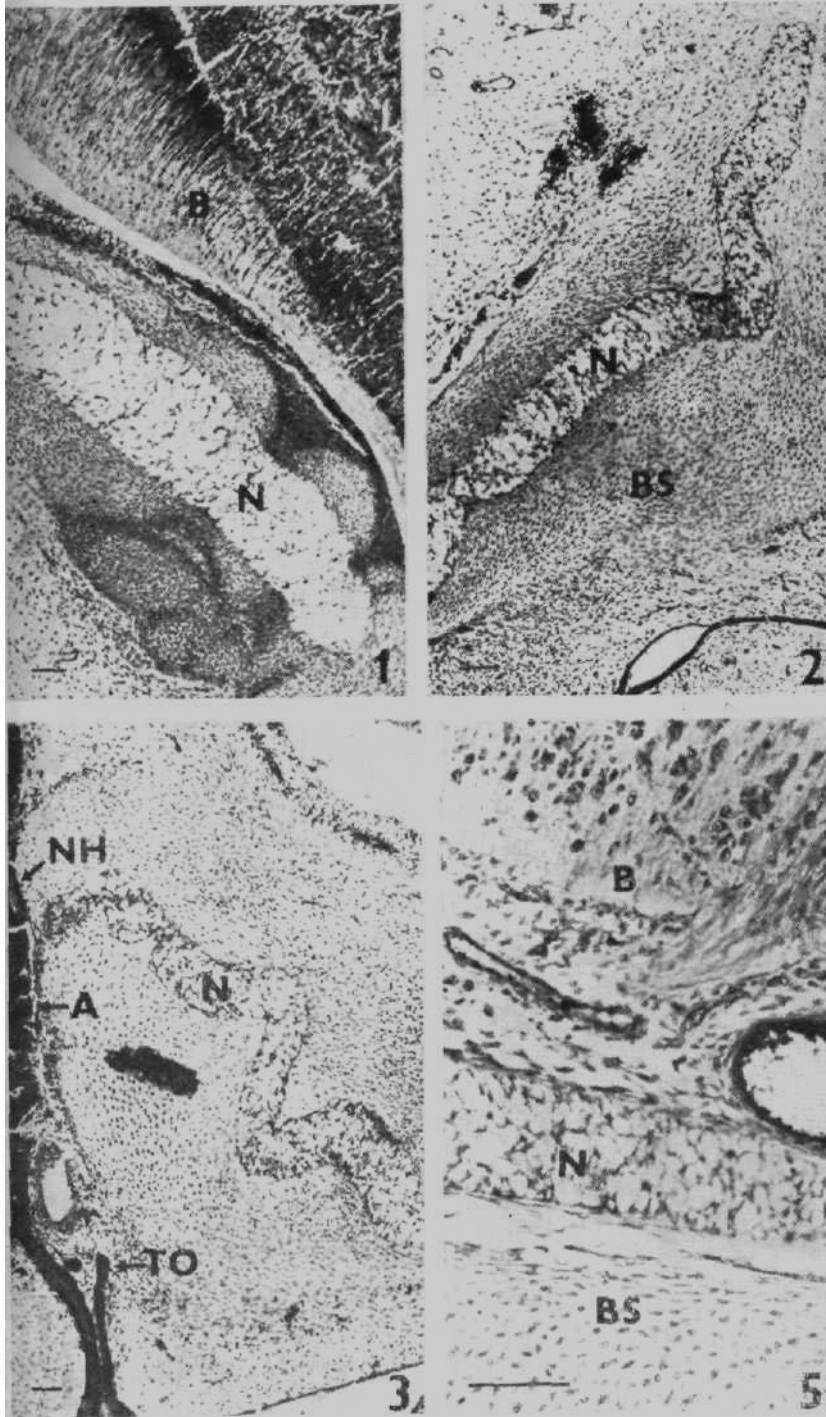
Fig. 1. Primordia of upper cervical vertebrae and cervical segment of notochord. Sagittal section. B — brain (central nervous system), N — notochord. 10th day of embryogenesis (d.e.), exencephalic embryo. — Fig. 2. Twisted (spiral) course of notochord in base of skull. N — notochord, BS — base of skull. Dorsum sellae to right and upwards. Sagittal section, 11th d.e., exencephalic embryo. — Fig. 3. Spiral course of ventral segment of notochord. NH — neurohypophysis, A — adenohypophysis, N — notochord, TO — third organ. 10th d-e., exencephalic embryo. — Fig. 5. Suprabasal course of notochord, notochord localized directly below brain. Sagittal section. B — central nervous system, N — notochord, BS — base of skull. 13th d.e., exencephalic embryo. Scales = 10 μm.
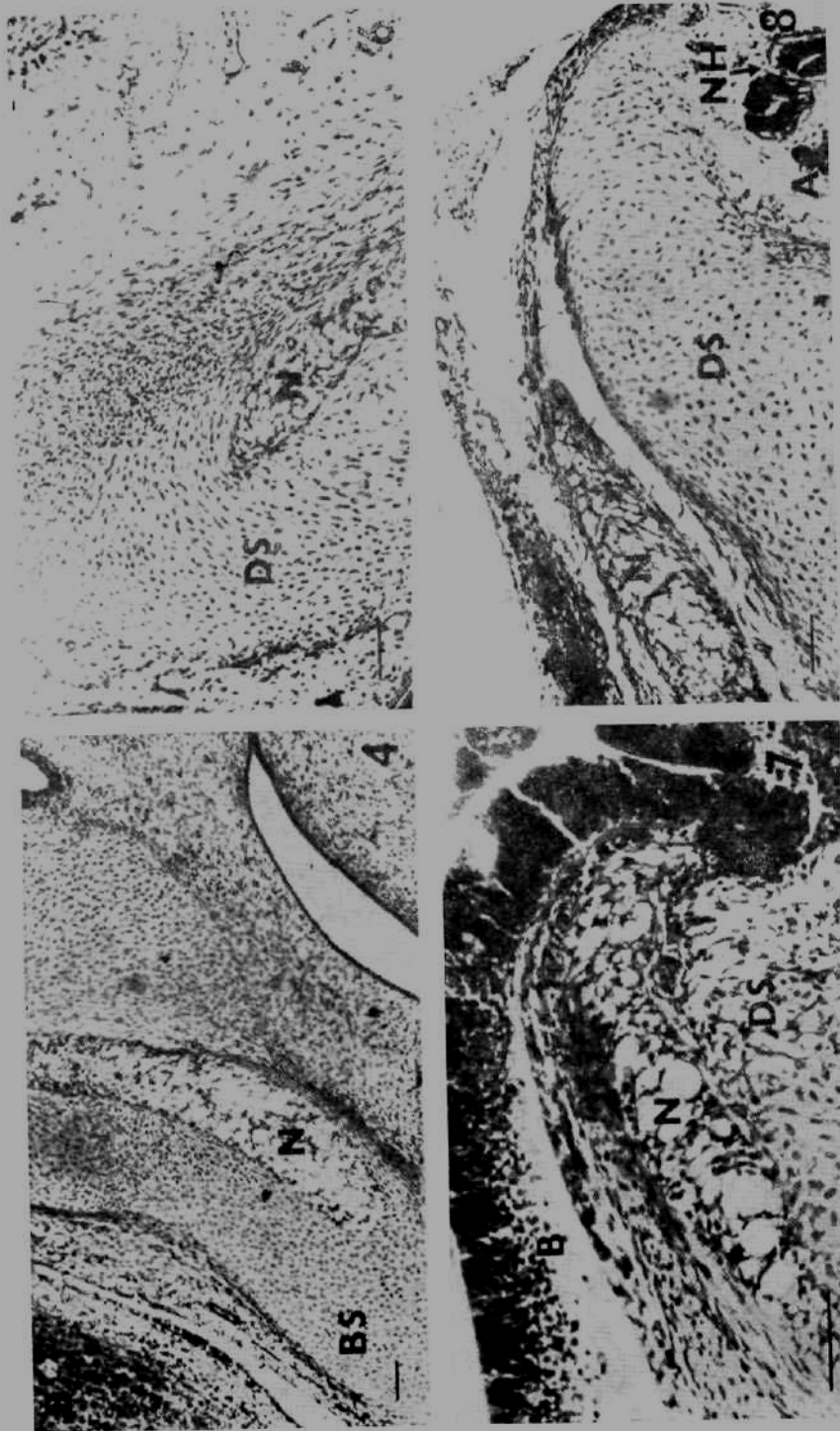
Fig. 4. Subbasal course of notochord. Notochord in contact with perichondrium on under surface of base of skull. Sagittal section. B — central nervous system. BS — base of skull. N — notochord. 12th d.e., exencephalic embryo. — Fig. 6. Rostral segment of notochord in posterior surface of dorsum sellae. Sagittal section. DS — dorsum sellae. N — notochord. Pituitary localized on left, outside figure. 11th d.e., exencephalic embryo. — Fig. 7. Notochord encircling apex of dorsum sellae. Pituitary localized in top right corner. Sagittal section. B — central nervous system. N — notochord. DS — dorsum sellae. 9th d.e., exencephalic embryo. — Fig. 8. Regressing notochord behind and above dorsum sellae. Sagittal section. N — notochord. DS — dorsum sellae. NH — neurohypophysis. A — adenohypophysis. 13th d.e., exencephalic embryo. Scales = 10 μm.

Fig 4. *Soboliphyme hirudiniformis* in the stomach of Talpa europaea.

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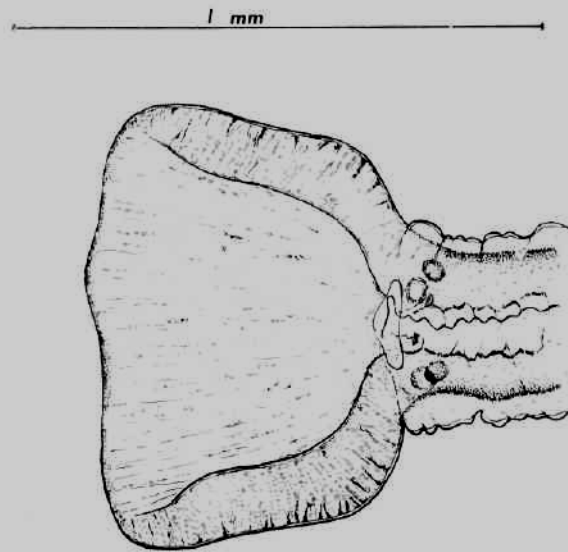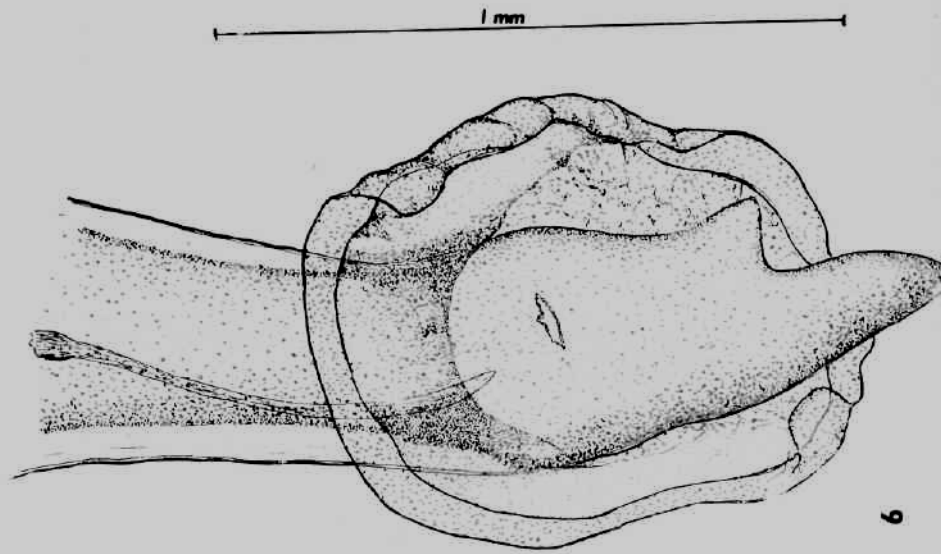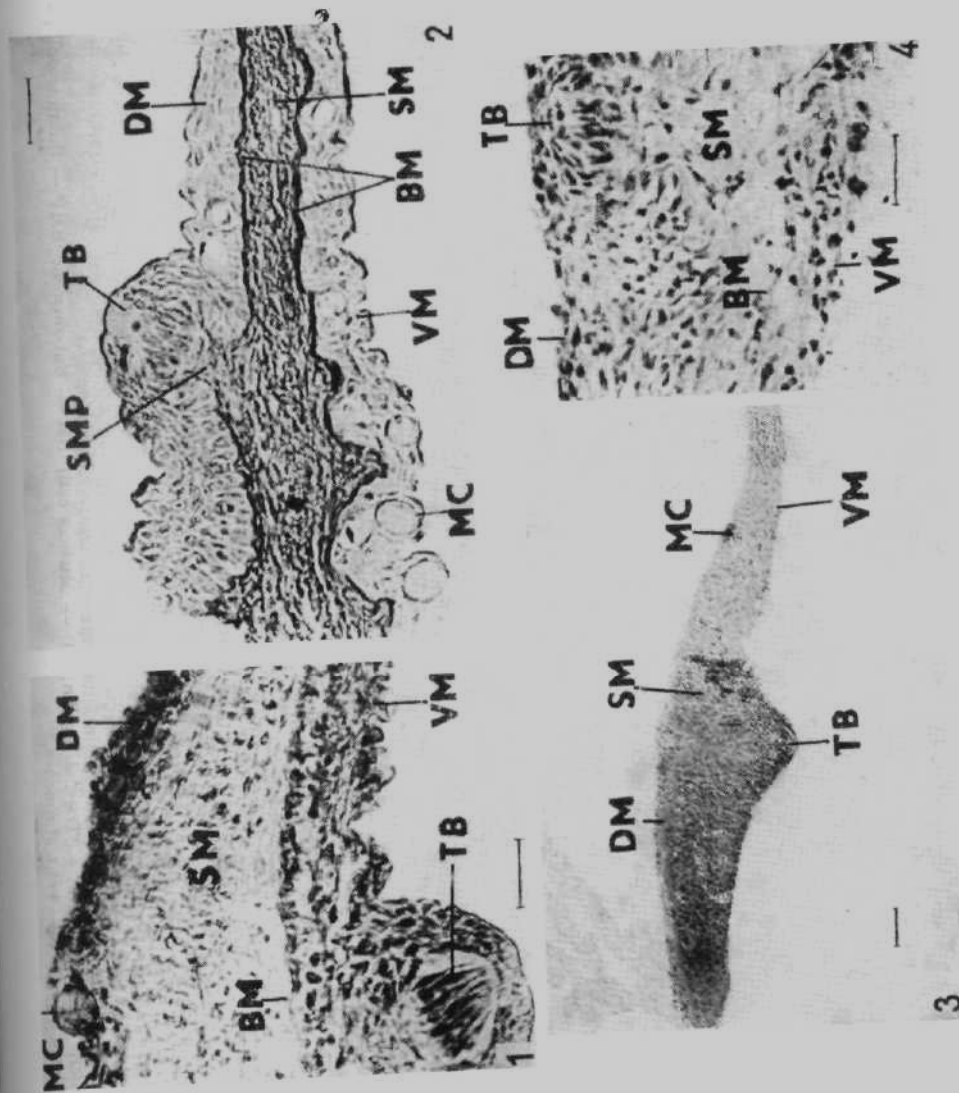
Fig. 1. A part of the T. S. through the maxillary oral valve of *Bagarius bagarius*, Fig. 2. — A part of the T. S. through the mandibular valve of *Bagarius bagarius*, Fig. 3. — A part of the T. S. through the maxillary oral valve of *Xenentodon cancila*, Fig. 4. A part of the T. S. through the mandibular oral valve of *Xenentodon cancila*. BM — Basement membrane; DM — Dermal papilla; MC — Mucous cell; SM — Submucosa; SMP — Submucosal papilla; TB — Taste bud; VM — Ventral mucosa.

Fig. 5. A part of the T. S. through the maxillary oral valve of *Badis dario*, Fig. 6. A part of the T. S. through the mandibular oral valve of *Colisa fasciata*, Fig. 7. A part of the T. S. trough the maxillary oral valve of *Chatoessus manminua*. Fig. 8. A part of the T. S. through the mandibular oral valve of *Chatoessus manminua*. BM — Basement membrane; DM — Dermal papilla; MC — Mucous cell; SM — Submucosa; SMP — Submucosal papilla; TB — Taste bud; VM — Ventral mucosa.
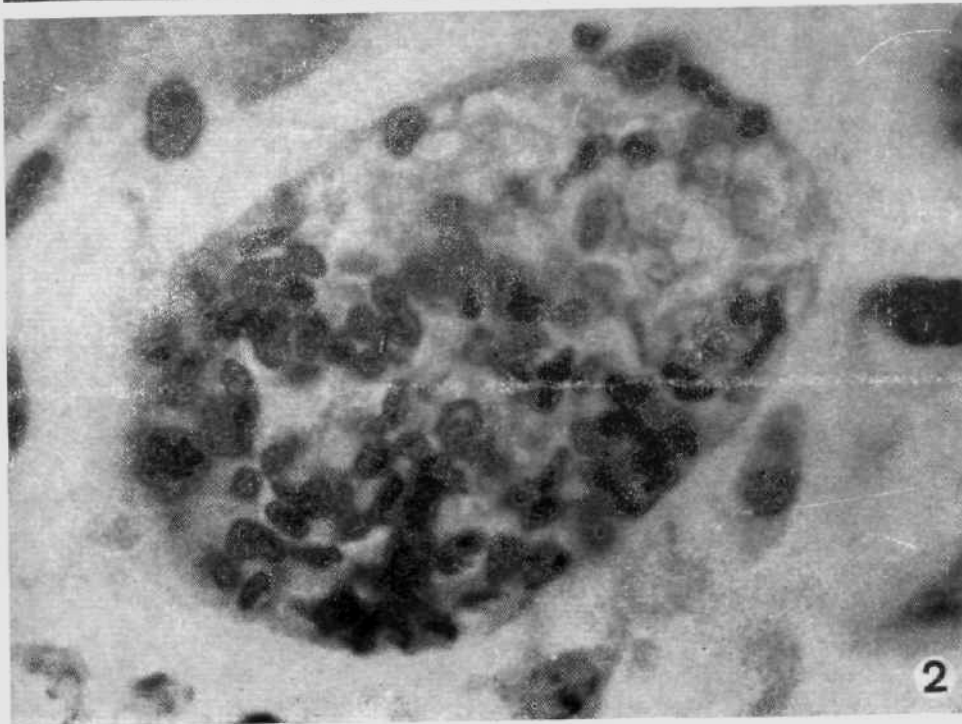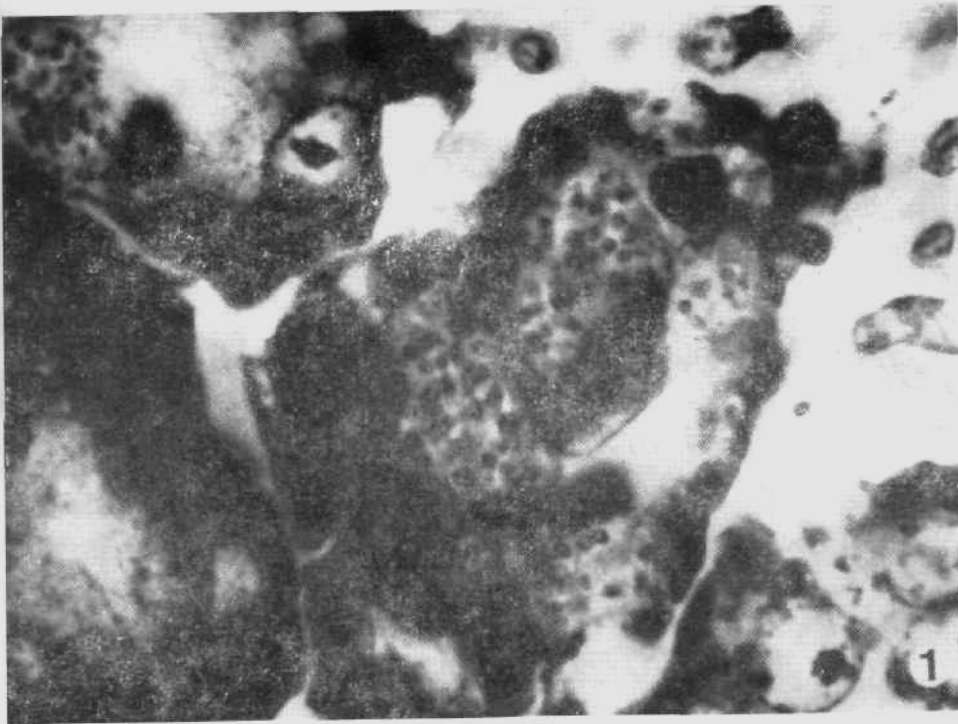
Fig. 1. *Encephalitozoon cuniculi* in the pancreas of the mouse. Heidenhain, 2000×.
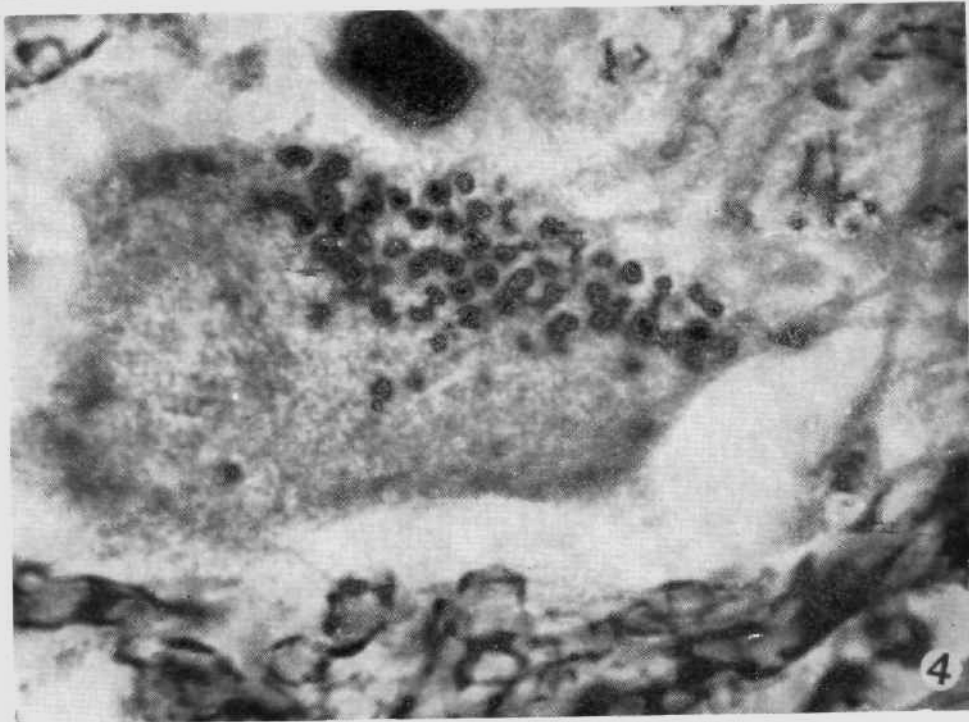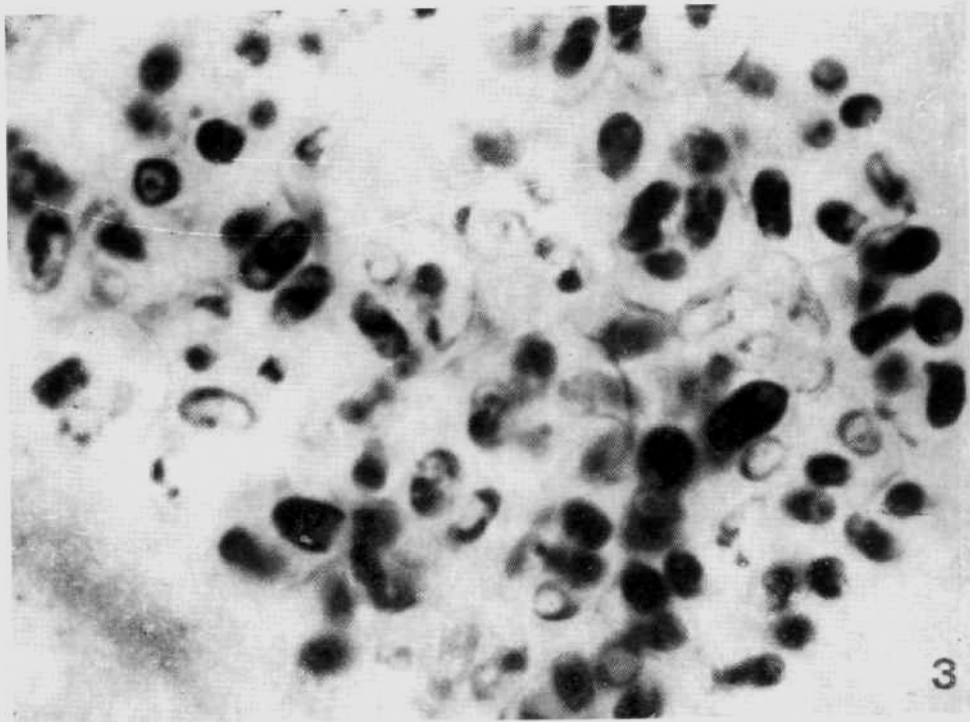Fig. 2. *Nosema connori* in the makrophagues of the child. Heidenhain, 2200×.

Fig. 3. *Thelohania apodemi*, a cyst in the brain of *Apodemus sylvaticus*, octosporous pansporoblasts. Heidenhain, 2000×.
Fig. 4. A Purkynje cell of the brain of a case with disseminated sclerosis with inclusions, Heiden-