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Laboratoire de Zoologie, Faculté des Sciences et Centre de Faune Portugaise (INIC) — Lisbonne, Portugal

RÉPARTITION GÉOGRAPHIQUE DES CYPRINIDAE IBÉRIQUES ET SECTEURS ICHTHYOGÉOGRAPHIQUES DE LA PÉNINSULE IBÉRIQUE

CARLOS ALMAÇA

Reçu le 23 Mars 1977

Abstract: Based on the geographic distribution of species and subspecies of Iberian Cyprinidae, the author recognizes three sub-districts in the Iberian Peninsule: ebro-cantabre, central, and meridional. The boundaries between these sub-districts are the geographical barriers which seem to have played an important part in the speciation of autochthone Iberian Cyprinidae.

INTRODUCTION

Au point de vue de l'ichthyofaune dulçaquicole, la Péninsule Ibérique constitue le district (Berg, 1932), ou province (Banarescu, 1964), ibérique de la sous-région méditerranéenne (Berg, 1932), ou euro-méditerranéenne (Banarescu, 1964). Rey (1952), se référant aux Poissons véritablement dulçaquicoles, considère que la Péninsule Ibérique forme un district faunistique complètement séparé du reste de l'Europe par les Pyrénées, pour lequel il suggère la désignation de "pyrénéen".

En se basant sur les bassins marins qui reçoivent les eaux douces et sur les Poissons fréquentant ces eaux, Arévalo (1929) a essayé une régionalisation des eaux intérieures de la Péninsule Ibérique. Cet auteur reconnait les "provinces" suivantes: (1) cantabrique (comprise entre les fleuves Bidasoa et Minho), se caractérisant par la présence du Saumon, (2) atlantique, qui ne possède ni le Saumon, ni des Cyprinodontidae, et (3) bético-méditerranéenne, caractérisée par la présence de Cyprinodontidae. Des critères un peu différents, dénonçant d'ailleurs le rôle essentiel que l'auteur attribue au bassin du Tage, ont mené Rey (1952) à considérer, en ce qui concerne la répartition géographique des Poissons des aux intérieures ibériques, deux "régions": (1) septentrionale et partie de la centrale, caractérisée par *Leuciscus cephalus, Phoxinus phoxinus, Rutilus arcasi, Chondrostoma toxostoma, Ch. polylepis, Barbus meridionalis, B. meridionalis graellsi, B. barbus bocagei* et *Cobitis barbutula;* et (2) méridionale, caractérisée par *L. cephalus pyrenaicus, L. alburnoides, L. lemmingii, Phoxinellus hispanicus, Ch. polylepis willkommi, Ch. toxostoma arrigonis, B. barbus sclateri, B. comiza* et *Valencia hispanica.* À propos de cette régionalisation on doit remarquer que les formes *alburnoides* et *lemmingi* sont comprises par Rey (1952) dans le genre *Leuciscus.* Cependant, dans d'autres travaux, le même auteur (Rey, 1935, 1947) les classe, correctement à mon avis, dans le genre *Rutilus.*

En étudiant la spéciation chez les Cyprinidae ibériques, Almaça (1976) a constaté que des barrières géographiques ayant vraisemblablement jouée un rôle important dans l'isolement de ces Poissons divisant la Péninsule Ibérique en trois secteurs, ou sous-districts, plus homogènes. Ces barrières géographiques sont formées par les Monts Cantabriques et le Système Ibérique, d'une part, et par le Système Tolédan, d'autrepart (fig. 1). Cette division en secteurs ichthyogéographiques sera reprise et approfondie dans ce travail, ainsi que des problèmes qu'elle soulève.

MATÉRIEL ET MÉTHODES

En ce qui concerne la nomenclature zoogéographique on suit de tout près Udvardy (1969). Les taxa "autochthones", ou "indigènes" sont ceux que je crois formés dans la Péninsule Ibérique. Les taxa "allochthones" se sont formés ailleurs, mais leur dispersion naturelle les a menés jusqu'en Ibérie. Par "Cyprinidae ibériques", ou "de la Péninsule Ibérique", on veut désigner l'ensemble des formes autochthones et allochthones, c'est à dire, les espèces et les sous-espèces qui n'ont *pas été introduites en Ibérie par l'action de l'homme. Les mots "endémisme"* et "endémique" sont employés, soit au niveau de la province, ou district, ibérique, soit au niveau des secteurs, ou sous-districts, reconnus dans ce travail. Le mot "forme" désigne, indifféremment, les espèces et les sous-espèces. Enfin, on nomme "secteurs", ou "sous-districts", les divisions ichthyogéographiques reconnues dans la province, ou district, ibérique.

Au point de vue de la répartition des Cyprinidae ibériques, je me base sur les travaux de Almaça (1965, 1967, 1971 et données non publiés), de l'Instituto Forestal de Investigaciones y Experiencias (1952) et de Rey (1952). Les formes introduites dans l'Ibérie, qui appartiennent aux genres *Cyprinus*, *Carassius* et *Gobio*, ne sont pas considérées dans ce travail.

En ce qui concerne la reconnaissance des secteurs, ou sous-districts, ichthyogéographiques, j'ai suivi la méthode décrite ci-dessous. On a cherché les bassins et versants hydrographiques dont la diversité spécifique et sous-espécifique en Cyprinidae est la plus grande (tableau 1). Ces bassins et versants sont également ceux dont la surface est la plus grande. Le nombre de formes communes à chaque paire de bassins et/ou versants a été retenu et, pour les bassins et/ou versants étant en contiguité géographique (pour que la distance influence au minimum l'affinité taxinomique), on a calculé les pourcentages du nombre de formes communes par rapport au nombre de formes du bassin ou versant où la diversité est moindre (tableau 2). Ces pourcentages peuvent être considérés comme des indices d'affinité relative des faunes de Cyprinidae entre bassins et/ou versants géographiquement contigus.

SECTEURS, OU SOUS-DISTRICTS, ICHTHYOGÉOGRAPHIQUES DE LA PÉNINSULE IBÉRIQUE

L'observation du tableau 2 montre que les pourcentages les plus élevés (égaux ou supérieurs à 80%) entre bassins et/ou versants étant en contiguité géographique (fig. 1), sont trouvés entre le bassin de l'Ebre et le versant cantabrique, entre le bassin du Tage et ceux du Douro, du Sado et du Jucar, entre le bassin du Douro et celui du Vouga, et entre le bassin du Guadalquivir et celui du Guadiana et le versant du Sud d'Espagne. Ceci permet de croire que, en ce qui concerne les faunes de Cyprinidae, les secteurs ichthyogéographiques plus homogènes seront les suivant (fig. 2):

(1) ebro-cantabrique (bassin de l'Ebre et versant cantabrique),
(2) central (bassins du Douro. Vouga, Tage, Sado et Jucar),
(3) méridional (bassins du Guadiana et du Guadalquivir et versant du Sud d'Espagne).

Cette division de l'Ibérie n'est pas très différente de celle proposée par Arévalo (1929). Les Cyprinodontidae n'étaient pourtant pas connus, à cette époque-là, du bassin du Guadiana. En effet, la découverte de *Valencia hispanica* dans la portion terminale de ce bassin est tout à fait récente (Coelho et al., 1976).

Le problème des bassins situés à la limite des secteurs doit être considéré ici. Ce sont les cas du bassin du Minho (entre les secteurs ebro-cantabrique et central), du Sado, du Mira et du versant de l'Algarve (entre les secteurs central et méridional) et du Jucar (entre les secteurs ebro-cantabrique, central et méridional) (fig. 1).

Dans le bassin du Minho sont connues 4 formes de Cyprinidae: *B. barbus bocagei, L. cephalus cabeda, R. arcasi arcasi* et *Ch. polylepis polylepis* (tableau 1). Ces 4 formes habitent également le bassin du Douro, tandis que seules les 3 dernières existent dans le versant cantabrique. Au point de vue de la faune de Cyprinidae l'affinité du Minho me semble plutôt avec le bassin du Douro.

En ce qui concerne les rapports entre le bassin du Sado et celui du Tage, d'une part, et le secteur méridional, de l'autre, il y a quelques points à considérer. Dans le bassin du Sado sont connues *B. barbus bocagei, L. cephalus pyrenaicus, R. arcasi arcasi, Ch. polylepis polylepis* et *Ch. toxostoma toxostoma* (tableau 1). Les 4 premières habitent également le Tage. Les petits fleuves du versant de l'Algarve et le Mira, qui voisinent par le sud avec le bassin du Sado, sont habités par *B. barbus sclateri, L. cephalus pyrenaicus* et des populations intermédiaires de *R. arcasi-R. lemmingi* (Almaça, 1965, 1967). Seules 2 formes habitant le Sado, *L. cephalus pyrenaicus* et *R. arcasi arcasi*, existent aussi au Guadiana (tableau 1). L'affinité entre le Tage et le Sado semble donc indéniable. Cette affinité est d'ailleurs basée sur des preuves paléogéographiques: pendant le Miocène ces deux fleuves convergaient dans un estuaire commum. Ceci pourra expliquer pourquoi le système Tage-Sado, et non seulement le Tage, coïncide avec la limite de répartition géographique, soît septentrionale, soît méridionale, de plusieurs formes de Cyprinidae. C'est ainsi que *B. barbus bocagei* et *Ch. polylepis polylepis* ont leur frontière méridionale dans le système Tage-Sado, tandis que ce même système représente la frontière septentrionale de *L. cephalus pyrenaicus*. Ceci pourra signifier que, au Miocène, ces formes étaient déjà différenciées, leur passage d'un bassin à l'autre étant alors possible. Cette hypothèse n'est pas en contradiction avec l'époque probable de formation de *B. barbus bocagei* et *Ch. polylepis polylepis* — ces taxa ne seraient pas formés avant la fin de l'Oligocène (Almaça, 1976) — et de *L. cephalus pyrenaicus* — qui ne serait pas formée avant le Pontien (Almaça, 1976). En fait, la liaison entre les bassins du Tage et du Sado peut avoir persistée pendant une partie du Pliocène (Carvalho, 1968).

La faune de Cyprinidae du Jucar est représentée par *B. meridionalis graellsi, B. barbus bocagei, R. arcasi arcasi, L. cephalus pyrenaicus* et *Ch. toxostoma arrigonis* (tableau 1). Cette faune est partagée avec le bassin du Tage et le bassin de l'Ebre, en ce qui concerne, respectivement, les 4 premières et les 3 premières formes (tableau 1). *R. arcasi arcasi* et *L. cephalus pyrenaicus* sont communes avec le bassin du Guadiana et seule cette dernière forme existe également dans le versant du sud d'Espane.

Tab. 1. Diversité spécifique et sous-spécifique en Cyprinidae des principaux bassins et

Espèce	Bassin de l'Ebre	Versant cantabrique	Bassin du Douro	Bassin du Vouga
Tinca tinca (L., 1758)	+		+	
Barbus meridionalis meridionalis Risso, 1826	+			
B. meridionalis graellsi Steindachner, 1866	+	+		
B. barbus bocagei Steindachner, 1865	+		+	+
B. barbus sclateri Gunther, 1868				
B. steindachneri Almaça, 1967				
B. comiza Steindachner, 1865				
B. microcephalus Almaça, 1967				
Phoxinus phoxinus (L., 1758)	+	+		
Leuciscus cephalus cabeda Risso, 1826	+	+	+	+
L. cephalus pyrenaicus Gunther, 1862				
Rutilus arcasi arcasi Steindachner, 1866	+	+	+	+
R. arcasi macrolepidotus Steindachner, 1866			+	+
R. lemmingi Steindachner, 1866				
Tropidophoxinellus alburnoides (Steindachner, 1866)			+	
Pseudophoxinus hispanicus (Steindachner, 1866)				
Chondrostoma polylepis polylepis Steindachner, 1865		+	+	+
C. polylepis willkommi Steindachner, 1866				
C. toxostoma toxostoma (Vallot, 1836)	+	+		
C. toxostoma arrigonis (Steindachner, 1866)				
Nombre de formes	8	6	7	5

Dans le bassin de l'Ebre *L. cephalus pyrenaicus* n'existe pas, étant remplacée par *L. cephalus cabeda*.

La comparaison des faunes de Cyprinidae des trois secteurs, ou sous--districts, reconnus dans le présent travail (tableau 3) montre que:

(1) une seule forme, *R. arcasi arcasi*, endémisme ibérique, est commune aux trois secteurs;

(2) le secteur ebro-cantabrique ne présente que deux formes exclusives — *Ph. phoxinus* et *B. meridionalis meridionalis* —, toutes les deux centro--européennes;

(3) en plus de *R. arcasi arcasi*, il y a six formes communes aux secteurs ebro-cantabrique et central, dont trois — *T. tinca*, *L. cephalus cabeda* et *Ch. toxostoma toxostoma* — sont centro-européenes et les trois autres — *B. meridionalis graellsi*, *B. barbus bocagei* et *Ch. polylepis polylepis* — sont des endémismes ibériques;

(4) il y a deux formes endémiques du secteur central, l'une de répartition occidentale littorale — *R. arcasi macrolepidotus* — et l'autre de répartition méridionale — *Ch. toxostoma arrigonis* (bassin du Jucar);

versants hydrographiques de la Péninsule Ibérique

Bassin du Tage	Bassin du Sado	Bassin du Guadiana	Bassin du Guadalquivir	Versant du sud d'Espagne	Bassin du Jucar
+					
+					+
+	+				+
		+	+	+	
+		+			
+		+	+		
		+			
+	+	+	+	+	+
+	+	+			+
+					
+		+	+	+	
+		+	+	+	
		+			
+	+				
		+	+	+	
	+				
					+
11	5	10	6	5	5

(5) la répartition actuelle des formes centro-européennes ne dépasse pas le secteur central; le secteur méridional n'est habité que par des endémismes ibériques;

(6) en plus de *R. arcasi arcasi*, il y a dans le secteur méridional quatre formes communes avec le secteur central — *B. steindachneri, L. cephalus pyrenaicus, R. lemmingi* et *Tr. alburnoides* — et quatre formes endémiques méridionales — *B. barbus sclateri, B. microphalus, Pseud. hispanicus* et *Ch. polylepis willkommi.*

DISCUSSION

Pour établir cette division en secteurs on a attribuée la même valeur zoogéographique à toutes les formes de Cyprinidae ibériques, indépendamment de leur statut spécifique ou sous-espécifique. Ceci tient au fait que je crois que le statut taxinomique de quelques Cyprinidae ibériques devra être révisé. Il me paraît que des formes telles que *B. barbus bocagei* et *B. barbus sclateri, Ch. polylepis polylepis* et *Ch. polylepis willkommi, L. cephalus cabeda* et *L. cephalus pyrenaicus*, dont la formation sera très

Tab. 2. Nombre de formes de Cyprinidae des principaux bassins et versants hydrographiques de la Péninsule Ibérique

Dans le corps du tableau: nombre de formes communes à chaque paire de bassins et/ou versants; pour les bassins et/ou versants étant en contiguïté géographique sont indiqués les pourcentages du nombre de formes communes par rapport au nombre de formes du bassin ou versant où la diversité est moindre

	Versant cantabrique 6 formes	Bassin du Douro 7 formes	Bassin du Vouga 5 formes	Bassin du Tage 11 formes	Bassin du Sado 5 formes	Bassin du Guadiana 10 formes	Bassin du Guadalquivir 6 formes	Versant du d'Espagne 5 formes	Bassin du Jucar 5 formes
Bassin de l'Ebre 8 formes	5 83,3%	4 57,1%	3	4 50,0%	3	1	0	0	3 60,0%
Bassin du Jucar 5 formes	2	2	2	4 80,0%	3	2 40,0%	1	1 20,0%	
Versant du sud d'Espagne 5 formes	0	1	0	3	1	5	5 100,0%		
Bassin du Guadalquivir 6 formes	0	1	0	4	1	6 100,0%			
Bassin du Guadiana 10 formes	1	2	1	6 60,0%	2 40,0%				
Bassin du Sado 5 formes	3	3	3	4 80,0%					
Bassin du Tage 11 formes	3	6 85,7%	4 80,0%						
Bassin du Vouga 5 formes	3	5 100,0%							
Bassin du Douro 7 formes	3 50,0%								

Tab. 3. Répartition des Cyprinidae ibériques par secteurs

Espèce	Secteur ebro-cantabrique	Secteur central	Secteur méridional
R. arcasi arcasi	+	+	+
B. meridionalis meridionalis	+	—	—
Ph. phoxinus	+	—	—
T. tinca	+	+	—
L. cephalus cabeda	+	+	—
Ch. toxostoma toxostoma	+	+	—
B. meridionalis graellsi	+	+	—
B. barbus bocagei	+	+	—
Ch. polylepis polylepis	+	+	—
R. arcasi macrolepidotus	—	+	—
Ch. toxostoma arrigonis	—	+	—
B. steindachneri	—	+	+
L. cephalus pyrenaicus	—	+	+
R. lemmingi	—	+	+
Tr. alburnoides	—	+	+
B barbus sclateri	—	—	+
B. microcephalus	—	—	+
Pseud. hispanicus	—	—	+
Ch. polylepis willkommi	—	—	+

ancienne (A l m a ç a, 1976) et qui tout au moins au Portugal, ne présentent pas des populations intermédiaires (A l m a ç a, 1965, 1967), auront éventuellement, leur statut sous-espécifique modifié lors d'une révision au niveau ibérique. D'autre part, des formes telles que *R. arcasi* et *R. lemmingi*, dont la formation sera récente (A l m a ç a, 1976) et qui présentent des populations à caractères intermédiaires (A l m a ç a, 1965), ne justifieront leur statut spécifique. Mais, pour arriver à des conclusions valables il faudra envisager ces exemples et encore d'autres d'une forme détailée et basée sur des échantillons de répartition géographique très large. Ceci ne vient que de commencer et seulement pour le genre *Rutilus*.

Quoi qu'il en soît, l'éventuel changement du statut taxinomique de quelques unes des formes ibériques de Cyprinidae, ne modifiera pas la caractérisation des sous-districts ichthyogéographiques, celle-ci étant basée sur les faits assez bien connus de la répartition géographique de ces Poissons.

Puisque les barrières géographiques limitant les secteurs ichthyogéographiques seront probablement effectives dans l'isolement d'autres populations animales, notamment de petits Mammifères, Reptiles et Amphibiens, il serait fort interéssant de chercher si, dans le cas de ces groupes, on arriverait à des conclusions semblables.

RÉSUMÉ

En se basant sur la répartition géographique des espèces et sous-espèces de Cyprinidae de la Péninsule Ibérique, l'auteur y reconnait trois sous--districts, ou secteurs, ichthyogéographiques: (1) ebro-cantabrique, (2) central et (3) méridional. Ces secteurs sont séparés par des barrières montagneuses ayant, vraisemblablement, jouée un rôle important dans

la spéciation des Cyprinidae ibériques. Ces barrières sont constituées par les Monts Cantabriques et le Système Iberique (entre les secteurs ebro--cantabrique et central) et par le Système Tolédan (entre les secteurs central et méridional).

La comparaison entre les faunes de Cyprinidae de chacun des secteurs est présentée. On constate que le nombre d'endémismes ibériques s'accroît du secteurs ebro-cantabrique vers le méridional.

RÉFÉRENCES BIBLIOGRAPHIQUES

Almaça, C., 1965: Contribution à la connaissance des Poissons des eaux intérieures du Portugal. *Rev. Fac. Ciên. Lisboa*, **13** (2): 225–262.

Almaça, C., 1967: Estudo das populações portuguesas do Gén. Barbus Cuvier, 1817 (*Pisces, Cyprinidae*). *Rev. Fac. Ciên. Lisboa*, **14** (2): 151–400.

Almaça, C., 1971: Sur la collection de Barbeaux (genre et sous-genre Barbus) ibériques et nord-africains du Forschungsinstitut Senckenberg (Frankfurt a. M.) *Arq. Mus. Boc.*, **3** (21): I–V.

Almaça, C., 1976: La spéciation chez les Cyprinidae de la Péninsule Ibérique (sous presse).

Arévalo, C., 1929: La vida en las aguas dulces. Editorial Labor, Barcelona, 198 pp.

Banarescu, P., 1964: Fauna Republicii Populare Romîne. Pisces Osteichthyes, 13. Acad. Republ. Pop. Romîne, Bucuresti, 959 pp.

Berg, L. S., 1932: Übersicht der Verbreitung der Süsswasserfische Europas. *Zoogeographica*, **1** (2): 107–208.

Carvalho, A. M. G., 1968: Contribuição para o conhecimento geológico da bacia terciária do Tejo. *Mem. Serv. Geol Port.*, **15**: 7–210.

Coelho, M., J. Gomes & P. B. Ré, 1976: Valencia hispanica, a new fish to Portugal. *Arq. Mus. Boc.*, **6** (25): I–V.

Instituto Forestal de Investigaciones y Experiencias, 1952: Las colecciones de Peces de la Seccion de Biologia de las aguas continentales. *Publ. Inst. For. Inv. Exp.*, **9** (63): 1–25.

Rey, L. L., 1935: Los peces fluviales de España. *Mem. Acad. Cien. Ex. Fis. Nat. Madrid*, **5**: 1–390.

Rey, L. L., 1947: Peces ganoideos y físostomos. *Mem. Acad. Cien. Ex. Fis. Nat. Madrid*, **9**: 1–840.

Rey, L. L., 1952: Los peces fluviales de España. Min. de Agricultura, Madrid, 251 pp.

Udvardy, M. D. F., 1969: Dynamic zoogeography. Van Nostrand, New York, 445 pp.

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RESULTS OF REEXAMINATION OF GYRODACTYLUS LUCIOPERCAE AND G. LONGIRADIX (GYRODACTYLIDAE: MONOGENOIDEA)

RADIM ERGENS

Received April 5, 1977

Abstract: Systematic studies of 57 specimens of *G. luciopercae* Gussev, 1962 and 54 specimens of *G. longiradix* Malmberg, 1957 from six fish species originating from Czechoslovakia, Hungary and the USSR were carried out. This enabled the author to supplement the original data on these two parasites and compare them in detail. The shape of the hook proper of marginal hooks is regarded as a single criterion for reliable and unambiguous differentiation of *G. luciopercae* and *G. longiradix*.

INTRODUCTION

In 1962, Gussev described a new species of the genus *Gyrodactylus* Nordmann, 1832 — *G. luciopercae* from the fins of *Stizostedion lucioperca* (L.) caught from the Volga delta. The author noted that the new species differed from very similar *G. longiradix* Malmberg, 1957 described from skin and fins of *Acerina cernua* (L.) from Sweden lake Mälaren only in smaller total length of anchors and smaller length of their root.

Unfortunately, this differentiation of so closely related species as *G. luciopercae* and *G. longiradix* does not seem to be quite reliable. They may be easily mistaken, especially during common determinations carried out, for example, in diagnostical laboratories. The results of our systematic studies of a large number of *G. luciopercae* and *G. longiradix* supply evidence of this fact. The present work was designed primarily to supplement the original data by Gussev (1962) and Malmberg (1957) and to compare these two species in terms of the present taxonomy of *Gyrodactylus* species.

MATERIAL AND METHODS

Morphological and metrical studies of the hard parts of opisthaptor of *G. luciopercae* and *G. longiradix* were carried out using only fixed specimens (mounted in glycerine jelly or ammoniumpicrate-glycerine mixture) deposited in the collections of the Institute of Parasitology, Czechoslovak Academy of Sciences (legit author), Zoological Institute of the USSR Academy of Sciences, Leningrad (legit Gussev), State University in Tomsk (legit Bocharova), the Urals Department of the Siberian Scientific and Research Institute of Fish Industry in Sverdlovsk (legit Kashkovsky) and Helminthological Laboratory of the USSR Academy of Sciences, Moscow (legit Roytman). The parasites were obtained from the fins, skin and gills of *Acerina cernua*, *Stizostedion lucioperca*, *Stizostedion volgense* (Gmelin), *Perca fluviatilis* L., *Gobio gobio* (L.) and *Rutilus rutilus* (L.) caught in various localities in Czechoslovakia, Hungary and the USSR.

The observations were made with a phase-contrast microscope and illustrations were prepared with the aid of a camera lucida. The technique of Ergens and Lom (1970) and Gläser (1974) was used in measurements of the hard parts of the opisthaptor. All measurements are in millimeters.

Tab. 1. Measurements of individual hard parts of opisthaptor of *G. luciopercae* Gussev, 1962

Hard parts of opisthaptor		Syntypes after Gussev (1962) and my measurements	From *Stizostedion lucipperca*	From *Stizostedion volgense*	From *Perca fluviatilis*	From *Acerina cernua*	Total range of variability
Anchors	Total length	0.069–0.080	0.064–0.074	0.069–0.070	0.064–0.071	0.067–0.068	0.064–0.080
	Shaft	0.049–0.051	0.045–0.051	0.049–0.050	0.048–0.051	0.045–0.046	0.045–0.051
	Point	0.027–0.030	0.027–0.031	0.030	0.027–0.031	0.027–0.028	0.027–0.031
	Root	0.023–0.028	0.022–0.027	0.024–0.026	0.023–0.025	0.025–0.027	0.022–0.028
Ventral bar	Length	0.005–0.008	0.006–0.007	0.007–0.008	0.006–0.008	0.006–0.007	0.005–0.008
	Width	0.029–0.033	0.028–0.031	0.029–0.030	0.026–0.033	0.027–0.030	0.026–0.033
	Membranous extension	0.014–0.019	0.014–0.018	0.015	0.016–0.017	0.014–0.015	0.014–0.019
Dorsal bar	Length	0.001–0.003	0.002–0.003	0.002	0.002–0.003	0.001–0.002	0.001–0.003
	Width	0.021–0.029	0.021–0.025	—	0.022–0.024	0.022–0.024	0.021–0.029
Marginal hooks	Total length	0.031–0.036	0.030–0.032	0.030–0.031	0.031–0.033	0.032–0.033	0.031–0.036
	Hook proper	0.006–0.007	0.006–0.007	0.006–0.007	0.006–0.007	0.006	0.006–0.007
Location		fins	skin, fins	fins, gills	fins	fins, gills	
Date of collection (month)		VI	V–IX	IX	V	V	V–IX
Number of measured specimens		5	34	4	8	6	57

RESULTS

G. luciopercae Gussev, 1962

Metrical values of hard parts of opisthaptor of all studied specimens, including five syntypes, are given in Table 1. The range of metrical variability is not yet definitive, since the measurements were based on parasites occuring only in warm seasons (May—September). Consequently, it may be supposed, with regard to the present knowledge of variability of some *Gyrodactylus* species (Malmberg, 1970; Ergens, 1976), that the values of the upper limit of metrical variability of G. luciopercae are higher.

The shape of individual parts of the complex of anchors and marginal hooks is illustrated in Fig. 1. The ratio of the length of root of anchors and their total length is 1 : 2.5—2.9, of the length of root and shaft 1 : 1.6—2.1. The ventral bar has distinctly developed lateral processes, and its membranous extension is more or less of triangular shape. The dorsal bar is identical in its morphology with the dorsal bars of most species belonging to the so-called "G. *wageneri*-complex" (Malmberg, 1957). The hook proper of marginal hooks is characterized by a massive base designated by Gläser (1974) as "Krallenwurzel", rather straight shaft and very sharp point (terminology after Mizelle and Kritsky, 1967). If the length of "Krallenhaken" (after Gläser, 1974) or "blade" (after Gussev, 1976) obtained by subtracting the lenght of base from the total length of hook proper is designated as A, maximum width of hook proper as B and its maximum length as C (see scheme in Fig. 2), then A : B = 1 : 1.2 and B : C = 1 : 1.2—1.4.

G. luciopercae has been hitherto recorded from fins, skin and gills of four fish species belonging to Percidae, namely *Stizostedion lucioperca*, *S. volgense*, *Acerina cernua* and *Perca fluviatilis*. Unfortunately, its relation to these host species cannot be exactly specified due to the lack of detailed information on the ecology of this parasite.

G. longiradix Malmberg, 1957

Measurements of individual hard parts of opisthaptor of all studied specimens are summarized in Table 2. Since these data are based on specimens originating from both warm and cold seasons, the range of metrical variability may be considered to be very close to a real one.

The shape of individual hard parts of opisthaptor is shown in Fig. 3. The ratio of length of root of anchors and their total length is 1 : 2.3—2.6, length of root and shaft 1 : 1.5—1.8. The membranous extension in shape of isosceles to equilateral triangle is attached to posterior margin of the ventral bar which possesses distinctly developed lateral processes. The dorsal bar is identical in its morphology with the dorsal bar of *G. luciopercae*. The hook proper of marginal hooks is characterized by an elongated base and relatively short shaft forming a regular arch and ending in a long, sharp point. A : B = 1 : 1.3—1.5 and B : C = 1 : 1—1.1.

G. longiradix was recorded not only from *Acerina cernua*, but also from *Perca fluviatilis*, *Gobio gobio* and *Rutilus rutilus*. Since the records from *G. gobio* and *R. rutilus* were only occasional, I consider these two fish

Tab. 2. Measurements of individual hard parts of opisthaptor of *G. longiradix* Malberg, 1957

Hard parts of opisthaptor		Syntypes after Malmberg (1957)	From *Acerina cernua*	From *Perca fluviatilis*	From *Gobio gobio*	From *Rutilus rutilus*	Total range of variability
Anchors	Total length	0.089–0.096	0.077–0.085	0.083–0.085	0.082–0.085	0.080	0.077–0.096
	Shaft	—	0.053–0.058	0.057–0.058	0.057–0.058	0.053	0.053–0.058
	Point	0.037–0.040	0.031–0.033	0.032–0.033	0.035	0.030	0.030–0.040
	Root	0.032–0.038	0.029–0.032	0.030–0.031	0.029–0.035	0.029	0.029–0.038
Ventral bar	Length	0.011–0.012	0.007–0.011	0.008	0.007	0.007	0.007–0.012
	Width	0.030–0.038	0.031–0.035	0.031–0.034	—	0.033	0.030–0.038
	Membranous extension	0.015–0.022	0.016–0.019	0.019–0.020	—	0.016	0.015–0.022
Dorsal bar	Length	0.001–0.002	0.002–0.003	0.001–0.003	0.002	0.002	0.001–0.003
	Width	0.022–0.039	0.024–0.030	0.025–0.027	—	0.022	0.022–0.039
Marginal hooks	Total length	0.038–0.042	0.033–0.039	0.035–0.037	0.036	0.034	0.033–0.042
	Hook proper	0.006–0.008	0.006–0.008	0.007–0.008	0.007–0.008	0.007–0.008	0.006–0.008
Location		fins, skin	fins, skin, gills	skin	skin, gills	skin	
Date of collection (month)		II	V	V	VI	VI	II–VI
Number of measured specimens		10	47	4	2	1	64 (54)

Tab 3 Length ratio of root and other parts of anchors of *G lucioperca*e Gussev, 1962 and *G longiradix* Malberg, 1957

	G. luciopercae	*G. longiradix*
$\frac{\text{length of root}}{\text{total length of anchors}}$	$\frac{1}{2.5-2.9}$	$\frac{1}{2.3-2.6}$
$\frac{\text{length of root}}{\text{lengtd of shaft}}$	$\frac{1}{1.6-2.1}$	$\frac{1}{1.5-1.8}$
$\frac{\text{length of root}}{\text{length of point}}$	$\frac{1}{1.0-1.3}$	$\frac{1}{0.9-1.0}$

species to serve as occasional hosts of *G. longiradix*. I assume that even the specification of its relation to *Perca fluviatilis* would be premature at the present situation.

Comparison of *G. lucioperca* and *G. longiradix*

From Tables 1 and 2 it may be seen that maximum measurements of individual hard parts of opisthaptor of *G. luciopercae* are either almost identical or even greater than minimum measurements of hard parts of opisthaptor of *G. longiradix*. This fact gives direct evidence for the statement mentioned in the Introduction that G u s e v's differentiation of *G. luciopercae* from *G. longiradix* (based on the differences in total length of anchors and length of root) cannot be regarded as reliable.

A comparison of the morphology of individual hard parts of opisthaptor in *G. longiradix* and *G. luciopercae* revealed the following:

a) Differences between *G. luciopercae* and *G. longiradix* in the shape of anchors related to the angle between shaft and root of anchors, to the shape of root proper and partly its length appear markedly only when a large number of specimens or specimens of different size are compared. The values expressing the ratio between length of root and length of other parts of anchors are practically the same in both species (Table 3).

b) The shape of ventral and dorsal bar is identical in these parasites.

c) Differences between *G. luciopercae* and *G. longiradix* in the shape of marginal hooks are quite explicit and they are due particularly to different size of individual parts of the hook proper. This follows from Fig. 4 and the above-mentioned ratios A : B and B : C. The ratios between the length of base and total length of hook proper, as well as between total length of hook proper and length of handle of marginal hooks regarded by G l ä s e r (1974) as criteria of taxonomic importance, are not applicable for separation of *G. luciopercae* and *G. londiradix*.

CONCLUSION

The results of my studies of *G. luciopercae* and *G. longiradix* indicate that these parasites are very closely related and may be successfully distinguished only on the basis of the shape of the hook proper of marginal hooks.

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REFERENCES

Ergens R, 1976: Variability of hard parts of opisthaptor of two species of Gyrodactylus Nordmann, 1832 (Monogenoidea) from Phoxinus phoxinus (L.). *Folia parasit* (Praha), **23**: 111–126.

Gläser H. – J., 1974: Sechs neue Arten der Gyrodactylus wageneri-Gruppe (Monogenea, Gyrodactylidae) nebst Bemerkungen zur Praparation, Determination, Terminologie und Wirtsspezifität. *Zool. Anz.*, **192**: 56–76.

Gussev A. V., 1962: Monogenoidea (Beneden) Bychowsky, 1937. In Bykhovskaya-Pavlovskaya et al.: (Key to Parasites of Freshwater Fish of the U. S. S. R.). Izd. AN SSSR, Moskva–Leningrad.

Gussev A. V., 1967: Freshwater Indian Monogenoidea. Principles of systematics, analysis of the world faunas and their evolution. *Ind. J. Helminth.*, **25** and **26** (1973) and 1974), pp. 1–241.

Malmberg G., 1957: Om forekomsten av Gyrodactylus pa svenska fiskar. *Skr. söd. Sver. Fisk. For. Arsskr.*, **1956**: 19–76

Malmberg G., 1970: The excretory systems and the marginal hooks as a basis for the systematics of Gyrodactylus (Trematoda, Monogenea). *Ark. f. Zool.*, **23**: 1–235.

Mizelle J. D., Kritsky D. C., 1967: Studies on monogenetic trematodes. XXX. Five new species of Gyrodactylus from the pacific tomcod, Microgadus proximus (Girard). *J. Parasit*, **53**: 263–269.

The figures 1–4 will be found at the end of this issue.

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THE COLEOPTERA IN NESTS OF PASSER DOMESTICUS IN CZECHOSLOVAKIA

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Abstract: The beetle fauna of nests of *Passer domesticus (Linnaeus, 1758)* is studied and a rewiev of found species is given. Thirty tree species occurred in the studied nests, twenty five of which were found in bird nests at first in general and eleven species at first in the nests of *P. domesticus*. Four trophical groups of beetles in the studied nests are distinguished (necrophage, carnivores, mycetophages and pantophages). The annual dynamics of the beetles and their trophical groups are put into relations to different groups of studied nests (winter nests, nests under construction, nests with avian eggs, nests with nestlings, nest abandoned by the young and nests prepared for wintering).

While pursuing the Research Project concerned with the flea (Siphonaptera) of avian nests, over 1965—70, we were collecting also the materials of other groups of animals found living in the studied nest (Jurík, 1967, 1974).

The results of study revealed the representatives of Coleoptera occupying a significant portion in the material. To our knowledge, this group of insects has not so far been investigated on a more extensive material from Central Europe; the data from the Scandinavian Peninsula being the only available (Nordberg, 1936). The various contributions and data, smaller in extent, reported so far in the literature from the whole world have been reviewed by Hicks (1962).

The aim proper was to trace the composition of Coleopteran fauna in the avian nests of Central Europe and derive their relations to nests of individual bird species and to animals living in these nests, to the Siphonaptera in particular. In this paper an evaluation has been made of the Coleoptera as found in the nests of *Passer domesticus* (Linneus, 1758). The reasons for assesing nest of *P. domesticus* first were seen, on the one hand, in the fact that they were occupying the largest portion of the studied material, and on the other hand, because a large number of nests were available from one type of the boxes observed in a single locality the whole year throughout. It is intended to utilize results of the present treatment as a model for subsequent studies of the coleopteran fauna in nests of the other birds' species. Publication of the results will follow in succession.

METHODS

The methods of collecting, recording, treating, and preserving the material from avian nests have been described in detail in earlier papers (Jurík, 1967, 1969, 1974).

The determination of coleopteran fauna was based primarily on the following

Tab. 1. Summary of the studied material

No.	Family and species	Trophic relations	No. of positive nests	No. of individuals detected in Bystrc	No. of individuals detected in other localities	Total No. of individuals	Dominance	Dominance	Frequency
	Histeridae					(342)			
1	*Gnathoncus buyssoni* Auzat	K	42	255	86	341	29.83	D	Ac
2	*Carcinops pumilio* (Erichson)	K	1	1		1	0.09	R	Ac
	Catopidae								
3	*Catops* sp.	N	1	1		1	0.09	R	Ac
	Ptiliidae					(1)			
4	*Acrotrichis intermedia* (Gillmeister)	P	1		1	1	0.09	R	Ac
	Staphylinidae					(207)			
5	*Phyllodrepa floralis* (Paykull)	K?	1	1		1	0.09	R	Ac
6	*Xantholinus linearis* (Olivier)	K	2	1	1	2	0.18	R	Ac
7	*Philonthus fuscus* (Gravenhorst)	K	7	20	2	22	1.92	S	Ac
8	*Atheta angusticollis* (Thomson)	K	12	38	13	51	4.46	S	Ac
9	*Microglotta pulla* Gyllenhal	K	19	121	2	123	10.76	D	Ac
10	*Aleochara sparsa* Heer	K	1		8	8	0.72	I	Ac
	Dermestidae					(451)			
11	*Dermestes lardarius* Linnaeus	N	9	9	9	18	1.58	S	Ac
12	*Megatoma undata* (Linnaeus)	N	2		2	2	0.18	R	Ac
13	*Anthrenus pimpinelae* Fabricius	N	40	101	330	431	37.70	D	k
	Cryptophagidae					(11)			
14	*Cryptophagus distinguendus* Sturm	M	1	6		6	0.53	I	Ac
15	*Cryptophagus dentatus* Herbst	M	1	1		1	0.09	R	Ac

16	*Cryptophagus dorsalis* Sahlberg	M	1	1		1	0.09	R	Ac
17	*Atomaria nigriventris* Stephens	M	2	1	1	2	0.18	R	Ac
18	*Atomaria* sp.	M	1	1		1	0.09	R	Ac
	Lathridiidae					(49)			
19	*Lathridius angusticollis* (Gyllenhal)	M	1	1		1	0.09	R	Ac
20	*Lathridius constrictus* (Gyllenhal)	M	1	1		1	0.09	R	Ac
21	*Enicmus minutus* (Linnaeus)	M	9	23	2	25	2.19	S	Ac
22	*Cartodere filiformis* (Gyllenhal)	M	2	2	2	4	0.35	R	Ac
23	*Cartodere ruficolis* (Marsham)	M	1	2		2	0.18	R	Ac
24	*Corticaria gibbosa* (Herbst)	M	2	1	1	2	0.18	R	Ac
25	*Corticaria longicollis* (Zetterstein)	M	3	14		14	1.23	S	Ac
	Mycetophagidae					(1)			
26	*Lytargus connexus* (Goeffroy)	M	1		1	1	0.09	R	Ac
	Coccinellidae					(2)			
27	*Propylaea quatuordecimpunctata* (L.)	K	1		1	1	0.09	R	Ac
28	*Coccidula scutelata* (Herbst)	K	1		1	1	0.09	R	Ac
	Ptinidae					(50)			
29	*Ptinus fur* (Linnaeus)	P	11	24	13	37	3.24	S	Ac
30	*Ptinus raptor* (Fabricius)	P	3	13		13	1.14	S	Ac
	Tenebrionidae					(7)			
31	*Tenebrio molitor* (Linnaeus)	P	2	5		5	0.44	R	Ac
32	*Cylindronotus aeneus* (Scopoli)	P	2	1	1	2	0.18	R	Ac
	Scarabaeidae					(20)			
33	*Trox scaber* (Linnaeus)	N	6	13	7	20	1.75	S	Ac
	Total			658	484	1142			

D — dominant, S — subdominant, I — influent, R — recedent, Ac — accidental, Ak — accessory, K — carnivore, N — necrophage, M — mycetophage, P — pantophage

papers: Reitter (1909, 1911), Gangelbauer (1894—1904), Freude, Harde, Lohse (1964—74). The ecological and faunistic data were drawn from papers by following authors: Roubal (1930—33), Nordberg (1936), Borchert (1951), Hicks (1962), and from others cited in References.

The evaluations of beetle occurrence involved the use of two indices, the index of occurrence (10 = the number of detected beetles to the number of studied nests) and the index of infestation intensity (IIV = the number of detected beetles to the number of positive nests), both suggested by Ioff (1949).

The composition of coleopteran fauna in the nests and its relation to the nests were studied using adult beetles as a basis. The material consisted of a large number of species some of which represented by individuals only but closely related in ecological respects. This explains why, in certain instances, the study of relations of the beetles to nests was approached from the level of families, or from that of trophic groups, where the studied relations tended to become more apparent.

The material collected in the Zoological garden of Brno — Bystrc, has been evaluated as a separate item in this paper, for the collection consists of a large number of nests from one type of boxes and a single year (1965).

MATERIAL

From among the nests of *P. domesticus* examined by us, 173 in number, a total of 94 were found positive to the occurrence of beetles. In these nests, altogether 1142 beetle individuals could be detected belonging to 12 families and 33 species In the findings, 3 coleopterous species were dominant (Nos. 1, 9, 13; Tab. 1), 7 subdominant (Nos. 7, 8, 11, 21, 28, 29, 32; Tab. 1), 2 influent (Nos 10 and 14; Tab. 1) and 21 species were receding (Nos. 2, 3, 4, 5, 6, 12, 15, 16, 17, 18, 19, 20, 22, 23, 24, 25, 26, 27, 30, 31, 33; Tab. 1). When judged by the frequency of occurrence, *Anthrenus pimpinelae* Fabricius, 1775 was an accessory species, all the others were accidental (Tab. 1).

Individual coleopterous families were found represented in the following order: Dermestidae (451 individuals, 3 species), Histeridae (342 individuals, 2 species), Staphylinidae (207 individuals, 6 species), Ptinidae (50 individuals, 2 species), Lathridiidae (49 individuals, 7 species), Scarabaeidae (20 individuals, 1 species), Cryptophagidae (11 individuals, 5 species), Tenebrionidae (7 individuals, 2 species), Coccinellidae (2 individuals, 2 species), Catopidae (1 individual, 1 species), Ptiliidae (1 individual 1 species), and Mycetophagidae (1 individual, 1 species).

Comparing the material collected in Bystrc 1965, to those obtained from the other Czechoslovakian localities, Brno, Bratislava, Zvolen, distinct differences could be traced in the composition of species only for *Microglotta pulla* Gyllenhal, 1827 and *A. pimpinelae*. In the Bystrc material, *M. pulla* was represented by 121 individuals, while in those from the other localities by 2 individuals only; *A. pimpinelae* was represented in Bystrc by 101 individuals, while in the materials from all other localities a total of 330 individuals were detected. Less significant differences in the composition of species as found in the Bystrc material of 1965 and in those collected on all other localities could be traced also in the representations of the receding and influent species of Coleoptera. The index of affinity, calculated after Jaccard, between the Bystrc and the other materials indicated 45,5 per cent; the index of dominance identity, as suggested by Renkonen, was 44,4 per cent. This difference may be explained as due to the fact that the Bystrc material covered nests collected over a whole-year period, in contrast to the latter in which the greater part of nests were those collected in the course of March in the Botanical Gardens affiliated to the Comenius University, Bratislava, at the time when the necrophages (*A. pimpinelae*) reached their spring maximum of occurrence and the carnivores represented in numbers (*M. pulla* and *Gnathoncus buyssoni* Auzat, 1917) did not yet occur in the nests (see subsequent chapters). Moreover, the different type of boxes from which nests in the Bratislava were removed doubtless played a role of its own, too (see Jurík, 1974).

A comparison of our findings to the data reported in available literature reveals that the coleopterous species detected in the nests of *P. domesticus* numbered 25 (Nos. 2, 4, 5, 6, 7, 8, 9, 10, 12, 14. 15, 16, 17, 19, 20, 23, 24, 25, 26, 27. 28, 30, 31, 32, 33; Tab. 1) and that 11 species were found in avian nests for the first time (Nos. 2, 4, 6, 16, 17, 20, 25, 26, 27, 30, 32; Tab. 1). The newly detected species for nests of *P. domesticus* except Nos. 6, 7, 8, 9, 14 and 30, were represented by individuals only and

showed low frequencies of occurrence (Tab. 1); therefore, considered from the faunistic point of view, their occurrence was to be taken as accidental. The number of these new findings was dependent upon the amount of nests included in the study. This very circumstance and the fact that earlier authors did not include such abundant material of avian nests in their observations — for instance Nordberg (1936) examined a total of 412 nests belonging to 56 bird species, in which only six were constructed by *P. domesticus* — may acount for the surprisingly high number of coleopterous species detected as new in the studied nests as a whole and in those of *P. domesticus* in particular. This statement is supported also by the finding that many of species whose occurrence was confirmed for the first time by us in nests of *P. domesticus* had been detected before by Nordberg himself in nests of other bird species, in such nests the types of which were identical, or similar, to those constructed by *P. domesticus*.

Tab. 2. Review of trophic group representations

Trophic group	No. of positive nests	No. of species	No. of individuals	Dominance, in %	Frequency, in %	IIV	IO
Carnivores	50	10	551	48.25	28.90	11.02	3.19
Necrophages	48	5	472	41.35	27.71	9.84	2.73
Mycetophages	22	10	61	5.33	13.31	2.56	0.35
Pantophages	16	3	58	5.07	9.28	3.62	0,33

RESULTS

Trophic relations of the coleoptera detected in nests

The coleopterous species detected in the studied nests could be classed with the following trophic groups: carnivores (48.25 %), necrophages (41.35 %), mycetophages (5.33 %), and pantophages (5.07 % (see Tab. 2).

The carnivores were represented by families: Histeridae (342 individuals, 2 species), Staphylinidae (207 individuals, 6 species), and Coccinellidae (2 individuals, 2 species). The proportion of individuals and species each point to trophic linkages of Histeridae and Staphylinidae to the nest, whereas Coccinellidae are to be considered accidental nest dwellers, either detected species being an aphidiphage (Hodek, 1973). Comparing tightness of the linkage in individual species of the Histeridae and Staphylinidae representatives to the nest (Tab. 1), we can see that the former were linked much more closely than the latter in their trophic requirements. Among the Histeridae there was but a single carnivorous species to be classed as ubiquitous in the nests of *P. domesticus* — *Carcinops pumilio* (Erichson, 1834). It is a cosmopolite, highly versatile in ecological respects, but rare in occurrence. Among the Staphylidae, three such species were detected, viz.; *Phyllodrepa floralis* (Paykull, 1789) which, on the one hand, lives on flowers where it catches insects and, as reported in the literature, also feeds on pollen; on the other hand, it may thrive in the litter; *Xantholinus linearis* (Oliver, 1794) an abundant species of the soil entomofauna; and *Aleochara sparsa* Herr, 1838 whose larvae are parasitic to those of Diptera and the presence and development of which

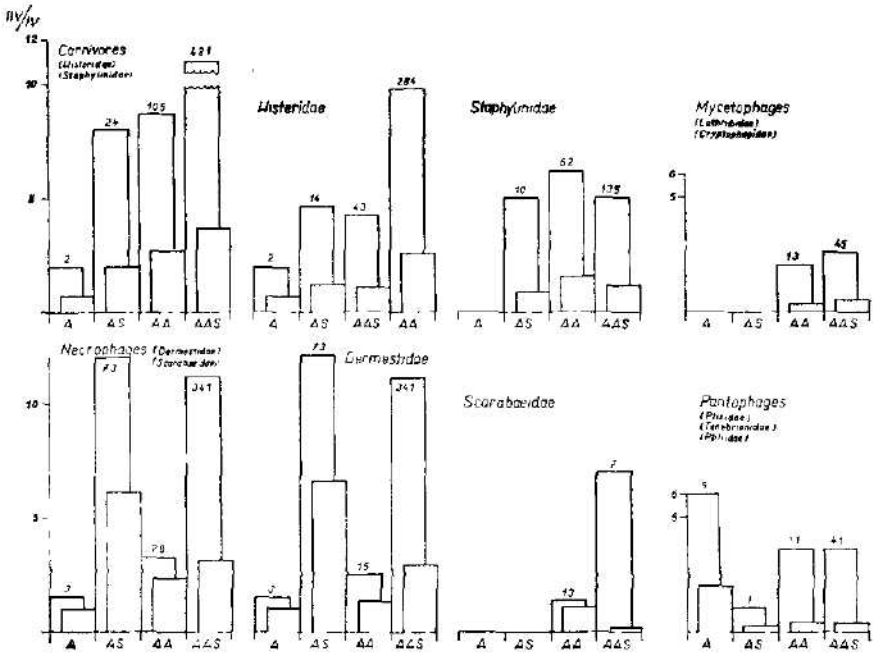

Diagram 1 – IIV and IO of trophic groups of Coleoptera depending on the presence of other animals in the nests of *P. domesticus*.
A – nests with various Arthropods (Chilopoda, Diplopoda, Oniscoidea etc.) and with Mollusca
AS – nests with various Arthropods and with Siphonaptera
AA – nests with various Arthropods and with Acarina
AAS – nests with various Arthropods and with Acarina and Siphonaptera

in the bird nest is accounted for by the presence of dipterous larvae in the same.

From the results of a quantitative analysis of the studied material and in compilance with available literary data it may be concluded that the coleopterous species Nos. 1, 7, and 9 are typical, in abundance occurring representatives that are fully linked to the nest in the trophic and developmental respects. The species designated as Nos. 8 and 10 here are trophic-bound to the nest, too, but capable of developing beyond it as well; in the nests of *P. domesticus* they make use of their convenient environment only. The species labelled Nos. 2, 5, 6, 27, 28 are quite accidental nest dwellers; therein, they may find a source of food, but the nest as such is no ecological niche for them to occupy. Dependence of the occurrence of carnivora on the presence of other animals in a nest is shown in Diagram 1, where it is evident that the occurrence of carnivores is in derect proportion to the varied structure and abundance of the other animal groups established in studied nests.

A marked difference could be traced between the representatives of Histeridae and Staphylinidae, in their respective preferences to different animal groups as prey; the latter occurred mostly in nests characterized by the presence of Acarina and other Arthropoda (Diagram 1), while the

former were more frequent in those distinguished by the presence of Siphonaptera and their larvae (Diagram 1). An explanation of the above difference is to be seen primarily in the predator-size to prey-size proportion (T i c h o m i r o v a, 1973). Thus, for instance *G. buyssoni* is equipped with much larger and more robust biting mouth parts (mandibles) than are the detected species of Staphylinidae for which the small-size mites living in nests are a more easily accessible prey than flea larvae or adults. In nests avoid of Arthropoda no carnivores occurred. Indeed, the above explanation may be objected to, claiming that a competition between the two families might be involved.

The n e c r o p h a g e s detected in the studied nest were represented by families: Dermestidae (451 individuals, 3 species), Scarabaeidae (20 individuals, 1 species), and Catopidae (1 individual, 1 species).

An evaluation of the function of necrophages in nests presents special difficulties. What can be stated with certainly is trophic dependence of the larvae of Dermestidae on the nest, for these are almost exclusively necrophages and the nests offer sufficient amounts of substances of animal origin for them to live on. The same holds, in all probability, for the larvae and adults of *Trox scaber* (Linnaeus, 1767), and for *Catops* sp. as well. On the other hand, a straightforward linkage, whether trophic or developmental, to the nest is far from being so invariable in adults of Dermestidae, for these are found occurring abundantly in the open, on flowers. As reported in the literature, they are partly phytophagous. Even if phytophagy can hardly be ruled out in these species (R ü s c h - k a m p in S o r a u e r, 1932; V a s i l i j e v et al., 1973), attention is to be drawn to the fact that, if these beetles were largely phytophagous (polinovores), they would have of necessity and a long time ago become the object of interest on the part of applied entomology, due to their huge abundance in nature. Putting the thing the other way round, it may be that behaviour of the beetles while on flowers assumes the character of, or also of, ravagers (predators), which is supported by the observed eating of caterpillars of certain butterflies by adults of the genus *Dermestes* (M i l l e r, 1956).

From the fact that the adults of Dermestidae were found, in our nests, to occur at regular intervals in all instances may be concluded that either newly hatched generations (immature *A. pimpinelae* were occurred, too), or egg-laying females were involved. The regularity of these intervals was in suport of the aforesaid, too (see subsequent chapter).

On the basis of (a) our quantitative analysis of the material, (b) the literary data available, and (c) the above considerations it may be concluded that *T. scaber* is a species which features trophic linkage to the nest, develops in the same, but is capable of surviving beyond the nest, too. The species *Dermestes lardarius* Linnaeus, 1758 and *A. pimpinelae* have trophic linkages to the nest during the larval stage of development, but this stage may occur also beyond the nest, in a convenient substrate. The stay of adults of these species in nests is confined only to the period of wintering, the interval following their hatching, and the time of egg laying. To these species, also *Megatoma undata* (Linnaeus, 1758 may, presumably, be added. Moreover, the development of species of the genus *Catops* may occur in the nest, too; despite the several findings of repre-

sentatives of this genus in avian nests, these are no convenient ecological niche for them. Dependence of the occurrence of necrophages on the presence of other animal species detected in our nests is to be seen in the amount of accumulated animal biomass rather than in a systematic structure of the fauna present in the nests of *P. domesticus* (Diagram 1).

The panthophages were found represented by following families: Ptinidae (50 individuals, 2 species), Tenebrionidae (7 individuals. 2 species), and Ptiliidae (1 individual, 1 species). The species *Ptinus fur* (Linnaeus, 1758), *Ptinus raptor* (Fabricius. 1775) and *Tenebrio molitor* (Linnaeus, 1758) may be characterized as trophically bound to the nest, developing in the nest, but capable of developing beyond it, too. The species *Acrotrichis intermedia* (Gillmeister, 1845) and *Cylindronotus aeneus* (Scopoli, 1763) may be considered ubiquitous; the former living in rotting plant residues, manure, and similar environments, while the latter under the bark of dead trees.

The mycetophages were represented in the studied nests by families: Lathridiidae (49 individuals, 7 species), Cryptophagidae (11 individuals, 5 species), and Mycetophagidae (1 individual, 1 species). Judging by the quantitative representations, the species *Cryptophagus distinguendus* Sturm, 1845, *Ericmus minutus* (Linnaeus, 1768) and *Corticaria longicollis* (Zetterstein, 1838) appear to be bound to the nest in trophic respects. From the aspect of the trophic relationships it is necessary to consider this groups to be a whole in spite of the great diversity of its species. The occurrence of mycetophages, irrespective of their systematic classification, is in correlation to the moister periods of the year and thus to the development of moulds associated with it in the Bystrc boles (Jurík, 1967). In addition, mycetophages occurred in heavily soiled nests which the young had already abandoned (see subsequent chapters). From the results of observations may be concluded that Mycetophagidae are a group commonly developing beyond nests of birds; nevertheless, during the spells of weather characterized by a higher humidity or when the nest has got moist, they find a source of food therein.

The dynamics of occurrence of the Coleoptera detected in nests (boxes) in Bystrc, 1965
(Diagrams 2, 3; Tab. 3)

Histeridae (*G. buyssoni*) appeared in the nests quite suddenly and in large amounts in May, and they maintained the same level of occurrence also in June. In July a slight drop in their occurrence was observed, while in August a strong decrease was recorded to revert again to moderate rising during September (second generation in all probability), when it also terminated. In the same month, September, the other species — *C. pumilio* — appeared in the nests; the high values obtained for IO and IIV are evidence of its high representations in a large number of nests.

Catopidae were represented by a single individual; this appeared in June.

Staphylinidae (the species designated Nos. 5—10) were detected in the studied nests in small numbers (*Philonthus fuscus* Gravenhorst, 1802) beginning the month of March, and during April their occurrence remained at the same level (*Atheta angusticollis* [Thomson, 1856], *M.*

Tab. 3. Review of coleopterous species in nests of *P. domesticus*, collected in Bystrc; quoted for individual months of 1965

Species	Month												Sum
	Jan	Feb	March	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	
G. buyssoni					85	85	56	9	20				255
C. quatuordecim-striata									1				1
Catops sp.						1							1
P. floralis					1								1
X. linearis						1							1
P. fuscus			5				7	2	6				20
A. angusticollis				2		12	21		3				38
M. pulla				2	18	95	6						121
A. pimpinelae	1	39	1		44	3		1	12				101
D. lardarius				1		1	4	1	2				9
C. distinguendus								6					6
C. dentatus					1								1
C. dorsalis						1							1
A. nigriventris					1								1
Atomaria sp.						1							1
L. angusticollis	1												1
L. constrictus						1							1
E. minutus	16		1			4		1	1				23
C. filiformis	2												2
C. ruficollis							2						2
C. gibbosa					1								1
C. logicollis				6	2				6				14
P. fur			1	1				6	16				24
P. raptor									13				13
T. molitor							1	4					5
C. aeneus						1							1
T. scaber							1	8	4				13
													658

pulla). A trend to rising was observed in May *(M. pulla, P. floralis)*. A peak occurrence was recorded during June, when *M. pulla* culminated and *A. angusticollis* tended to increasing in numbers, and when the other, little represented species occurred, too. In the course of July, the occurrence of Staphylinidae as a whole showed a downward trend, but slight risings were observed in the representations of *A. angusticollis* and *P. fuscus*. A steep decrease occurred in August, when only *P. fuscus* could be detected. Another, moderate in essence, increase did not occur until in September (new generation), and the occurrence of Staphylinidae also terminated in the same month. The high values calculated for IO and IIV brought evidence of the numerous representation of Staphylinidae in a large number of nests.

Dermestidae were detected to occur in large numbers in the studied nests during the winter season already, in January and February *(A. pimpinelae)*. However, their occurrence was found limited to a small number of the nests (Diagrams 2 and 3). A first maximum of occurrence was recorded in February, a steep decrease took place in March, and in April

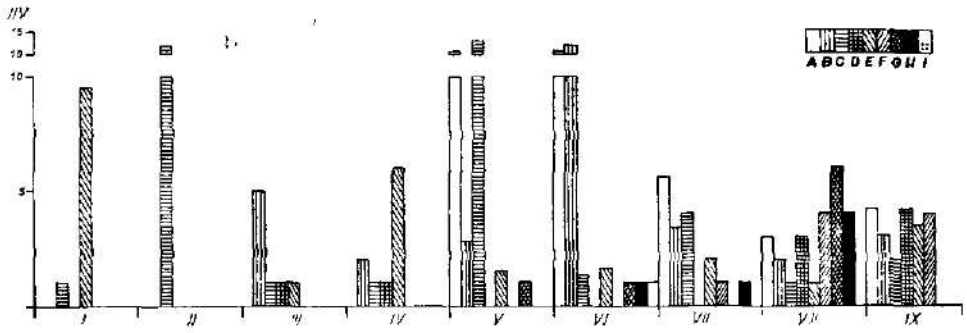

Diagram 2 — IIV of Coleoptera in the nests of *P. domesticus* in Bystrc. A — Histeridae, B — Staphylinidae, C — Dermestidae, D — Ptinidae, E — Lathridiidae, E — Scarabaeidae, G — Cryptophagidae, H — Tenebrionidae, I — Catopidae

there was but a single individual of *D. lardarius* in entire collection. A second maximum of occurrence of *A. pimpinelae*, and thus of Dermestidae as such, was observed in May, while in June there came another strong drop with either species. In July *D. lardarius* bein confined to a single nest attained an indistinct maximum of its occurrence, while *A. pimpinelae* was completely missing. In August, too, the presence of either species in the studied nests was quite slight. In September the occurrence of *A. pimpinelae* tended to increase, while that of *D. lardarius* was maintained low. Termination of the occurrence of Dermestidae also fell to the same month.

Cryptophagidae appeared in the nests for the first time in May and June, but the number of representatives was very low. Their complete disappearance occurred during the month of July, whereas in larger amounths they did not appear until in August when a maximum was recorded followed by complete termination of their occurrence.

Lathridiidae were present in the nests also during the winter season

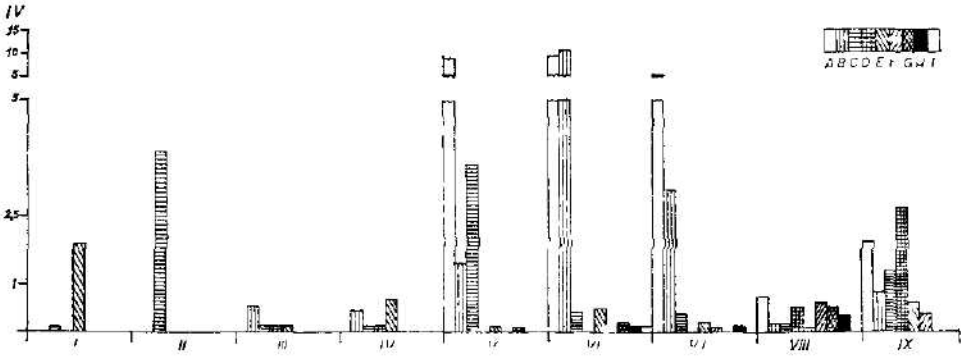

Diagram 3 — IO of Coleoptera in the nests of *P. domesticus* in Bystrc. A — Histeridae, B — Staphylinidae, C — Dermestidae, D — Ptinidae, E — Lathridiidae, F — Scarabaeidae, G — Cryptophagidae, H — Tenebrionidae, I — Catopidae

(January); the relatively large difference between the IO and IIV values for this month suggested concentration of their occurrence in a low number of nests. No individuals were detected during February, while in March the occurrence maintained low values and these did not turn to rising until in April but with their presence confined to a single nest only, as indicated by the respective IO and IIV values (Diagrams 2 and 3). During subsequent months the occurrence continued to maintain a low level until September, when some increase took place.

Ptinidae were found in the nests during March and April, and their amounts were small. Thereafter, they did not appear until in August and September, when a maximum of occurrence was recorded at rather high IO and IIV values (Diagrams 2 and 3).

Tenebrionidae appeared in the studied nest in June, July, and August, when their occurrence also attained an indistinct culmination. The difference in the IO and IIV values was indicative of their accumulation in a small number of nests (Diagrams 2 and 3).

Scarabaeidae appeared in the nests for the first time in July and attained a maximum of occurrence in August. In the course of September their occurrence tended to decrease slightly and terminated with expiration of the same.

The dynamics of occurrence of the coleopterous trophic groups in nests in Bystrc, 1965

(Diagram 4)

The carnivores (Histeridae and Staphylinidae) commenced appearing in the Bystrc nests in March, and until April their numbers were kept low. At that time there was a rather large difference between the IO and IIV values, which was suggestive of an irregularity in their occurrence. During the same months the carnivores were represented by Staphylinidae only. In the subsequent three months a steep rise in occurrence was recorded for each carnivorous family and a maximum was attained in June. The calculated IO and IIV values were high and approximated one another very closely, which pointed to a numerous and frequent occurrence of the carnivores in nests. During August the numbers of carnivores tended to decrease strongly, and they commenced rising again in September, when the new generation of beetles came into being. Both these families displayed identical patterns in their dynamics of occurrence, the representatives of Histeridae appearing in the nests two months later than those of Staphylinidae. As a whole, the carnivores displayed two peaks of occurrence: one was recorded in June and attained very high values, the other appeared in September and was low (the new generation).

The necrophages (Dermestidae, Scarabaeidae, and Catopidae) appeared in the nests as early as in January, first maximum being attained in February. In the subsequent period their occurrence maintained a low level, and another increase did not take place in May. In June they showed a steep decline in numbers, and a rising trend was resumed in July through August, when a third maximum was attained. In Steptember the occurence of necrophages tended to decrease slightly and finally terminated.

Formation of the curve to show the necrophage occurrence dynamics was due mainly to the family Dermestidae, and among these to *A. pimpinelae* in particular. Over the period covering June through September the necrophages occurrence dynamics was affected, in addition, by the presence of *T. scaber* and *D. lardarius*. In its course the necrophage occurrence dynamics curve revealed three distinct peaks falling, in succession, to February, May, and August. The IO and IIV values found for peak

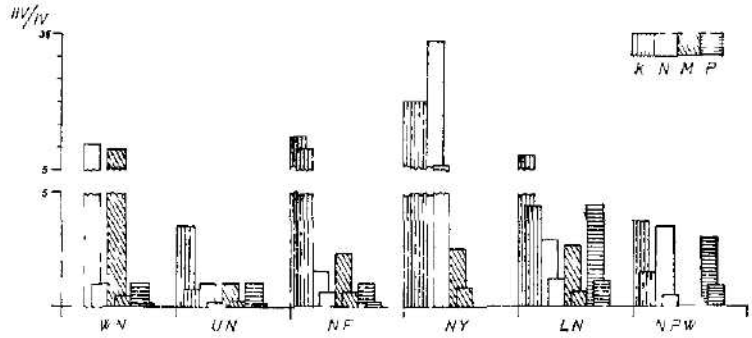

Diagram 4 — IIV and IO of trophic groups of Coleoptera in the individual groups of nests. K — carnivores, N — necrophages, M — mycetophages, P — polyphages

intervals were high, but the differences between them were larger than those obtained for the carnivores. This is an indication of a numerous yet less frequent and regular occurrence in studied nests and of a looser linkage of necrophages to the same.

The mycetophages (covering Lathridiidae and Cryptophagidae) were present in the nests in January already, when the first maximum of occurrence was attained (Lathridiidae). In February the nests were completely void of them, in March there were but very low numbers of them present, while in April a second maximum of their occurrence could be recorded. Thereafter, the mycetophages resumed another steep decrease in their numbers. Over the period from June through September there was gradual increassing with culmination, ind ultimately termination. in the latter month. Over the former half of the year's period the dynamics of mycetophage occurrence was influenced solely by that of Lathridiidae, whereas during the latter half also the dynamics of Cryptophagidae was involved. Concerning the IO and IIV values, rather great differences were evident between them in all of the above periods, pointing to the fact that the mycetophages found convenient conditions only in a portion of the nests included in the examination.

The pantophages (covering Ptinidae and Tenebrionidae) appeared in the nests in March, and their complete absence was observed in May. Over the period from March through July the occurrence of polyphages indicated very low values. A rising trend was recorded in August, and a maximum was attained in September when the occurrence also terminated. Great differences between the IO and IIV values were found for the March — through — July period, while in August and September the differences tended to become level. This trend suggests relatively

Tab. 4. Review of coleopterous species in individual groups of nests of *P. domesticus* (Byatre, 1965)

Species	Groups of nests						
	Winter nests	Nests under construction	Nests with avian eggs	Nests with nestlings	Nests abandoned by the young	Nests under propar. for wintering	Sum
G. buyssoni			106	56	81	12	255
C. quatuordecimstriata					1		1
Catops sp.			1				1
P. floralis			1				1
X. linearis					1		1
P. fuscus		5			15		20
A. angusticollis		2	13		20	3	38
M. pulla			28	85	8		121
D. lardarius		1			8		9
A. pimpinelae	41		4	36	19	1	101
C. distinguendus					6		6
C. dentatus			1				1
C. dorsalis				1			1
A. nigriventris					1		1
Atomaria sp.				1			1
L. angusticollis	1						1
L. constrictus			1				1
E. minutus	16	1		4	2		23
C. filiformis	2						2
C. ruficollis					2		2
C. gibbosa			1				1
C. longicollis			6	2	6		12
P. fur	1	1			13	9	24
P. raptor					13		13
T. molitor			1		4		5
C. aeneus					1		1
T. scaber			1		8	4	13
							658

regular representations of polyphages in the nests during the latter two months. Ptinidae occurred in the nests during the spring (March, April) and summer (August, September) seasons; Tenebrionidae were present during the May-through-August interval.

The occurrence of Coeloptera in nest of P. domesticus related to its nidobiology

(Tab. 4; Diagram 5)

A total of six groups of nests can be distinguished in the studied nest material: winter nests (January, February, March); nests under construction (March, April); nests with avian eggs (April, May, June, July); nest with nestlings (May, June, July); nests abandoned by young birds (May, June, July, August, September); and nest to be used in the winter season (September) (Jurík, 1967). There are appreciable differences among the groups of nests concerning moisture content, accumulation and condition of organic matter, and presence of other animal groups. In the occurrence of coleopterous species under the different nest groups of *P. domesticus* there are agencies which become operative, mainly: trophic relations, seasonal dynamics

of the occurrence of individual coleopterous species, and various, in general ecological linkages. The time overlapping of individual nest groups together with the use of the knowledge gathered on seasonal dynamics and ecology of Coleoptera provide for a deeper analysis of their relations to nests. The following chapter has therefore been conceived as an attempt at making a synthesis of the coleopterological and nidibiological knowledge.

The carnivorous species began to appear in nests under construction (the difference between IO and IIV values was large). In nests with avian eggs a steep rise in the number of carnivores occurred (species Nos. 1, 5, 8, 9) with values of IO and IIV almost level, which evidenced regularity in their occurrence and a strong linkage to nests with avian eggs. A closer examination reveals that concentration of the occurrence of carnivorous species in nests with avian eggs fell to May and June, maximum being attained in the latter month. In April their occurrence recorded very low levels, and in July the numbers were lower than those established for either May or June. In nests with young birds the occurrence of carnivores showed a moderate rising, the IO and IIV values became completely level. It appears that *M. pulla* was more tightly bound to nests inhabited by the young, while the linkage of *G. buyssoni* was more tight those containing eggs (Tab. 4). In the group of nests already abandoned by young birds an apreciable reduction in the numbers of carnivorous species was observed, the difference between IO and IIV values tended to become larger. From the time overlapping of nests abandoned by the young with those containing avian eggs, and with the ones inhabited by young birds, further from behaviours of the IO and IIV values, and finally from the seasonal dynamics of occurrence it may be concluded that the carnivorous species tended, at the time of their maximum occurrence, to concentrate in nests with avian eggs or in those inhabited by the young, whereas in the nests already abondoned by young birds the trend was to retreating. It is further concluded from the above findings that the nests harbouring either avian eggs or young birds did offer, in all probability, more favourable conditions of existence to the carnivorous species, such conditions that were given, on the one hand, by the intensive supply of organic materials and thust the more convenient environment for the other animals and on the other hand, by the presence of the birds alone, and of their parasites as well. In nests to be used during the winter season, further decreasing in the numbers of carnivores could be observed, which was consistent in full with the pattern of their occurrence dynamics.

The occurrence of necrophages was established for winter nests already, when the first maximum was recorded. The great difference between IO and IIV values indicates that the occurrence of necrophages was limited to a small number of nests. In the nests under construction and in those with avian eggs, necrophages occurred as individuals. The other maximum of their occurrence appeared in the nests with young birds, but it concentrated to a single nest (see respective IO and IIV values). The nests abondoned by the young revealed a steep drop in the numbers of necrophages; despite that, their occurrence maintained higher levels than were those established either for nests under construction or for the ones with avian eggs. In the nests to be used during the winter season only individual necrophages were detected. The distribution of

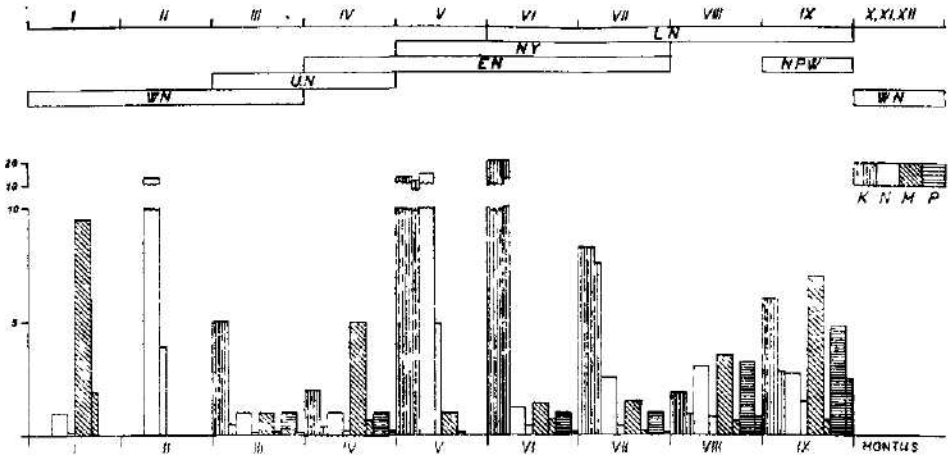

Diagram 5 — IIV and IO of trophic groups of Coleoptera in the nests of *P. domesticus* and the chronological overlap of annual dynamic of Coleoptera and of individual groups of nests K — carnivores, N — necrophages, M — mycetophages, P — polyphages, W. N. — winter nests, U. N — nest under construction, E. N. nests with eggs, N. Y. — nest with nestlings, L. N nests abandoned by birds, N. P. W. — nest prepared to be used in winter.

necrophages over the above groups of nests during the year's period was roughly consistent to the dynamics of their occurrence. The concentration to a single nest at the time of the other maximum does not allow to analyse their relations to individual nest groups, for at that time the groups were overlapping. The distribution of necrophages during the September maximum to nests already abandoned by young birds and to those to be used in winter points to their tighter linkages to the former type of nests. But it seems that the factual reason was developmental continuity of the necrophages, which due to reconstruction of the nests being prepared for the winter season, was interfered with.

The occurrence of m y c e t o p h a g e s could be confirmed for winter nests already, when a maximum was attained, but the range of findings was limited to a small number of nests. In the nests under construction the findings of mycetophages consisted of individuals only; in subsequent nest groups the occurrence of mycetophages tended to rise gradually and maximal numbers were recorded in abandoned nests, with which it also came to an end. A comparisoin of the occurence of mycetophages as traced in individual nest groups with the dynamics of occurrence indicates the nests being prepared for the winter season as unsuitable for this coleopterous species, owing to reconstruction of the nests; for in September, when the autumnal maximum is attained, their occurrence concentrates to abandoned nests which, with regard to time, are overlapping with those under preparation for the winter use.

The occurrence of p o l y p h a g e s was detected in winter nests, in those under construction, and with avian eggs. No polyphage occurred in the group of nests with young birds, and a culmination was recorded in those already abandoned by young birds. Subsequently, in nests under

preparation for the winter use, the occurrence of polyphages tended to decrease slightly and terminated. Throughout the time under observation there were relatively large differences between IO and IIV values, and their occurrence was in full agreement with the dynamycs of polyphage occurrence over the year's period.

Considered from the aspect of nest development only, the development of coleopterous fauna in studied nests displays the following pattern during the year:

In composition of their coleopterous fauna the winter nests are a continuation to those being prepared for the winter use. They are distinguished by the fauna of beetles which is poor in species and composed mainly of necrophages and mycetophages. With more numerous nest material included in the study, also a moderate occurrence of the other coleopterous trophic groups might be assumed. The beetles detected in the winter nests were, in all probability, hibernating individuals that had terminated development late in autumn. For under favourable conditions these beetles, and mycetophages in particular, may be expected to display some activity during the winter months, similarly as has been established for fleas (J u r i k, 1967). In the group of nests under construction gradual settlement by all of the recognized coleopterous trophic groups was traced. In those wherein eggs of *P. domesticus* had been laid intensive development of carnivorous species occurred (from May onward) and continued also in the nests with nestlings. At the same time, necrophages and mytophages appeared in some, presumably suitable, of the nests. Apart from the mentioned coleopterous species also other beetle groups established as occuring in small numbers were found. The nests abandoned by young birds experienced gradual reduction in the numbers of carnivores and simultaneous expansion in the proportions of necro-, myceto, and panthophages, the latter two groups of Coleoptera attaining their maxima of occurrence there. In the nests being prepared for the winter season further reduction in the numbers of carnivores could be recorded, their occurrence tending to become more irregular. Due to reconstruction of the nests their mycetophagous species disappeared, the other trophic groups remained and their levels of occurrence dropped but slightly. The existence of Coleoptera in individual groups of nests was found strongly affected by seasonal dynamics of the occurrence of individual species, and of trophic groups during the year. Only in two instances did the influence of dynamics overshadow that of trophic relations; in carnivores this occurred in the case of abandoned nests, while with mycetophages the nests being prepared for the winter use were involved.

CONCLUSIONS

1. In the total of 173 nests of *P. domesticus* collected over 1964/65 there were 1142 individuals of beetles belonging to 12 families and 33 species. When compared with the findings reported before in the literature, this nest material contained 25 species detected for the first in nests of *P. domesticus* and 15 species discovered for the first time in avian nests in general.
2. The studies of trophic relations indicated the occurrence of four trophic groups of beetles in the studies nests of *P. domesticus* (Tabs. 1, 2).

The species represented as the most numerous were carnivores (Histeridae, Staphylinidae, Coccinellidae), followed by necrophages (Dermestidae, Scarabaeidae, Catopidae); the remaining two groups of beetles, i. e. mycetophages (Lathridiidae, Cryptophagidae, Mycetophagidae) and polyphages (Ptinidae, Tenebrionidae, Ptiliidae), were less numerous.

3. The results revealed the tropic and developmental relations to nests to be highest in the case of carnivorous species. The necrophages occurred in large numbers but were limited to a lower number of nests; only the larvae showed a full trophic and developmental dependence upon nests. Things were similar with both mycetophages and polyphages.

4. The study of 117 nests of *P. domesticus* removed from one type of boxes in the Bystrc locality, 1965, was used as a basis upon which to determine the dynamics of individual beetle species, families, and trophic groups. Carnivorous species were found occurring in the nests from April through September, one maximum of their occurrence was observed in June, the other (less distinct) in September (new generation). Their occurrence in the nest coincided with those of the other arthropods detected in the same. The occurrence of necrophages revealed three peaks in succesion, falling to the February, May, and September. The same number of peaks was recorded for the occurrence of mycetophages, falling to January, April, and September; the first two peaks being slightly shifted behind the maxima of relative air humidity, the third one was in association with condition of the nests following departure of the young. The occurrence of polyphages featured a single peak falling to September.

5. Using the studies of trophic relations, seasonal dynamics, and ecology of Coleoptera as a basis, the relations to individual groups of nests were ascertained. The results indicated the presence of coleopterous species in the nests of *P. domesticus* to be determined primarily by their seasonal dynamics; the trophic relations affected their occurrence in two instances only.

6. Considering the aspects of parasitology, epizootology, and epidemiology, the coleopterous fauna detected in the studied nest is to be approached in a highly affirmative way for evaluation, because the results brought evidence on connection between the development of carnivores in particular and the abundance of flea fauna, flea larvae, mites, and other arthropodes. Moreover, an agreement could be traced in seasonal dynamics of the carnivores and the other arthropods, which pointed to significance of the former for natural reduction of the parasitic arthropods in nests. The high percentages of necrophages and polyphages provide for liquidation of dead animal bodies in the nest. In type former, however, the fact is to be taken into account that only their larvae undergo development in nests, whereas the adults disperse, after hatching, in the vicinity and thus become potential co-actors in the foresis of parasites.

REFERENCES

Borchert W., 1951: Die Käferwelt des Magdeburger Raumes, Magdeburger Forschungen, Magdeburg, Band 2, 264 pp.

Freude H., Harde, K. H., Lohse, G. A., 1964–1974: Die Käfer Mitteleuropas, Krefeld, Band 1, 214 pp., Band 4, 264 pp., Band 5, 386 pp., Band 7, 275 pp.

Gangelbauer L., 1894–1904: Die Käfer von Mitteleuropa, Wien, Band 2, 880 pp., Band III, 1046 pp., Band IV, 286 pp.

Hicks E. A., 1962: Check-list and bibliography on the occurrencens of insects in bird's nests, Supplement I, *Iowa State Journ. of Science*, 36: 233–48.

Hodek, I., 1973: Biology of Coccinellidae, Academia Praha, 428 pp.

Ioff, I. G., 1949: Izučenie aktivnosti perenosčikov, Med. Paraz. parazit bolezni.

Jurík, M., 1967: Aphaniptéria vtáčich hniezd, Brno (CSc. thesis).

Jurík, M., 1969: Beschreibung und Verwendung einer Neokonstruktion des Thermoelektors. *Ent. Nachrichten*, 13: 95–8.

Jurík, M., 1974: Bionomics of fleas in bird's nests in the territory of Czechoslovakia. *Acta Sc. Nat. Brno*, 8(10) pp. 1–54.

Miller, F., 1956: Zemědělská entomologie, Praha, 1056 pp.

Nordberg, S., 1936: Biologisch-ökologische Untersuchungen über die Vogelindicolen. *Acta zool. Fennica*, 21: 1–168.

Reitter, E., 1909, 1911: Fauna Germanica, Stuttgart, Band 2, pp. 392, Band 3, 436 pp.

Roubal, J., 1930, 1933: Katalog Coleopter Slovenska a Podkarpatské Rusi, Bratislava, díl 1, pp. 239–527, díl 2, pp. 115–357.

Sorauer, P., 1932: Handbuch der Pflanzenkrankheiten V., Berlin, pp. 82–350.

Tichomirova, A. L., 1973: Morfoekologičeskie osobennosti i filogenez Stafilinid, Moskva, pp. 192.

Vasilijev, V. P. et coaut., 1973, 1974: Vreditěli selskochozjastvennych kultur i lesnych nasažděnij. 1, 2, Kijev, 1, pp. 362–473, 2, pp. 1–217.

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VERSUCH EINER CHARAKTERISTIK DER LEPIDOPTERENSYNUSIEN ALS PRIMÄRER KONSUMENTEN IN DEN VEGETATIONSSTUFEN DER TSCHECHOSLOWAKEI

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Abstract: On the basis of about 100 000 specimens of Lepidoptera belonging to about 3000 species, of which 650 were selected as characteristic from the zoocenological viewpoint, an attempt is made to characterize the individual vegetation tiers of Czechoslovakia as defined by Zlatník, 1963 etc. according to their Lepidoptera-synusies. It could be found that very distinctive synusies of Lepidoptera exist within the individual tiers, especially in those of tiers 1, 2 and 7, 8, 9, as well as in azonal biochoruses. Certain problems appeared in connection with Lepidoptera-synusies of tiers 3 and, especially, 4 and 5 belonging to the formations of the Central European Forest Zone. It can be stated that the phytocenological conception applied by Zlatník contributes substantially also to a better understanding of entomocenology and synecology of Lepidoptera.

ZUR CHARAKTERISTIK EINIGER GRUNDBEGRIFFE

Die geobiozönologische Betrachtung der Natur und die hier angewandten Begriffe und deren gegenseitige Beziehung dürfen folgendermassen formuliert werden:

Die Organismen und ihre Raumkomplexe — Biozönosen — sind offene Systeme, die sich im Zustand eines fortwährenden Stoff- und Informationswechsels mit ihrer Aussenwelt befinden. Die Einheitlichkeit der lebenden und nicht lebenden Natur in allen ihren Ebenen, z. B. vom Individuum einer Art mit deren Aussenwelt bis zum Allgemeinen der irdischen Welt wird oft als Ökosystem bezeichnet. Biogeozönose in der Auffassung von V. N. Sukačev — in unserer Terminologie vorzugsweise Geobiozönologie genannt — wodurch das Wort Biozönose nicht getrennt wird — ist also ein Ökosystem auf dem Niveau einer Biozönose.

Die Unterschiedlichkeit des materiell Lebenden und des materiell Nichtlebenden bei ihrer gleichzeitigen Einheitlichkeit wird durch Begriffe ausgedrückt, die, methodisch gesehen, verschiedene unterscheidbare Ebenen aufweisen. So geht man z. B. von der Spezifizität der Taxone und deren chorologischen und ökologischen Typisation aus. Es wurden ihre Biozönosen und deren gemeinschaftliche Teilkomplexe als Teilbiozönosen und Synusien, ebenso auch ihr Aufbau typisiert. Auch das Nichtlebende der Natur wird typisiert, sowie dessen ökologische Beziehungsform zur Einheitlichkeit der Natur. Die Typisierung erfolgt also immer anhand des Typisierbaren.

Selbst methodisch gesehen: die Grundomponenten der lebendigen terrestrischen Natur und ihrer Einigkeit sind Chtonophyten, d. h. Pflanzen, die das Wasser aus ihrem Substrat schöpfen (verwitterte Gesteine, Boden, Humusschichten, Torf usw.), zu dem sie entweder dauernd geknüpft (adnat) sind oder in dem sie teilweise stecken (radikant). Diese Autotrophen als Primärproduzenten bilden mittelbar oder unmittelbar die trophische Basis für die heterotrophen Konsumenten — sekundäre Produzenten, Dekompositoren und Reduzenten als die wichtigsten Komponenten der Biozönose, sowie für alle übrigen Komponenten des Geobiocyklus. Ausnahmen sind Organismen, die trophisch von den Komponenten des Limno- oder des Pelagobiozyklus (etwa fischfressende Fische und Vögel) abhängig sind. Die Grundorganismen

von chtonophytischen Synusien sind auch die eigentlichen Schopfer der stabilen Raumstruktur terrestrischer Biozonosen, weiter modifizierend wirkende Medien im atmospharischen und edaphischen Innenraum der Biozonose, als auch die Lieferanten des grossten Volumens des abgestorbenen organischen Stoffes Soweit wir nicht imstande sind, andere Komponenten der Biozonose zu einer Typisierung und Klassifikation von terrestrischen Biozonosen und hoherer Aufbaueinheiten anzuwenden, konnen wir von den erwahnten Funktionen die chtonophytischen Komponenten als diesem Zweck entsprechend und ausreichend betrachten

Der Mensch, der sich durch seine Vernunft und vernunftbedingte (aber nicht immer vernunftige) Tatigkeit von der ubrigen lebendigen Natur differenzierte und abtrennte, griff und greift immer mehr als ein Aussenregulator und ein Destruktor in die Prozesse der Autoregulation und sogar selbst in das Wesen der lebenden Systeme und der Naturokosysteme ein Anhand der durch den Menschen relativ am wenigsten heimgesuchten Reste der autochtonen Natur, als auch auf Grund von anderen materiellen und schriftlichen Belegen, versuchen wir, uns eine Vorstellung von der ursprunglichen potenziellen, der jetzt herrschenden klimatischen Bedingungen entsprechenden Natur, vor allem also der potenziellen Vegetation und der von ihr abhangigen ursprunglichen Tierwelt zu bilden

Den unteilbaren Komplex der okologisch bedingten Chtonophyten, als Grundkomponenten der Synusialstrukturen, versuchen wir durch deren Einteilung in verschiedene okologische Kategorien zuganglich und verstandlich zu machen die klimatische, die edaphisch-hydrische und edaphisch-trophische Das bringt die Notwendigkeit der kausalen Klarung von Beziehungen in der nichtlebenden Natur mit sich, wie z B der Terrainkonfiguration, des Charakters von ursprunglichen Mineralien, von Bodenarten usw Die Kompliziertheit dieser Bedingungen verursacht die mosaikartige Umwandlung von Biozonosetypen der ursprunglichen potenziellen Natur

Die jetzt bestehenden Reste der ursprunglichen potenziellen Natur, wie sie durch die existierenden bestimmten Biozonosetypen, sowie durch alle durch die menschliche Tatigkeit entstandenen und in verschiedenen quantitativen Abstufungen veranderten, verwandelten oder ganz umgewandelten Biozonosen (z B Anthropobiozonose) — die sog Biozonoide einschliesslich ihrer Übergangs- oder Entwicklungsstadien sind als ein Typ der Natur (Umwelt) zu charakterisieren und sie sollen Typ des Biozons heissen In der Auffassung der Einheitlichkeit von Natur handelt es sich also um einen Typ des Geobiozons (im Falle eines Waldes als biozonologischer Waldtyp bezeichnet) mit einem Naturtyp der Geobiozonose mit entsprechenden veranderten Geobiozonosen und Geobiozonoiden Falls der Mensch in einem Segment solcher Einheiten eine dauerhaft irreversibile Veranderung unmittelbar verursachte (z B durch die sog Melioration), oder durch seine Tatigkeit am Anfang einer induzierten Veranderung (z B Erosion, Deflation usw) stand, so handelt es sich um den Übergang in einen anderen Naturtyp, der eventuell dem am ahnlichsten erscheinenden Naturtyp zuzuordnen ware

Durch seine ortlich unterschiedliche Tatigkeit vergrosserte der Mensch (meist) entweder absichtlich oder unabsichtlich mehrfach das bestehende Mosaik der Natur, oder trug zu dessen Ausprägung bei So z B behielt der Mensch auf ursprunglichem Waldsegment einer Biozonose den Wald aber im anderen Teil dieses Waldsegments schuf er eine Wiese, ein Feld, oder einen Waldbestand von verschiedenartiger Zusammensetzung der Holzarten und deren Alter Oder er konnte diese Mannigfaltigkeit im Gegenteil (teilweise rein optisch) verringern, z B durch eine Fichtenmonokultur

Die Aufbaueinheiten, die den Geobiozontypen ubergeordnet sind, bezeichnen wir als Geobiozon-Typenreihen Diesen ubergeordnet als Aufbaueinheiten oder als Ordnungseinheiten stehen okologische Reihen gegenuber, Zwischenreihen und Unterreihen, als auch — endlich — Vegetationsstufen Die zuletztgenannten sind, was die chorologische und chronologische (epiontologische) Seite der Problematik anbelangt, mit Vegetationszonen zu vergleichen

Vegetationszonen im ursprunglichen Sinne (E Schmidt) sind floristische, bzw floristisch-faunistische, also konkrete biochorologische Einheiten, die induktiv gebildet wurden Sie wurden fur den europaischen Teil der Holarktis (in Zoochorologie "Arctoarctis" genannt) gebildet und zwar in der endgultigen Form wurden sie im Jahre 1961 formuliert anhand einer Analyse von hoheren Pflanzen, vom taxonomischen, phylogenetischen, genetischen, chorologischen, epiontologischen (chronologischen), okologischen und zonologischen Standpunkt Die Pflanzen- und Tierwelt

Europas bildete wahrend ihrer glazialen und postglazialen Migrationen und auch nach diesen aus ihren Refugien raumliche Gemeinschaften, und zwar je nach den okologischen Bedingungen bei andauernden Schwankungen von klimatischen Bedingungen, wobei es zur Vermischung von Elementen aus verschiedenen Vegetationszonen kam

Im grundsatzlich flachen, ortlich leicht gewellten Gebiet Osteuropas (mit Maximalhohen von 300 m u M), zwischen dem Schwarzen Meer und der Barents-See entstanden grossflachige Vegetationszonen im Einklang mit der vorwiegend makroklimatisch bedingten Zonalitat In Mitteleuropa ist dagegen das Klima in Bezug auf die betrachtliche Terrainkonfiguration sowohl regional als auch lokal, hohenmassig und expositionsmassig derart verschiedenartig, dass die vorhandene vegetationsmassige Abstufung eine beinahe vollstandige Analogie der erwahnten osteuropaischen Vegetationszonalitat mit vielen identischen Taxonenen oder deren Kombinationen aufweist

Obwohl also die Ähnlichkeit der Vegetationszonalitat und der Vegetationsstufen naheliegt, und die Entstehung von Vegetationsstufen in den erwahnten Migrationsfolgen palynologisch und sonst nachgewiesen wurde, war trotzdem unvermeidlich, induktiv und vorwiegend vom okologischen Studium einzelner Taxone und der Terrainforschungen vorzugehen

Die edaphisch vermittelte erhohte Hydritat einer Lokalitat wird andererseits durch erhohte Trockenheit verwischt, die durch die Seichte des Bodens und dessen Neigung zur Vertrocknung verursacht wird Auf diese Weise entstehen Umweltunterschiede, die sich in der Kombination von Chtonophyten widerspiegeln Wahrend der Untersuchung der Abhangigkeiten vom Klima mussten also komplizierte okologische Beziehungen in Betracht gezogen werden Deswegen wurden zusammen mit den Vegetationsstufen und in deren Rahmen auch noch die okologischen Reihen, Zwischenreihen und Unterreihen gebildet, die Beziehung zur Trophik und Hydrik des Substrates widerspiegeln Als Leitreihen wurden diejenigen bezeichnet deren Boden nur durch Wasser von atmospharischen Niederschlagen versorgt wird Die Einheiten, die weniger Wasser wegen Seichte, Neigung zur Vertrocknung und Durchlassigkeit (z B Tiefsand) aufweisen, werden als beschrankt bezeichnet Und diejenigen Reihen, die Überfluss an Wasser wegen akzessorischen Wasser (das aus der Nachbarschaft als Durchflusswasser, Überschwemmungswasser oder stagnierendes Wasser durchsickert), aufweisen, werden als durchnetzt oder nass bezeichnet Naturlich sollen diese Beispiele nur die Kompliziertheit dieser Beziehungen andeuten Fur die angefuhrte Unterscheidung wurden auch die sog Indikator-Taxone eliminiert, ebenso wie fur die Gesichspunkte der Trophik Erst nach grundlichen Untersuchungen im Terrain (besonders der Kontaktsegmente von einzelnen Biozonosen mit Berucksichtigung der Terrainkonfiguration, seiner Exposition, des Bodenprofils usw) wurde es moglich, den Differentialwert von Pflanzentaxonen und derer Kombinationen richtig okologisch auszuwerten Fur die Feststellung der Vegetationsstufen waren die Leitreihen entscheidend, wahrend die ubrigen nur in ihrer Beziehungen zu den letzteren untersucht wurden Im landschaftlichen Segment bilden die Vegetationsstufen mehr oder weniger zusammenhangende Flachen, die allerdings nach der Meereshohe unterschiedlichen Verlauf und bei verschiedenen Expositionen auch mosaikartige Unterschiede aufweisen konnen Auf der Nord- und Sudseite ein und desselben orographischen Kammes finden wir oft verschiedene Vegetationsstufen in der sudlichen Exposition "niedrigere", in der nordlichen "hohere , und zwar in einer annahernd entsprechenden Meereshohe

Demnach ist die Vegetationsstufe als eine biozonologische oder geobiozonologische Aufbaueinheit zu definieren, die den Einflus des Klimas durch die Zusammensetzung der chtonophytischen Synusien von Biozonosen und Geobiozonosen widerspiegelt und die durch diese Zusammensetzung bestimmt wird

Die vegetationsmassige Stufenartigkeit ist mehr oder weniger fur bestimmte Landschaftsegmente charakteristisch In unterschiedlichen Landschaftsegmenten unterscheidet sie sich durch die Zusammensetzung von chtonophytischen Synusien und deren Tierarten-Synusien aus chorologischen (z B wegen der Unterschiedlichkeit der Pflanzenwelt- und Tierweltrefugien) und okologischen Grunden Dies bezeichnen wir als chorologische und okologische Varianten der vegetationsmassigen Stufenartigkeit, als azonale Synusien usw

MATERIAL UND ZIELSETZUNG

Die anhand dieser Vorstellungen (z. B. Zlatník, 1961, 1963 und Zlatník in litt.) entstandene kartographische Bearbeitung der Vegetationsdecke und der Vegetationsstufen der Tschechoslowakei (Zlatník & Rauš er, 1966) stellte an die biozönologisch orientierten Zoologen die wichtige Aufgabe, einen Versuch der adäquaten Charakteristik der entsprechenden Zoosynusien zu untersuchen mit der Zielsetzung:

1. Die von Zlatnik und seiner Schule postulierte Theorie der Vegetationsstufen im Bereich der Zoozönologie zu beglaubigen.

2. Zu diesem Zweck die entsprechenden für diese Synusien charakteristischen Differenzialarten aus der Ordnung der Lepidoptera, als einer besonders ökologisch und taxonomisch repräsentativen phytophagen Konsumentengruppe, zu eliminieren.

3. Die meist zu populär deklarierte Problematik der Umweltforschung und des Umweltschutzes zu objektivisieren, damit die Biologen im Argumentationsbereich der Diskussionen mit den oft entscheidenden ökonomischen Stellen stufenweise zugemessene Gesprächspartner würden.

Diese Studie stützt sich auf ungefähr 100 000 Belegexemplare von Lepidopteren, die in len letzten 30 Jahren gesammelt wurden. In den letzten 25 Jahren fand dies durch moderne Sammelmethoden (z. B. unter Anwendung spezialisierter UV-Strahlquellen) fast systematisch statt, indem früher weitgehend unbesammelten oder wenig bekannten Gebieten der Tschechoslowakei besondere Aufmerksamkeit alljährlich durch die ganze Flugzeit der Ordnung (Februar—November) gewidmet wurde. Auf diese Weise wurde es möglich, sich nicht nur eine ziemlich vollständige Vorstellung von der Anzahl der Lepidopterentaxone, sondern auch von den für die entsprechenden Vegetationsstufen charakteristischen Differentialarten zu bilden. Es konnten auch weitgehend quantifizierbare Daten zur Charakteristik der Abundanz- und Frequenzwerte von vielen kennzeichnenden Arten zusammengetragen werden, die in spezialisierten Einzelstudien künftlich veröffentlicht werden sollen. Die Auslese von Differentialarten wurde nach den folgenden Kriterien durchgeführt:

1. Als konkretes Ausgangsmaterial dienten die erwähnten Belegexemplare in den Sammlungen der Autoren und teilweise Material aus Instituts- und Privatsammlungen in der Tschechoslowakei.

2. Jede Art wurde nach ihrer bereits bekannten Autökologie (Standortsansprüche, Nahrungspflanze(n), geographische Verbreitung usw. — soweit bekannt) und ökologischer Potenz, wie sie sich sowohl in Originalquellen als auch in Kompendialwerken widerspiegeln, kritisch beurteilt und in die Kartei eingertagen.

3. Die auf diese Weise gewonnenen Resultate wurden mit jahrelangen praktischen Erfahrungen aus eigener Sammeltätigkeit, Terrainarbeit, zahlreichen Zuchten usw. verglichen, die später weitgehend mit anderen Spezialisten besprochen und mit modernen biogeographischen Studien aus den benachbarten Ländern konfrontiert wurden.

Die Auslese der für die einzelnen Synusien charakteristischen Arten ist also ein Resultat kritischer Untersuchungen, um die entworfene Charakteristik für eine seriöse Unterlage der zu erwartenden Diskussion zu gestalten. Aus diesem Grund wird zur Nebenaufgabe dieser Studie, die allgemeine Unterlage für weitere spezialisierte Studien zu bilden. Sie

sollen vor allem der Autökologie und Synökologie von Einzelarten oder Einzelgruppen (wie dies bereits teilweise geschieht — z. B. Novák & Spitzer, 1974) — und speziellen Verhältnissen der Teilgebiete der Tschechoslowakei (z. B. Herzynicum — Karpatikum) gewidmet werden.

Die einzelnen Lepidopteren-Synusien sind nach den entsprechenden Vegetationsstufen zusammengestellt. Die Charakteristik dieser Vegetationsstuffen erübrigt sich aus der entsprechenden Literatur (z. B. Zlatník, 1961; Zlatník, 1963 und Zlatník & Rauser, 1966). Wir halten es z. Z. für unmöglich, auch die einzelnen Reihen im Rahmen von Vegetationsstufen in Betracht zu zienen, da selbst die Synusien mancher Vegetationsstufen im Rahmen der mitteleuropäischen gemischten Waldzone noch offene Probleme sind. Die Arten wurden in jeder der Synusien nach ihrer Populationsdichte und Frequenz in fünf Kategorien aufgeteilt, weil ihre genauere (quantitative) Charakteristik den Rahmen dieser Studie weit überschreiten müsste. Aus demselben Grunde konnten auch sonstige wichtige Kriterien (z. B. phenologische Aspekte) nicht in Betracht genommen werden. Diesen Fragen müssen spezielle Studien vorbehalten bleiben.

5 — Eine durchaus häufige und in der entsprechenden Vegetationsstufe selbst im Rahmen eines (meist geringen) Massenwechsels immer anwesende, also vor allem durch ihre Populationsdichte charakteristische Art. Beispiel — *Entephria caesiata* in der Vegetationsstufe 6—7.

4 — Eine im wesentlichen häufige, durch ihre Anwesenheit und Populationsdichte für die gegebene Vegetationsstufe ebenfalls charakteristische Art, die allerdings merkbare Schwankungen der Populationsdichte aufweisen kann. Beispiel — *Aglia tau*, in der Vegetationsstufe 3, allgemeiner manche *Erebia* — Arten (z. B. *E. euryale*) in der Vegetationsstufe 5.

3 — Eine recht oft vorkommende, jedoch durch ihre relativ niedrige Populationsdichte charakterisierbare Art, die nur lokal häufiger vorkommen kann. Beispiel — *Cochlidion limacodes* in der Vegetationsstufe 3.

2 — Eine wenig häufige bis seltene Art, die nur unter besonderen ökologisch bedingten Umständen oder auf gut erhaltenen, ursprünglich geprägten Biotopen etwas häufiger vorkommt. Beispiel — *Chesias rufata* in der Vegetationsstufe 2.

1 — Eine ausgesprochen stenöke, seltene und mehr oder weniger nur auf spezifische und durchaus ursprüngliche Biotope gebundene Art. Es handelt sich oft um Reliktformen, die teilweise aussterben, oder durch die Veränderungen ihrer Biotope existenzbedroht sind, oder bereits ausstarben. Biespiel — *Thecophora fovea* in der Vegetationsstufe 1.

Bemerkung: Die in Klammern angegebenen Ziffern hinter dem Namen einer Art bedeuten, dass die Art auch in der entsprechenden benachbarten Vegetationsstufe auftreten kann, und zwar wegen der in der Einführung angegebenen (ökologischen) Umstände. Die in Klammern angegebenen Ziffern vor dem Namen einer Art bedeuten, dass die entsprechende Art unter anderen ökologischen Umständen (z. B. in spezifischen Vegetationsreihen) auch häufiger oder seltener vorkommen kann, als im Rahmen der angegebenen Synusie angeführt wird. (+) — eine bedrohte oder bereits ausgestorbene Art.

In unsere Auslese von Lepidopteren-Synusien wurden vorläufig auch die sog. Microlepidopteren einbezogen. Wegen ihrer oft sehr ausgeprägten

Oligophagie entsprechen nämlich nicht nur ihre Einzelarten, sondern oft ganze Gattungen den Typisationsansprüchen, was bes. bei Minierergattungen der Fall ist. Auch die Wickler (Tortricidae) dürften bedeutsam der Charakteristik der Waldstufen mit Übergewicht von Laub- oder Nadelholzarten beitragen, wo bisher spürbare Lücken bestehen. Die Kenntnis der Microlepidopteren ist besonders in quantitativer Hinsicht (mit Ausnahme von Schädlingen) auf beträchtlich niedrigerem Niveau (z. Z. befasst sich bei uns praktisch kein Spezialist mit der Faunistik dieser Gruppe), und auch die Bionomie vieler Arten ist unbekannt. Wegen der zweifellosen Bedeutung dieser übrigens rein künstlichen Lepidopterengruppe und trotz ihrer lückenhaften Kenntnis wurde ein Versuch gemacht, durch kritische Auslese von Arten, wenigstens eine beschränkte Anzahl, die unseren Typisationsansprüchen entsprechen, in Betracht zu ziehen. In die Häufigkeitsstufen konnten sie allerdings (mit einigen Ausnahmen) nicht eingereiht werden. Es bleibt also die künftige Aufgabe, diese Gesichtspunkte zu vertiefen.

DIE FÜR DIE EINZELNEN VEGETATIONSSTUFEN CHARAKTERISTISCHEN LEPIDOPTERENSYNUSIEN

Vegetationsstufe 1:

1 — *Thecophora fovea, Cucullia xeranthemi, C. gnaphalii, C. argentea, C. thapsiphaga, Conistra veronicae, Caradrina aspersa, Aegle koekeritziana, Porphyrinia respersa, Catocala puerpera, Dysgonia algira, Toxocampa limosa, Sterrha rubraria, S. subsericeata, S. infirmaria, Eupithecia gueneata, Eilicrinia cordaria, E. trinotata, Roeselia pannonica, Celama cicatricalis, Dipsosphecia megillaeformis, Chamaesphecia colpiformis, Paranthrene tineiformis, Carcharodus floccifer, C. lavatherrae* (+).

2 — *Euxoa temera, Calophasia casta, Egira pulla, Apaustis rupicola* (+), *Catocala hymenea, Sterrha nitidata, S. degeneraria, Synapsia sociaria, Discia conspersaria, Phalera bucephaloides, Thaumetopoea processionaea, Ocneria rubea, Procris graeca, Lycaena thersamon.*

3 — *Euclidia triquetra, Cucullia fraudatrix, Catocala nymphagoga, Sterrha filicata, Polyploca ruficollis.*

4 — *Oxycesta geographica.*

Microlepidoptera:

Stigmella aeneofaciella, S. staphylaeae, Antispila pfeifferella, Ypsolophus chazariellus, Y. persicellus, Lithocolletis delitella, Bedellia somnulentella, Parornix torquilella, Catoptilia fidella, C roscipennella, Coleophora ahenella, C. hemerobiella, C. arenariella, C. bilineatella, C. croccinella, C. balotella, C. gallipennella, C. conspicuella C. partitella, C. ditella, C. vibicella, C. silenella, C. clypeiferella, C. squalorella, Elachista collitella, E. heringi, Yponomeuta vigintipunctatus, Scythris ericetella, S. flaviventrella, S. aenescens, S muelleri, Chrysoesthia roesella, Cosmopterys eximia, Pyroderces argyrogammos, Agonopteryx furvella, Topeutis labiosella, Lecithocera briantiella, L. luticornella, Brachmia trianulella, Mesophleps trinotellus, Sophronia consanguinella, Argyritis superbella, Xystophora carchariella, Metzneria neuropterella, M. paucipunctella, Dichrorampha gruneriana, Laspeyresia succedana, Pammene amygdalana, Phaneta albidulana, Pygolopha lugubrana, Epiblemma graphana, Notocelia incarnatana, Hysterosia pulvillana, Lozopera francillana, Eugnosta parreyssiana, Cochylidia contractana, Diceratura purpuratana, Aethes sanguinana, Crombrugghia tristis, Capperia celeusi, Adaina inulae, Wheeleria spilodactyla, Rhodophaea legatella, Acrobasis fallouella, Salebria palumbella, Epischnia prodromella, Hypochalcia decorella, Nyctegretis achatinella, Phloeophaga charlottae, Ematheudes punctella, Ancylolomia palpella, Calamotropha aureliella, Pediasia fascelinella, Agriphila deliella, Agriphila poliella, A geniculea, Cledeobia bombycalis, C. moldavica, Titanio normalis, Pyrausta ostrinalis, P. obfuscata, Loxostege turbidalis, Udea accolalis, Udea elutalis, Metasia ophialis.

Vegetationsstufe 2:

1 — *Eremobia ochroleuca, Cucullia lychnitis, C. scrophulariae, Oria musculosa.*

2 — *Lamprosticta culta, Cucullia verbasci, Anticollix sparsata, Semiothisa plumaria, Chesias rufata, Procris notata, Chamaesphecia stelidiformis, Glaucopsyche alexis, Eriogaster rimicola.*

3 — *Synvaleria oleagina, Amphipyra berbera, Hoplitis milhauseri, Oreopsyche plumifera, Chamaesphecia astatiformis, Polyommatus thersites, P. damon, Eriogaster catax.*

4 — *Notodonta trepida, Erannis bajaria, Brephos notha, Eriogaster lanestris.*

5 — *Talaeporia politella.*

Microlepidoptera.

Stagmatophora tririvella, Diurnea phryganella (1, 3), *Agonopteryx cervicella, Aristotelia decurtella, Agrotera nemoralis.*

Vegetationsstufe 1—2 (Zwischenstufe):

1 — *Epilecta linogrisea, Griposa aeruginea, Dryobotodes monochroma, Simyra nervosa, Chloridea peltigera, Porphyrinia parva, Catephia alchymista, Cosymbia orbicularia, C. albiocellaria, Ocnogyna parasita, Eudia spini* (+), *Ocneria detrita, Cletis maculosa, Chamaesphecia masariformis, Hypopta caestrum, Colias chrysotheme* (+), *Euphydryas maturna* (+), *Polyommatus eroides, Pieris manni* (+).

2 — (3) *Melitaea trivia,* (3) *Zerynthia polyxena, Zygaena punctum, Z. laeta. Marumba quercus, Spatalia argentina, Omphalophana antirrhinii, Periphanes delphinii, Porphyrinia noctualis. Phyllophila obliterata, Porphyrinia communimacula, Eublemma arcuinna, Acontia lucida, Scopula decorata, S. flaccidaria, Sterrha moniliata, Cataclysme riguata, Mesotype virgata, Ennomos quercaria, Malacosoma castrense, Roeselia togatulalis, Procris chloros, Rhagades budensis, Chamaesphecia bibioniformis, Melitaea britomartis, M. aurelia, Everes decoloratus, E. alcetas.*

3 — *Dicycla oo, Porphyrinia purpurina, Sterrha rusticata, Ortholita coarctaria, Nyssia zonaria, Poecilopsis pomonaria* (3), *Exaereta ulmi, Endrosa roscida, Polyploca diluta, Hyssia cavernosa, Procris globulariae, Aegeria conopiformis, Chamaesphecia annelliata.*

4 — *Apterona crenulella* f *helix.*

Microlepidoptera:

Stigmella bahniella, Antispila treitschkella, Adela leucocerella, Neurothaumasia ankerella, Atehotum hungaricellum, Euplocamus anhracinalis (3), *Thyris fenestrella, Scytrophia crataegella, Bucculatrix noltei, B. absinthii, Leucopteryx scitella, Lithocolletis hortella, L. abrasella, L. mannii, L. distentella* (1), *L. scitulella* (1), *Dialectica simploniella, Aspilapteryx limosella, Coleophora otitae, Ochromolopis ictella, Epermenia pontificella, Ethmia sexpunctella, Scythris fuscoaenea, S. disqueella, S. succisae, Millierera dolosana, Diurnea phryganella* (3), *Topeutis barbella, T. criella, Pleurota pyropella, Holoscolia forficella, Oecophora staintoniella, Psoricoptera gibbosella, Anacampsis disquei, Compsolechia scintilella, Ephysteris inustella, Teleia scalela, T. tessella* (1). *Acleris schalleriana* (1). *Phaneta pupillana, Ph. maritima, Myelopsis tetricella, Spermatophthora hornigi, Ancylosis cynnamomella, Talis quercella, Xanthocrambus saxonellus, Pyralis regalis, Actenia brunnealis, Evergestis exstimalis, E. limbata, E. politalis, Titanio pollinalis. Aporodes floralis, Heliothela atralis, Pyrausta cingulata, P. sanguinalis, Perinephila verbascalis, Mecyna trinalis.*

Vegetationsstufe 3:

1 — *Ochrostigma velitaris, Ochropleura musiva, Chersotis glareosa, Heterogenea asella* (2), *Psyche viadrina, Epirrhanthis diversata, Hypoxistis pluviaria.*

2 — *Endromis versicolora* (2), *Odontosia carmelita, Drymonia ruficornis, D. querna, Chersotis cuprea* (2). *Graphiphora augur, Cerastis leucographa, Taeniocampa populi, Amphipyra perflua, Hydraecia petasitis, Callopistria juventina, Drepana curvatula, D. harpagula, Cymotophora fluctuosa, Celama confusalis, Cybosia mesomela, Fumaria casta, Pennisetia hylaeiformis, Hepialus lupulina, Minucia lunaris* (2), *Schistostege decussata, Trichopteryx sertata* (2), *Lygris dotata, Lampropteryx suffumata, Coenotephria berberata, Euphyia frustata, E. pictata, Hydrellia testaceata, Ennomos quercinaria, Gonodontis bidentata, Angerona prunaria, Semiothisa notata* (2), *Boarmia consonaria, Lithina chlorosata.*

3 — *Stauropus fagi* (2), *Odontosia sieversi*, *Ochrostigma melagona*, *Diarsia mendica* *Polia bombycina*, *Eriopygodes imbecilla*, *Orthosia opima*, *Drepana binaria*, *D cultraria* *Polyploca ridens* (2), *Cochlidion limacodes* (2), *Miltochrista miniata* (2), *Aegeria spheciformis*, *Enargia paleacea*, *Earis chlorana*, *Bena prasinana* (2), *Cosymbia pendularia*, *Anaitis praeformata*, *Trichopteryx carpinata* (2), *Triphosa dubitata*, *Eustroma reticulata*, *Thera variata*, *Xanthrrhoe biriviata*, *Calostigia parallelolineata*, *Eclipto ptera capitata* *Caenocalpe lapidata*, *Abraxas sylvata*, *Babta punctata*, *B bimaculata* *Anagoga pulveraria*, *Campaea margaritata*, *Selenia bilunaria*, *S tetralunaria*, *S lunaria*, *Plagodis dolabraria* (2)

4 — *Aglia tau* (2), *Cymatophora or*, *Polyploca flavicornis* (2), *Operophtera fagata* *Brephos parthenias*, *Alsophila aceraria*, *Odezia atrata*, *Thera juniperata*, *Hydriomena coerulata*, *Theria rupicapraria*, *Boarmia repandata*

Microlepidoptera

Agrotera nemoralis, *Ectoedemia liebuerdella*, *Nemapogon emortuellus*, *Scardia polypori*, *Ypsolophus parenthesellus*, *Lithocolletis faginella*, *Parornix fagivora*, *Dichomeria ustulella*, *Ptycholoma lecheana*, *Acleris sparsana*, *Strophedra weirana*

Vegetationsstufe (4) — 5

1 — *Aegeria gaderensis*, *Euxoa recussa*, *Rhyacia lucipeta* (6), *Eupsilia grisescens* *Discestra marmorosa*, *Nycteola degenerana* (6), (2) *Babtria tibiale*, *Calostigia turbata* (6), *C kollariaria*, *Eupithecia dissertata*, *Gnophos ambiguata*, *G intermedia*

2 — *Zygaena brizae* (3), *Dasychira fascelina*, *Nudaria mundana*, *Aegeria cephiformis* *Euxoa nigricans*, *E birivia* *Eupsilia latens*, *E grissescens*, *A ashworthii candelarum* *A collina* (6) *Calierges ramosa* (6), *Dasypolia templi* (6), *Polymixis gemmea*, *Photodes captiuncula*, *Syngrapha interrogationis* (6), *S ain* (6), *Chrisaspidia chryson* (6), *Hypena obesalis* (5), *Thera albonigrata*, *Th strangulata*, *Chloroclysta miata* (6), *Calostigia aptata* (6), *C salicata*, *C didymata* (6), *Puengeleria capreolaria* (6), *Eupithecia succenturiata* (6), *Semiothisa signaria*, *Boarmia arenaria*, *Gnophos pullata*, *G glaucinaria* (5)

3 — *Erebia ligea*, *Argynnis paphia*, *A. aglaia*, *Parnassius apollo* (6), *Polyommatus semiargus*, *Lasiommata hiera* (karp), *Pheosia dyctaeoides*, *Lymatria monacha*, *Selenephera lunigera*, *Dendrolimus pini*, *Parasemia plantaginis* (6), *Apamea rubrirena* (6) *Hyppa rectilinea* (6), *Ponthea coenobita*, *Phlogophora scita* (6), *Chrysaspidia bractaea* (6), *Lygris populata* (6), *Xanthorrhoe incursata*, *Calostigia olivata*, *Euphyia luctuata* *E molluginata* (6), *Mesoleuca alaudaria* (6), *Ellopia fasciaria* f *prasinaria*, *Gnophos operaria* (6)

4 — *Erebia euryale*, *P mnemosyne* (3), *Lycophotia porphyrea*, *Eurois occulta* (6) *Mamestra bi-ren* (6), *Scopula ternata* (6), *Xanthorrhoe montanata*, *Coenotephria verberate* (6)

5 — *Itame brunneata* (6)

Microlepidoptera

Pharmacis carna (6), *Coleophora vacciniella* (6), *Cyphophora idaei* (6), *Pleurota bicostella* (6), *Anchinia daphnella* (6), *Clepsis rogana* (6), *Epinotia nigricana*, *E pygmeana*, *Anchylopera unguicella* (6), *Dioryctria schuetzeella* (6), *Catastia marginea* (6), *Udea alpinalis* (6)

Vegetationsstufe (6) — 7

1 — *Standfussiana lucernea*, *Cerastis sobrina*, *Entephria flavicinctata* (5), *E infidaria* (5), *E nobiliaria*, *Coenotephria nebulata*, *C aequata*, *Melasina lugubris*

2 — *Anomogyna rhaetica*, *Lithophane consocia* (tyrph), *Apatele menyanthidis* (tyrph), *Entephria cyanata* (5), *Coenotephria veratraria*, *C obsoletaria*, *C incultraria* *Perizoma affinitata*, *Hydriomena ruberata*, *Horisme aemulata* *Eupithecia veratraria* *E subumbrata*, *Gnophos sordaria* (5), *G operaria*

3 — *Parexarnis fugax* (5), *Polia hepatica*, *Taeniocampa opima* (5, 4), *Venusia cambrica*, *Boarmia maculata bastelbergeri*, *Gnophos dilucidaria* (tyrph)

4 — *Anomogyna speciosa* (tyrph), *Cerapteryx graminis* (5), *Leucania comma* (5)

5 — *Blepharia adusta* (5), *Entephria caesiata* (5)

Microlepidoptera

Incurvaria rupella (7), *Subeidophasia senilella*, *Lithocolletis junoniella*, *Callisto coffeella*, *Coleophora vitisella*, *C glitzella*, *Kessleria zimmermannii*, *Cataplectica auromaculata*, *Schiffermuelleria similella*, *Sch rhaetica*, *Lozotaenia forsterana*, *Acleris*

maccana (tyrph) *Cnephasia alticolana* (7), *Dichrorampha cacaleana, Cacochroea grandaevana, Griselda myrtillana* (tyrph), *Rhopobota ustomaculana, Anchylopera myrtillana, Olethreutes obsoletana* (7), *Aterpia corticana* (7), *Stenoptylia graphodactyla, Aciptilia nephelodactyla, Catastia marginea* (5), *Catopria coulonella* (7), *C margaritella* (tyrph), *Eudoria valesialis* (7)

Vegetationsstufe 8–9

1 — *Sattleria dziedaszycki, Psodos noricana*
2 — *Erebia gorge, E pharte, Torula quadrifaria*
3 — *Erebia sudetica* (end), *E epiphron, Boloria pales, Psodos alpinata* (4)
4 — *Erebia manto, E pandrose roberti, Psodos canaliculata schwingenschussi, Gnophos operaria*

Microlepidopteia

Elachista dimicatella, Kessleria tatrica, Scythris noricella, Gelechia elatella, Neofaculta infernalis (tyrph), *Blasthesthia mughiana, Argyroploce schulziana* (tyrph), *A noricana, Catoptria maculalis, C furcatella C radiella, Eudoria imparella, Udea inquinatalis, Orenaia alpestralis*

AZONALE LEPIDOPTEREN-SYNUSIEN

Warme (Weh) Sandgebiete niedrigerer Lagen (Sudostmahren, Sudwestslowakei)

1 — *Melicleptria cognata, Scopula punctata* (nur mit hoherem Niveau von Grundwassei), *Chamaesphecia aestivata, Ch leucopsiformis, Psychidea pectinella, Elachista stabilella, Aristotelia brizella*
2 — *Satyrus statilinus* (+), *Hipparchia aelia, Coscinia cribraria, Porphyrinia noctualis, Conisania leineri, Hadena irregularis* (3), *Actinotia radiosa, Phyllophilla obliteterata, Rebelia nudella* (3), *Masonia crassiorella, Zygaena punctum, Bradyptesis appendiculata Stagmatophora serratella*
3 — *Anaitis efformata, Catolaenia celsia*
4 — *Pleurota pyropella*
5 — *Narraga fasciolaria*

Flachmoore (eutroph) niedriger Lagen

1 — *Arenostola morrisi, Archanara dissoluta, A algae, Cosmopteryx scribaiella, Sclerocoma acutella, Paraponyx nivalis, Acleris udana,* (2) *Ostrinia palustralis*
2 — *Melitaea dictynna, Chamaesphecia palustris, Photodes pygmina, Ph extrema, Sedina buettneri, Calamia phragmitidis, Nonagria typhae, Archanara sparganii, Chilodes maritima, Perizoma lugdunaria, Pelosia obtusa, Chamaesphecia hungarica, Plusia zosimi, Calamotropha paludella, Scirpophaga praelata, Donacaula mucronella*
3 — (4) *Phragmatoecia castaneae,* (4) *Rhizedra lutosa, Archanara geminipuncta, Schoenobius gigantellus,* (4) *Donacaula forficella, Catoptria margaritella*
4 — *Photodes fluxa, Archanara nexa,* (3) *Chilo phragmitellus, Nymphula stagnata.*
5 — *Paraponyx stratiotata, Nymphula nymphaeata,* (4) *Cataclysta lemnata, Acentropus niveus*

Hochmoore

1 — *Anarta myrtilli* (in spaterer Succession bis Haufigkeitsgrad 3), *Diarsia dahlii, Cerastis sobrina, Argyroploce turfosana, Coleophora ledi, Acleris maccana, Buckleria paludum, Crambus uliginosellus, C alienellus*
2 — *Melitaea dictynna, Apatele menyanthidis, Carsia paludata, Anarta cordigera, Celaena haworthi, Lita virgella Olethreutes lediana, Argyroploce myginda na*
3 — (4) *Colias palaeno europome, Coenonympha tullia, Vaccinina optilete, Brenthis ino, Sterrhopteryx standfussi, Lithophane lamda, Lithomoia solidaginis, Syngraphe microgamma*
4 — *Boloria aquilonaris, Amphipaea lucens,* (5) *Argyroploce schulziana*
5 — *Boloria aphirape* (herz), *Elachista albidella*

Canyon-Taler der Vegetationsstufe 2–3

1 — *Paidia murina, Ogygia nigrescens, Mamestra splendens, Hadena albimacula, Hoplodrina superstes, Metachrostis dardouini, Panchrysia deaurata, Calpe capucina*

2 — *Nudaria mundana, Coscinia cribraria, Apamea platinea, Oligia versicolor, Dyscia conspersaria*
3 — *Eucharia casta, Dyspessa ulula, Ogygia forcipula, Sideridis evidens, Aucmis comma Cucullia campanulae, Cryphia ereptricula, Calocalpe cervinalis*
4 — *Endrosa roscida, Chersotis fimbriola, Hoplodrina respersa*
Bemerkung Manche dieser Arten sind psammophil (Sand-Azonal)

Canyon-Taler der hoheren Vegetationsstufen

1 — *Diarsia dahlii, Cerastis sobrina, Callostigia collariaria, C aequata, Coenotephria nebulata, Gnophos dumetata, G ambiguata, G intermedia*
2 — *Amathes ashwothii candelarum, Discestra marmorosa, Calostigia aptata, Gnophos glaucinaria*
3 — *Calostigia salicata Gnophos pullata*
4 — *Gnophos dilucidaria*
Bemerkung Manche dieser Arten sind tyrphophil (Hochmoor-Azonal)

Auenwald

1 — *Nymphalis xanthomelas* (+) *Ostrinia palustralis*
2 — *Brephos puella, Epizeuxis calvaria Phyllocnistis unipunctella*

DISCUSSION

Auf dem Gebiete der ČSSR wurden bisher fast 3000 Lepidopterenarten festgestellt Von diesen wurden ca 650 zur Charakteristik der Synusien von einzelnen Vegetationsstufen ausgewahlt Wahrend die sog Macrolepidopteren-Synusien bereits recht reprasentativ erscheinen, durfte entsprechend der Zunahme der Kenntnis von sog Microlepidopteren diese Anzahl um weitere 100—150 Arten steigen Man kann also feststellen dass ungefahr 750—800 Lepidopterenarten den Anspruchen der zoozonologischen Differentialarten (Indikator-Taxone) entsprechen durften

Von den in dieser Studie charakterisierten Synusien, deren artspezifische Zusammensetzung als eine Unterlage fur weitere kritische Untersuchungen dienen soll, gelten als ausgepragt vor allem diejenigen, welche auf phytozonologisch ausgesprochen eindeutig charakterisierbare Biotope oder Biozonosen im Rahmen mancher Vegetationsstufen gebunden sind Fur diese Synusien ist charakteristisch, dass sie meist aus stenoken, d h trophisch oder sonst okologisch anspruchsvollen Arten bestehen, die an ausgepragte Umweltbedingungen gebunden sind Dies gilt vor allem fur die Vegetationsstufe 1, also hauptsachlich fur die sudmahrischen und sudslowakischen nur teilweise fur die torzoartigen Steppenenklaven (besonders auf Kalkstein) Zentral-Bohmens (das sog Bohemicum) Diese Schlussfolgerung sei noch insofern zu differenzieren dass die submediterranen Steppenrelikte Mittelbohmens (z B aus historisch-biogeographischen Grunden) weniger ausgepragt und vor allem noch mehr zersplittert sind als in Sudmahren und in der Sudslowakei, und dass sie eindeutige Merkmale der atlantomediterranen Beeinflussung aufweisen (z. B *Luperina nickerlii, Stagmatophora nickerlii, Pennisetia bohemica).* Ein untrennbarer Bestandteil dieser Vegetationsstufe ist die ausgedehnte Biozonose des Auenwaldes (teilweise im Inundationsgebiet groserer Flusse) mit seinen charakteristischen Arten, stellenweise mit Begleitarten des Azonals von eutrophen Flachmooren Ahnliches gilt auch uber die ausgepragten Lepidopterensynusien der Vegetationsstufe 7, die im Einklang mit den entsprechenden Phytozonosen ebenfalls sehr charakteristisch sind Dies gilt vor allem fur diese Synusien in den Karpaten die besser charakteri-

sierbar sind als in derselben Stufe des Bohmischen Massivs (Herzynikum) Ganz einmalig sind naturlich die Lepidopterensynusien der Stufen 8—9, die besonders in den Hochgebirgslagen der Tatra stark ausgepragt sind mit ihren ausgesprochenen Endemismen In diesem Zusammenhang sei z B auf das Fehlen von *Erebia sudetica* (endemisch im Altvatergebirge, wo dagegen ein ganzer Komplex von Arten dieser Gattung, die in den Karpaten und in anderen europaischen Gebirgen ahnlicher Stufen vorkommen, ganzlich fehlen) in der Tatra hingewiesen. Dieselben oder sehr ahnliche Unterschiede kann man an mehreren Arten oder Gattungen demonstrieren (z B Arten der Gattung *Psodos*) Zu diesen Unterschieden gehoren aber auch Beispiele da im Rahmen der Synusien des Bohmischen Massivs dieselben Arten vorkommen wie im Karpaten-System, doch in unterschiedlichen Unterarten (z B *Erebia epiphron, Boloria aquillonaris, Parnassius apollo, P mnemosyne*) Die Unterschiedlichkeit der Lebensbedingungen in entsprechenden (oder benachbarten) Vegetationsstufen und Azonalen kann sich aber auch in verschiedenen Populationsdichten derselben Arten widerspiegeln, die im Herzynikum seltener sind als im Karpatikum oder umgekehrt (*Anomogyna speciosa, A rhaetica, Calaena haworthi, Thera cognata* usw)

Auch azonale Biozonosen und Biochore weisen recht ausgepragte Lepidopterensynusien auf. Dies gilt vor allem fur die Formation der warmen (Weh) Sandgebiete im Bezirk von Hodonin und Bzenec (Sudmahren) und fur ahnliche Sandgebiete der transkarpatischen Westslowakei Dort reagieren die sonst fur die Synusien der Vegetationsstufen 1 und 2 charakteristischen Arten ganz anders — namlich durch unterschiedliche Populationsdichten Gerade diese und nicht etwa die Anwesenheit einer bestimmten Art ist fur diesen Azonalbiochor kennzeichnend (z B *Zygaena punctum, Hipparchia aelia, Porphyrinia noctualis, Bradyptesis appendiculata*) Der jetzige Endemismus mancher Arten in diesem Azonal oder in anderen Biotopen kann nur scheinbar sein, da es sich in Wirklichkeit um reliktartiges Vorkommen von Formen handelt, die nachweisbar auch in anderen Formationen lebten, von denen sie restlos verschwanden, und es scheint nur eine Zeitfrage zu sein, bis sie auch da verschwinden (beinahe klassische Beispiele bieten *Ammobiota hebe,* und die offenbar restlos ausgestorbene *Eudia spini*, teilweise *Malacosoma castrense* usw) Aber auch echte Endemismen, wie z B *Zygaena cynarae*-ein Terziarrelikt-konnen als Differentialarten fur unsere Zwecke belanglos sein

Einen ahnlichen azonalen Biochor stellen offenbar die Hochmoore dar Und gerade in diesem Fall ist die faunistische Unterschiedlichkeit der (haufigeren) herzynischen gegenuber den (selteneren) karpatischen Hochmooren am auffallendsten So kommt *Colias palaeno* z Z nur in je einem nordmahrischen (Rejviz) und karpatischen (Suchá Hora) Hochmoor vor, wo sie offenbar ausstirbt Dagegen ist sie in den sudbohmischen Ubergangsmooren und in den Hochmooren des Bohmerwaldes doch mehr ververbreitet und es besteht auch Hoffnung, dass sie dort langer uberleben durfte Auch da gibt es spezifisch-endemische Unterschiede (*Syngraphe microgamma* ist bisher nur aus einem einzigen Hochmoor in den Karpaten bekannt (Sucha Hora), *Vaccinina optilete* fehlt bei Rejviz usw) Es gibt aber auch Beispiele verschiedener Populationsdichten einer Art in den herzynischen und karpatischen Hochmooren Ahnliche Lebensausserungen

kennen wir übrigens bei Arten, die für gewisse Vegetationsstufen charakteristisch sind (so ist z. B. *Dasypolia templi* häufiger in der Vegetationsstufe 6 ev. 7 des Böhmerwaldes als in der Tatra). Ein spezifisches obwohl bereits im anderen ökologischen Zusammenhang erwähntes Beispiel, ist das Vorkommen gewisser Formen in waldsteppenartigen, relativ warmen N-schen der Stufen 1, 2, die aber gleichzeitig beträchtlich höhere Populationsdichten auf den (trockenen) Rändern von Hochmooren mit Vaccinien und *Calluna* aufweisen (*Rhagades pruni*). Solche Populationen haben dann auch unterschiedliche Futterpflanzen in verschiedenen ökologischen Nischen. *Anarta myrtilli* und *A. cordigera*, bei uns streng tyrphophile bis tyrphobionte Falter, sind z. B. in Thüringen in den Meereshöhen um 600—700 m Leitarten oder wenigstens Begleiter von Vaccinien, bes. *Vaccinium vitis-idaea*, die auf degradierten Böden mit Föhre ausgedehnte Bestände bilden. *Anarta myrtilli* kommt übrigens auch bei uns neben den trockeneren und überwucherten Hochmoorrändern, wo sie weniger häufig als Pseudotyrphophil fliegt, auf trockenen *Calluna*-Heiden vor (Südwestmähren, bei Znojmo). Ähnlich unterschiedlich benehmen sich manche Populationssegmente von *Eurois occulta*, ganz besonders aber *Ochropleura praecox* in den Vegetationsstufen 1—2, oder in den Azonalen einerseits (wo sie mest geringe Populationsdichten aufweisen), und in der Vegetationsstufe 5—6 andererseits. In den zuletzt genannten erreichen sie nicht nur höhere Populationsdichte, sondern sie werden zu ausgesprochenen Leitarten. Analoges gilt über *Ceratopteryx graminis* usw. Ganz einmalig ist das Beispiel des Schmetterlings *Leptidea morsei*, der vor seinem Aussterben in Südmähren eine Leitart der Vegetationsstufe 1 und der Ränder der Vegetationsstufe 2 war, während er im Karpatensystem für manche Biotope der Vegetationsstufe 5 charakteristisch ist.

Eine stark ausgeprägte azonale Formation bilden eutrophe Flachmoore niedriger Lagen mit ihrer einmaligen Synusie thermopsychrophiler Arten, die trophisch an deren spezifische Vegetation mit überwiegenden *Phragmites*-Beständen gebunden sind. Mit Ausnahme von *Melitaea dictynna* (und teilweise *Buckleria paludum*) gibt es hier kaum gemeinsame Falterarten in echten Hochmooren.

Eine besonders in den höheren Karpatenlagen gut ausgeprägte Lepidopterensynusie finden wir in der Vegetationsstufe 7. Diese wird durch einen repräsentativen Artkomplex der Geometridengattung *Entephria* und durch mehrere Noctuiden charakterisiert. In diesem Zusammenhang sei betont, dass manche besonders an die Vaccinien-Bestände gebundenen Arten dieser Stufe auch als tyrphophil vorkommen können (*Lithophane consocia, Anomogyne speciosa, Acleris maccana, Griselda myrtillana, Catoptria margaritella* usw.). Ein Kennzeichen dieser Synusie ist ein zeitweise saison-bedingtes Überschneiden mit der Vegetationsstufe 6. Auch im Rahmen dieser Synusie gibt es teilweise beträchtliche faunistische Unterschiede zwischen dem Herzynikum und dem Karpatikum (so z. B. bei *Entephria* usw.).

Etwas problematisch wird die Charakteristik der Synusie der Vegetationsstufe 2. Alle Umstände scheinen anzudeuten, dass besonders bei der kartographischen Bearbeitung (Z l a t n i k & R a u š e r 1966) diese Stufe etwas breit (zu Ungunsten der Vegetationsstufe 3) aufgefasst wurde. Auch eine strenge Abgrenzung der Synusien der Stufe 1 und 2 war nur teilweise

moglich Diese Schwierigkeiten mussten durch die Bildung einer gemeinsamen Synusiengruppe (Übergangssynusie) fur diese beiden Stufen uberbruckt werden Deswegen erscheint die kunftige Eliminierung mancher Arten (nach Klarung deren Autokologie), die klar in die Vegetationsstufe 2, besonders aber 3 fallen, unvermeidbar

Trotzdem muss man auf einen sehr reprasentativen Komplex von Lepidopterenarten im Rahmen der Vegetationsstufe 3 aufmerksam machen (z B mehrere Drepaniden, *Aglia tau, Diarsia mendica, Amphipyra perflua, Hydriomena coerulata, Bapta punctata, B bimaculata, Anagoga pulveraria*) Auch in diesem Rahmen gibt es naturlich manche Differentialarten, die z B nur fur manche mahrische Biozonosen charakteristisch sind (*Odontosia sieversi, Schistostege decussata* — eine fur die Waldsteppenbiotope der Kleinen Karpaten ganz typische Art) Auch in diesem Fall wird es offensichtlich notwendig sein, spezielle Aufmerksamkeit der Differenzierung dieser Synusie im westlichen und ostlichen Teil der ČSSR zu widmen Die Vegetationsstufe 3 erscheint vorlaufig als relativ artenarm Betrachtliche Schwierigkeiten bieten ebenfalls die sog Microlepidopteren Die bestehenden Mangel sind also wenigstens vorlaufig auch methodischen Charakters

Ahnliche Schwierigkeiten bieten die Charakteristik und Differenzierung der Synusien der Vegetationsstufen 4 und 5 Besonders die varmeren Reihen der *Fagus*-Stufe (4a) sind anhand von Lepidopterensynusien nur schwierig von denjenigen der Vegetationsstufe 3 zu trennen Die Synusien der Vegetationsstufe 5 sind mehr ausgepragt, aber auch in diesem Fall wurde es notwendig, einer synthetisierenden Vorgangsweise Vorgang zu geben und zwar desto mehr, als hierher auch manche Arten aus der Vegetationsstufe 6 reichen Das ist teilweise durch den Umstand verursacht, dass hier ein Übergewicht von euryoken und betrachtlich polyphagen Arten besteht, und dass wir bisher ungenugend die an Nadelbaumbestande und Laubbaumbestande und ihre Begleitpflanzenarten trophisch gebundenen Formen unterscheiden konnen (was besonders die sog Microlepidopteren anbelangt)

Es ware zu umfangreich und ware wenig sinnvoll, die Vegetationsstufen 6 und 7 zu differenzieren Ihre Arten sind vielfach gemeinsam, die bestehenden Unterschiede sind eher quantitativen als qualitativen Charakters, oder sie sind den faunistisch-zoogeographischen Unterschieden zwischen den Elementen des Herzynischen oder Karpaten-Systems zuzuschreiben

Diesen und ahnlichen Problemen soll in Zukunft notwendigerweise die entsprechende Aufmerksamkeit gewidmet werden Andererseits widerspiegelt die teilweise Unmoglichkeit einer strengen Unterscheidung der Vegetationsstufen der sog eigentlichen westpalaearktischen Waldzone die Kompliziertheit der in der Einfuhrung erwahnten Vorgange im Laufe des Holozans, die die chtonophytische Zonalitat Osteuropas gerade in den Bergstufen verwischte oder zu einem Mosaik umwaldelte.

Die *Pinus cembra*- und Knieholzzone (Vegetationsstufe 8) von der eigenen alpinen Zone (Vegetationsstufe 9) zu trennen, ware, rein zoozonologisch gesehen, recht formell Knieholzbestande bilden mit den alpinen Wiesen eine mosaikartige Formation, so dass die Synusie der Stufe 8 nur

anhand von an *Pinus cembra* und *P. mugho* monophag gebundenen Arten (wie etwa *Blasthesthia mughiana*) charakterisierbar wäre.

Ein eigenartiges hochinteressantes geobiozönologisches Problem dürften dagegen die Synusion der phytozönologisch bisher wenig beachteten (azonalen?) Formationen der Canyon-Tälern darstellen, wie wir sie vor allem aus dem Karpatensystem kennen. Diese sind sowohl ökoklimatisch (zonale Inversion, beschränkte Insolation besonders nahe der Grundschicht, Wärmeausstrahlung der Felsen in der Nacht, mehr oder weniger gesetzmässige Luftströhmung, Radiationscharakter des Wetters usw.) als auch edaphisch und bodentypisch (z. B. Kalkstein, Serpentin, aber auch physikalische Faktoren — wie steile senkrechte Felsenhänge usw.) und dadurch auch phytozönologisch gut charakterisierbar. In diesem Zusammenhang sei noch bemerkt, dass mehrere Arten nur in zwei unterschiedlichen Azonalen vorkommen, oder nur dort höhere Populationsdichten aufweisen:

1. In den Canyon-Tälern und im Sand-Azonal einerseits (*Hadena albimacula*) und

2. in den Canyon-Tälern und Hochmooren andererseits (*Diarsia dahlii, Cerastis sobrina, Gnophos dilucidaria*).

Im allgemeinen darf festgestellt werden, dass der Versuch einer Charakteristik der Lepidopterensynusien einzelner Vegetationsstufen im Sinne von Zlatník (z. B. 1961, 1963) einer Vertiefung der biozönologischen Auffassung synökologischer Lepidopterenforschung bedeutsam beitrug. Dies wird besonders klar, wenn wir diese Auffassung mit derjenigen von Mařan, 1958, die auch von Hrubý, 1964 und Slanečková, 1967 übernommen wurden, und die schliesslich auch in den Veröffentlichungen im Bereich des Naturschutzes vorherrscht. Dies soll keinesfalls als eine Art Kritik verstanden werden, sondern vielmehr als Feststellung, dass die phytozönologische Auffassung von Zlatník eine exakt fundierte Basis für die theoretische Rekonstruktion der Geobiozönosen und deren Insektensynusien in der Tschechoslowakei und im breiteren Sinne auch in Mitteleuropa bildet. Obwohl dieser Auffassung noch beträchtliche Verfeinung, Vertiefung usw. fehlt, wie dies bei jeder Theorie der Fall ist. Da auch in unserem Fall nur ein Versuch vorliegt, ist es erforderlich, durch kritische Bemerkungen, neue Sichtwinkel usw. die von uns entworfene Auffassung zu verbessern, zu vertiefen, kurz zu vereindeutigen, damit sie sowohl theoretisch als auch praktisch weiter anwendbar werden könnte.

SCHLUSSFOLGERUNGEN

1. Aus dem Gesamtkomplex von ungefähr 3000 Lepidopterenarten wurden auf Grund von etwa 100.000 grösstenteils quantitativ gefangenen Faltern rund 650 Arten eliminiert, und zwar nach den ökologischen Kriterien, die sie als Differentialarten für die von Zlatník theoretisch postulierten Vegetationsstufen auf dem Gebiete der Tschechoslowakei vorbestimmen.

2. Diese Differentialarten wurden in die den einzelnen Vegetationsstufen entsprechenden Synusien nach Häufigkeitsgrad, Populationsdichte, chorologischen Ansprüchen usw. eingeordnet, und zwar mit folgendem Resultat:

3. Für die Vegetationsstufen 1, 2 und 7, sowie für die azonalen Biochore der Sandgebiete, der Hochmoore, der Flachmoore und teilweise für Canyon-Täler konnten einwandfreie charakteristische Faltersynusien de-

finiert werden. Dasselbe gilt auch für die Vegetationsstufen 8 und 9, deren Abtrennung im Falle der Fyltersynusien wegen ihres mosaikartigen Charakters allerdings unwichtig erscheint.

4. Die Vegetationsstufe 2 scheint besonders in der kartographischen Bearbeitung von Z l a t n i k & R a u š e r, 1965 etwas breiter aufgefast zu sein, wodurch die Faltersynusien der Vegetationsstufe 3 zusehr eingeschränkt wurden.

5. Dagegen stellen sich einer eindeutigen Abtrennung der Faltersynusien der Stufen 4 und 5, sowie 6 und 7 gewisse Schwierigkeiten entgegen. Diese sind zwar teilweise rein methodisch bedingt (z. B. mangelnde Kenntnis der Autökologie und die dadurch entstandene Schwierigkeit, Differentialarten eindeutig zu eliminieren), andererseits scheint aber klar zu sein, dass diese Verhältnisse auf die Vegetationsstufen bedingenden Faktoren zurückzuführen sind. Der westpalaearktische Waldbiochor verlor nämlich aus bekannten Gründen in Mitteleuropa seine für Osteuropa charakteristische Zonalität. Statt dessen entstanden in Mittelgebirgslagen Mitteleuropas standortbedingte Biotope, die als sog. Reihen (im Sinne von Z l a t n i k) den Charakter der Vegetationsstufen zum Mosaik machen. Deswegen gibt es neben der für die erwähnten vier Stufen charakteristischen Arten eine grosse Zahl von Arten, die auch in der benachbarten Stufe auftreten. Obzwar die künftige Forschung diese Schwierigkeiten noch korrigieren kann, behalten sich mehrere sonst für manche Waldbiozönosen recht charakteristische Arten diesen ökologisch intermediären Charakter bei. Die Eliminierung dieser charakteristischen Arten aus dem Differenzialkomplex ist jedoch kaum denkbar, weil dadurch nicht nur die Anzahl der brauchbaren Differentialarten zu gering bliebe, sondern es müsste dadurch auch eine nicht zu begründende quantitative Disproportion bei diesen so artenreichen Synusien entstehen.

6. Bei manchen Falterarten wird ihre zoozönologische Wichtigkeit nicht durch ihre blosse Mitgliedschaft in einer Synusie bestimmt, sondern viel mehr durch ihre für die entsprechende Vegetationsstufe charakteristische Populationsdichte.

7. *Mehrere Differentialarten zeichnen sich auch durch unterschiedliche* Populationsdichten oder sogar durch die Zugehörigkeit zu den Synusien unterschiedlicher Vegetationsstufen im Böhmischen Massiv und im Karpatensystem aus.

8. Für manche Vegetationsstufen sind auch Arten unterschiedlicher zoogeographischer Elemente, oder sogar Endemismen charakteristisch. Das gilt z. B. für sog. Herzynicum, Bohemicum (mit dessen eher atlantomediterranen Beeinflussung) im Gegensatz zu den mehr pontisch oder osteuropäisch geprägten Biozönosen des Karpatensystems. Auf diesem Gebiet sind weitere Untersuchungen erforderlich, damit die notwendige Genauigkeit bei der Auswahl von Differentialarten erzielt werden könnte.

9. Eine wohl "pseudoazonal" wirkende Geobiozönose bilden canyonartige Täler, deren Falterbiozönosen gewisse chorologische Konvergenzen *mit den azonalen Synusien der Sandgebiete oder Hochmoore aufweisen* können. Dies ist insofern wichtig, als dabei die Anwesenheit der Nahrungspflanze eine unterordnete Rolle spielt, was die Differentialarten als mezoklimatisch oder mikroklimatisch besonders abhängig charakterisiert.

Zusammenfassend dürfte man also feststellen, dass der Versuch um die

Charakteristik der für die von Zlatník entworfenen Vegetationsstufen charakteristischen Faltersynusien eine wesentliche Vertiefung der bisherigen synökologischen Betrachtungsweisen dieser Problematik brachte. Deswegen scheint dieses Vorgehen in der Zoozönologie sowohl theoretisch als auch praktisch perspektiv zu sein.

SCHRIFTTUM

Bergmann A., 1951–1955: Die Grosschmetterlinge Mitteldeutschlands, Leipzig – Jena.

Čaputa A., 1970: Lepidoptera prírodnej rezervácie Devínska Kobyla, *Ent. probl.*, **8**: 55–153.

Daniel F., 1957: Die Föhrenheidegebiete des Alpenraumes als Refugien wärmeliebender Insekten. *Ztschr. Wien. ent. Ges.*, **40**: 13–71, 104–135.

Daniel F., 1957. Die Föhrenheidegebiete des Alpenraumes als Refugien wärmeliebender Insekten *Mitt. Münchn. Ent. Ges., e. V.*, **47**: 21–121.

Forster W. & Wohlfahrt A., 1954–1960: Die Schmetterlinge Mitteleuropas, Bd. 1–3, Stuttgart

Friese G., 1956: Zoogeographische Betrachtungen zur Rhopaloceren-Fauna Mitteleuropas. *Beitr. Ent.*, **1–6**: 53–100, 403–442, 625–628.

Hormuzaki C., 1930: Die Entwicklung der europaischen Lepidopteren-Fauna seit der Terziarzeit im Lichte der Palaeogeographie und Palaeontologie. *Cernauti Bul Fac de stiinte*, **4**:

Hruby K., 1956: Motýlí fauna mlyňanského arboreta. *Biol. práce*, **2**: 1–74.

Hrubý K., 1964. Prodromus Lepidopter Slovenska, 1–962, Vydav SAV, Bratislava

Kostrowicki A. s., 1953: Studia na fauna motyli wzgórz kserotermicznych nad Dolna Nida. *Fragm. faunist. Mus. Zool. Pol.*, **6** (16): 264–447.

Králiček M., 1971: Faunisticky významne nálezy Lepidopter ze Slovenska a Moravy. *Acta rer. nat. Mus. Nat. Slov.*, **17**: 77–84.

Králiček M. 1976: Einige bemerkenswerte Funde von Lepidoptera aus unserem Gebiet, besonders aus Mähren und aus der Slowakei. *Acta rer. nat. Mus. Nat. Slov.*, **22**: 93–109:

Kralíček M., Marek J., Povolný D., 1970: Významné a nové faunistické nálezy Lepidopter z Moravy a Slovenska. *Ochrana fauny*, **4**: 1–9.

Lattin de G., 1952: Zur Evolution der westpalaearktischen Lepidopteren-fauna, *Decheniana*, **1–2**: 115–164.

Maïan J., 1958: Zoogeografické členění Československa. *Sbor. Čsl. spol. zeměp.*, **63**: 89–110.

Novák I., Spitzer K., 1972: Výsledky faunisticko-ekologického studia Lepidopter (Noctuidae a Geometridae) rašeliniště Mrtvý luh u Volar a okolí. *Sbor. Jihoč. Muz v Čes. Buděj., ser. přír. vědy*, **12**, supl. 1: 3–63.

Osthelder L., 1939: Die Schmetterlinge Sudbayerns. *Mitt Münchn. Ent. Ges.*, **24**:

Slamečková M., 1967: Rozšírenie a ekológia múch tribu Sarcophagini (Diptera) na Slovensku. Dissertationsarbeit, 1–147, Nitra.

Steuer H., 1965, 1966, 1970: Die Schmetterlinge von Bad Blankenburg. *Dtsch. ent Zeitschr.*, **12**: 1–48, **13**: 447–459, **17**: 411–431.

Varga Z., 1963–1964: Zoogeographische Analyse der Marcolepidopterenfauna Ungarns 1, 2. *Acta biol. Debr.*, **2**: 141–154, **3**: 147–180.

Warnecke G., 1965: Die Grosschmetterlinge des Niederelbegebietes und Schleswig-Holsteins. *Verh. Ver. naturw. Heimatf. Hamburg*, **32**: 69–103.

Warnecke G., 1961: Rezente Arealvergrösserungen bei Macrolepidopteren in Mittel- und Nordeuropa. *Bonn. Zool. Beitr.*, **1–2**: 113–141.

Zlatník A., 1961: Grossgliederung der slowakischen Wälder in waldtypologischer und pflanzensoziologischer Auffassung. *Veröff. Geobot. Inst. Eidg. Techn. Hochsch Zurich*, **36**: 52–90

Zlatník A., 1963: Die Vegetationsstufen und deren Indikation durch Pflanzenarten am Beispiel der Walder der ČSSR. *Preslia*, **35**: 31–51.

Zlatník A., in litt.: Zum Begriff der Vegetationsstufe.

Zlatník A., Raušer J., 1966: Atlas Československé socialistické republiky, list 21, ÚSGK, Praha.

Zlatník et kol., 1970 Lesnická botanika speciální, SZN-Praha, 1–667.

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CONTRIBUTION TO THE MORPHOLOGICAL VARIABILITY OF GUDGEON, GOBIO GOBIO (OSTEICHTHYES, CYPRINIDAE)

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Dedicated to Professor V. D. Vladykov's 80th birthday anniversary

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Abstract: 180 sp. of gudgeon, *Gobio gobio* (Linnaeus, 1758), from Danube drainage of Czechoslovakia and 78 sp. from the river Labe drainage were measured and 28 morphometrical features together with 3 meristic ones were studied with regard to eventual subspecific differences among them, and comparisons were performed with data from English, Polish, Rumanian and Kazachstan gudgeons. The relative growth variability was also studied.

There are differences between native and Kazachstan populations (here *G. gobio lepidolaemus*), *G. gobio sarmaticus* from Poland, and *G. gobio obtusirostris* sensu Banarescu, 1959 from Rumania. It is believed that in our territory both river drainages are inhabited by the typical form, *Gobio gobio gobio* (Linnaues).

INTRODUCTION

The gudgeon. *Gobio gobio* (Linnaeus, 1758), is geographically wide--ranging. Therefore, it is an interesting species for a systematic study. The following contribution offers a morphometric comparison of the populations of gudgeons sampled in the rivers Orava, Bečva, Dyje, Morava and in the creek Výrovka. In comparing the results of these localities with those of foreign authors, in the frame of Eurasia, I have tried to precise the subspecific classification of our gudgeons.

Berg (1914, 1923, 1949) dealt with the variability of the gudgeons; Vladykov (1931) studied from the systematical point of view the populations of the gudgeons from the river Tisa. Further authors interested in this problem: Banarescu (1953, 1961, 1962) has studied the taxonomy of the populations of the gudgeons in England, Kazachstan and Rumania. The same author (1959) synonymized *Gobio obtusirostris* (Cuvier et Val., 1842) found in the Munich area with *Gobio gobio carpathicus* (Vladykov, 1931) from the river Tisa drainage as *Gobio gobio obtusirostris* (= *carpathicus*) from the Danube drainage. According to Krupka (1969) the existence of *Gobio gobio obtusirostris* from the Danube drainage is at issue for the time being. Žukov (1965) studied the populations of the gudgeons taken from the Upper Dněpr River, Rolik (1967) described the gudgeons from Poland. Michailova (1966) has described the gudgeons from Bulgaria and Alexandrova, Smirnov (1969) were concerned in the gudgeons from the Middle Dněpr River.

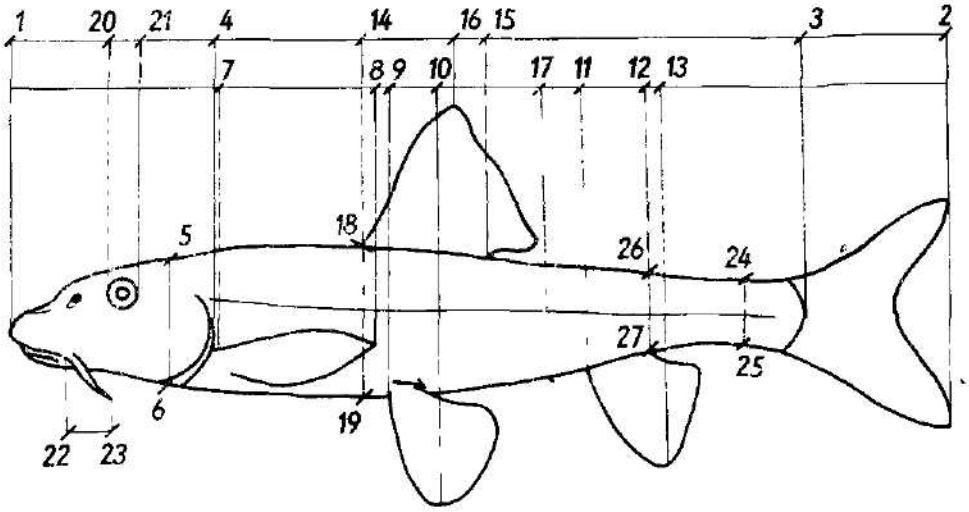

Fig. 1. Measurements on *Gobio gobio*.
1–2 total length, 1–3 body length, 1–4 head length, 5–6 head height, 7–8 length of pectoral fin, 9–10 lenght of ventral fin, 11–12 lenght of anal fin, 11–13 height of anal fin, 14–15 length of dorsal fin, 16–18 height of dorsal fin, 7–9 P–V distance, 9–11 V–A distance, 9–17 V – anus distance, 17–11 anus – A distance, 18–19 body height, 1–14 predorsal distance, 1–9 preventral distance, 1–11 preanal distance, 1–20 preorbital distance, 21–4 postorbital distance, 20–21 diameter of eye, 22–23 length of barbels, 12–3 length of caudal peduncle, 24–25 the shortest body height, 26–27 height of caudal peduncle.

Our authors pursuing the taxonomical problems of gudgeons are: Mahen (1931), Albertová, Suchomelová (1953), Oliva (1959, 1962), Lohnický (1961) and Krupka (1969).

MATERIAL AND METHODS

All measured specimens come from the collections of the Faculty of Natural Sciences of Charles University. The fishes were fixed in cca 4% formaldehyde solution. In general, I have measured 258 specimens taken from 5 bodies of water: from the river Orava – at the river mouth near Kralovany town – 25 specimens (leg. Balon and coll.); from the creek Výrovka – Zvěřinek near Nymburk town – 78 specimens (leg. Skořepa); from the river Bečva – near Kamenec village – 78 specimens (leg. Balon and coll.); from the river Dyje – 10 km south of Znojmo town – 55 specimens (leg. Brychta); and from the river Morava – channel in the Šur reservation – 22 spec. (leg. Holčík).

The measurements have been made in accordance with the definitions of Holčík, Hensel (1971). In general, I have measured 31 morphologic features; out of these 3 meristic and 28 plastic features. (Measured features are shown in Fig. 1).

The measurements stated in percentage of the body length (in % longitudinis corporis), in percentage of the head length (in % longitudinis capitis), in percentage of the interorbital length (in % longitudinis interorbitalis), the shortest body height is stated in percentage of the body height (in % altitudinis corporis) and in percentage of the length of caudal peduncle (Table 8).

All measurements have been taken by a pointed sliding gauge. In biometric evalution, there were following basic statistics applied: Arithmetic mean ($\bar{x}$), standard deviation (s), error of the mean ($s_{\bar{x}}$), coefficient of variation (V), difference of mean values (M diff) and CD coeff (Holčík, Skořepa, 1971).

Tab. 1. Mean values of plastic features in various classes of length (regardless to the localities)

long. corp. (mm)	41–50	51–60	61–70	71–80	81–90	91–100	101–110	111–120	121–130	131–140	differ in % min value
in % longitudinis corporis											
long. cap.	23.5	23.1	24.1	24.7	24.8	24.7	24.8	24.4	25.0	26.1	12.8
alt. capit.	14.4	14.3	14.7	15.7	15.3	15.1	14.7	15.2	15.3	15.7	9.0
dist. praeorbit.	9.5	9.1	9.9	10.2	10.4	10.4	10.5	10.1	11.0	11.2	23.1
diameter oculi	6.2	5.7	5.2	5.5	5.2	5.1	4.9	4.7	4.7	4.4	40.9
long. cirri	4.1	4.5	5.8	6.1	6.0	5.8	5.7	5.8	6.6	7.5	82.9
dist. interorbit.	7.8	7.1	7.9	7.4	7.4	7.5	7.9	7.3	7.8	7.5	11.3
long. D	11.9	11.7	11.7	12.3	12.3	12.4	13.0	12.2	12.1	12.7	11.1
alt. D	21.8	21.9	21.7	22.2	21.9	21.4	20.9	20.9	19.7	20.9	12.6
long ped. caudae	22.1	21.9	21.1	21.5	21.0	20.6	21.0	20.7	19.9	20.2	11.1
alt. corp.	16.1	17.8	19.3	19.7	19.4	19.7	21.2	20.4	20.7	18.7	31.7
dist. praedors.	45.1	44.3	46.6	46.9	46.8	46.6	46.7	45.1	46.3	47.0	6.1

RESULTS

1. Growth variability of plastic features (relative growth)

Before proceeding to a statistic evaluation of the morphologic features of various populations of gudgeon, *Gobio gobio*, the growth variability had been observed and thus: in all 5 bodies of water and in 11 plastic features. (All proportions are in % of the body length) — Table 1.

The purpose was the elimination of those features in which there might be found greater differences in proportions of various size groups than between the populations belonging to various subspecies. These features would be eliminated in the morphologic comparison of the populations of *Gobio gobio*. Mean values of plastic features in % of the body length are given in Table 1, regardless to the localities.

From the total evaluation of plastic features dependent on the enlarging body length, it is to be seen that the observed features may be divided into 3 groups:

a) Features relatively diminishing during the growth (diameter of eye, height of dorsal fin, length of caudal peduncle).

Tab. 2. Statistic values of meristic features

local.	number of scales			rays D			rays A		
	$\bar{x} \pm s_{\bar{x}}$	s	V	$\bar{x} \pm s_{\bar{x}}$	s	V	$\bar{x} \pm s_{\bar{x}}$	s	V
Orava	40.32±0.24	1.18	2.93	7.22±0.10	0.42	6.54	6.20±0.10	0.76	12.13
Výrovka	37.54±0.25	2.21	5.88	7.02±0.07	0.65	8.94	5.78±0.08	0.75	12.97
Bečva	39.65±0.15	1.34	3.37	7.03±0.08	0.66	8.69	6.14±0.08	0.68	11.05
Dyje	40.05±0.20	1.51	3.77	7.01±0.06	0.43	5.34	6.29±0.08	0.63	9.99
Morava	39.45±0.23	1.06	2.68	7.09±0.06	0.29	3.72	5.86±0.15	0.71	12.11

Tab. 3. Values of M diff (belowleft) and CD (upper right) coeff. for number of lateral line scales

local.	Orava	Výrovka	Bečva	Dyje	Morava
Orava	—	0.82	0.26	0.10	0.38
Výrovka	7.94	—	0.59	0.67	0.58
Bečva	2.38	7.24	—	0.14	0.08
Dyje	0.89	7.84	1.60	—	0.23
Morava	2.71	5.61	0.74	2.00	—

b) Features relatively enlarging during the growth (head length, head height, preorbital length, length of dorsal fin).

c) Features not varying or fluctuating during the growth (length of barbels, interorbital length, body height, predorsal length).

In some cases the plasticity of the features observed are relatively high (see Table 1); nevertheless. it is impossible to eliminate the features which are widespread in literature (p. e. diameter oculi in $^0/_0$ longitudinis corporis).

2. Statistic values of morphometric features

2.1. Meristic features

The values of meristic features are given in Table 2. The table clearly shows that the gudgeons from the river Orava attain the highest mean

Tab. 4. Values of M diff and CD coeff. for number of branched rays in dorsal fin

local.	Orava	Výrovka	Bečva	Dyje	Morava
Orava	—	0.18	0.17	0.24	0.18
Výrovka	1.66	—	0.007	0.009	0.07
Bečva	1.46	0.09	—	0.02	0.06
Dyje	1.75	0.11	0.20	—	0.11
Morava	1.08	0.77	0.60	1.00	—

values as to the number of scales in the lateral line, and the gudgeons from the Výrovka Cr., attain the lowest values, whereby the values of M diff and CD coeff (Table 3, 4, 5) do not show significant values. The

Tab. 5. Values of M diff and CD coeff. for number of branched rays in anal fin

local.	Orava	Výrovka	Bečva	Dyje	Morava
Orava	—	0.27	0.04	0.06	0.23
Výrovka	3.23	—	0.25	0.36	0.05
Bečva	0.46	2.27	—	0.11	0.20
Dyje	0.69	2.63	1.36	—	0.32
Morava	1.88	0.47	1.64	2.86	—

Tab. 6. M diff and CD coeff. — Summary

local.	Orava	Výrovka	Bečva	Dyje	Morava
Orava	—	2	0	0	0
Výrovka	15	—	0	0	2
Bečva	8	16	—	0	0
Dyje	5	15	4	—	0
Morava	8	16	5	5	—

number of branched rays of the dorsal and anal fin does not therefore exhibit any difference after the comparison of various populations.

2.2. Plastic features

All localities studied were compared by means of M diff and CD coeff. The numbers in Table 6 show how many times the previously chosen limits of M diff and CD coeff. vere overpassed (M diff > 3, CD coeff > 1,28).

As regards the features studied it is possible to conclude (basing on CD coeff.) that almost in no case do the features exhibit chosen limits. The only exceptions are the CD coeff. of the Výrovka creek and the Orava river in the case of one feature (length of barbels in percentage of the body length and in % of the head length) and between the Výrovka creek and the Morava river the above mentioned coefficient in two cases is higher (length of barbels and body height in % of the body length). That means that the observed populations cannot be morphologically differentiated. It is not out of question that in applying other body measurements certain differentiations could be observed; however, proportions commonly used by all quoted authors do not indicate it.

Statistic data of our 5 localities studies are in Table 8.

DISCUSSION OF RESULTS

1. Comparison of morphologic features of European gudgeons

1.1. Meristic features

Table 7 shows mean values, and ranges of meristic features — according to European authors.

In the frame of the ČSSR. the least number of scales in the lateral line is in the gudgeons from the Výrovka Cr. — 37.54 — (experienced results), the highest number is in gudgeons from the Blatná Cr. — 42.38 (Albertová, Suchomelová, 1953). Mean values vary from 39.45 to 41.92 at other localities. The gudgeons from the river Morava exhibit mean values 39.45 (exp. results) and the gudgeons from the Mšec lake (Albertová, Suchomelová, 1953) attain the values 41.92. The most common number of scales is 38—42. From our populations the population from the River Dyje exhibits the great variability of this feature (37—43), mean values are 40.05.

In the frame of Eurasia, the gudgeons from Albania attain the lowest mean values 36.33 (Oliva, 1959). The gudgeons from the rivers Thames

Tab. 7. Survey of meristic features of European gudgeons

author and locality	n	number of scales	$\bar{x}$	number of branched rays	
		min—max	$\bar{x}$	dorsal fin	anal fin
Berg (1949), USSR	—	40—45	—	7	6
Mahen (1931), ČSSR					
Svratka, Dyje	72	40—45	—	—	—
Vladykov (1931) Tisa, USSR	33	39—42	40.48	7	(5) 6
Albertová, Suchomelová (1951), ČSSR					
Blatná	180	41—43	42.38	—	—
Mšec	95	41—43	41.92	—	—
Ohře	117	40—44	41.76	—	—
Vltava	304	38—44	40.83	—	—
Oliva (1959), Albania	3	35—37	36.33	7	5
Banarescu (1954), Romania	—	39—44	—	7	6
Banarescu (1962)					
Thames, England	18	41—44	42.50	—	—
ČU, USSR	10	37—41	39.40	—	—
Talass, USSR	10	39—42	40.45	—	—
Lohniský (1961) ČSSR					
Blatná	119	38—41	39.88	—	—
Bříve, Šeberák	12	39—41	40.08	—	—
Lhoták	33	39—43	41.45	—	—
Mšec, Bašta	16	39—42	40.31	—	—
Vykán	38	39—43	40.50	—	—
Malá Arazimova	107	39—42	40.52	—	—
Bezednice, Poltruba	65	39—42	40.60	—	—
Kačák, Kocába	26	39—41	39.92	—	—
Červený, Krčelovský	89	39—41	39.69	—	—
Výmola	51	39—42	41.13	—	—
Labe	17	39—41	40.17	—	—
Teplá	26	39—41	39.80	—	—
Moravice, Odra	91	39—42	40.18	—	—
Oliva (1962)					
Prut, Poland	—	39—42	41.40	7 (8)	6 (7)
Žukov (1965), USSR					
Upper Dněpr	82	—	41.61	7	6
Dorko (1966)					
Ondava, ČSSR	—	—	41.00	—	—
Michailova (1966)					
Bulgaria	366	36—42	—	7	6
Rolik (1967)					
Poland	86	39—43	—	(6) 7	(5) 6 (7)
Alexandrova, Smirnov (1969), USSR	82	38—43	40.60	7—9	6—8
Krupka (1969)					
Turiec, ČSSR	227	39—43	40.72	—	—
Orava	25	38—42	40.32	7	6
Výrovka	78	37—42	37.54	7	6
Bečva	78	38—42	39.65	7	6
Dyje	55	37—43	40.05	7	6
Morava	22	37—41	39.45	7	6

and Blatná attain the highest mean values 42.5 and 38–42 respectively. Berg (1949) states 40 to 45 scales in the lateral line. Mahen (1931) records the same number.

The mean number of branched rays of the dorsal fin is seven, according to all authors. Alexandrova, Smirnov (1969) state a range from 6 to 8 with a mean value of 7.16 for the Middle Dněpr River. This feature show practically no variability.

The number of rays of the anal fin is again in accordance with those of all authors. The most common number of branched rays is 6.

1.2. Plastic features

Table 8 show a survey of plastic features of *Gobio gobio*. The gudgeons from our bodies of water attain the largest size of the body length (52–152 mm) – (longitudo corporis) – and such is the case in the gudgeons from the river Thames (120–138 mm) – Banarescu (1962). The gudgeons from Kazachstan attain the smallest size in this feature (50–68.5 mm) – Banarescu (1962).

Head length in % of the body length – Vladykov (1931) states a range from 25.64 to 30.30 for the gudgeons from the river Tisa. The values for the gudgeons from Albania (Oliva, 1959). from the river Thames and from Kazachstan (Banarescu, 1962) are also within this range. The gudgeons taken from our localities exhibit lower values in this feature (20.3–28.0). The gudgeons from Rumania (Banarescu, 1954) attain lower values as well (23.8–28.4). The gudgeons from the river Prut – Poland (Oliva, 1962) and those from the Dněpr River (Žukov, 1965; Alexandrova, Smirnov, 1969) also exhibit lower values, contrary to the description of Vladykov (1931).

Head height in % of the body length – Rolik (1967) was the only one who has described this feature. and that in the gudgeons from Poland. Stated values are lower (15.6–18.2) than those recorded in gudgeons taken from our waters.

Preorbital and postorbital length in % of the body length – the gudgeons recorded from our localities exhibit lower values than those from other European localities – as in the preceding case. Interorbital length in % of the body length – this feature was again described only by Rolik (1967) in the gudgeons from Poland. The values of the gudgeons taken from our waters are lower again.

Lenght and height of anal fin and lenght and height of dorsal fin in% of the body length – Vladykov (1931) described these features in the gudgeons taken from the river Tisa. Further authors recording these features in the gudgeons from the Dněpr River are: Žukov (1965) and Alexandrova, Smirnov (1963). The values stated by the above mentioned authors conform with these features. The gudgeons taken from the observed localities exhibit similar values in length of the anal fin – the values are lower in other features.

Length of caudal peduncle in % of the body length – Vladykov (1931) states a range of (19.60) 20.83–25.0 (26.31) for the gudgeons from the river Tisa. The values for the gudgeons from the river Thames, from Kazachstan (Banarescu, 1954). from Poland (Rolik, 1967) and from the Dněpr River (Žukov, 1965; Alexandrova, Smirnov, 1969) are within this range. Our gudgeons exhibit slightly lower values.

Tab. 8. Plastic characters of gudgeon *(Gobio gobio)*

locality	Orava			Výrovka		
n	25			78		
	min–max	$\bar{x} \pm s_x$	V	min–max	$\bar{x} \pm s_x$	V
long. corp.	86–152	11.16		52–116	76.49	
in % longitudinis corporis						
long. cap.	22.5–26.1	24.68±0.19	3.88	20.3–26.2	23.20±0.17	6.54
alt. cap.	14.1–15.7	14.85±0.18	5.99	13.7–15.3	14.70±0.12	7.42
dist. praeorb.	8.6–11.5	10.27±0.14	6.78	7.8–10.2	9.68±0.13	11.65
dist. postorb.	9.4–11.5	10.56±0.09	4.44	9.8–11.1	10.13±0.10	8.37
diameter oculi	4.2– 5.9	4.80±0.09	8.90	3.8– 7.1	5.52±0.07	11.18
long. cirri	6.1– 7.8	6.85±0.10	7.30	3.3– 5.6	4.55±0.08	15.79
dist. interorb.	7.0– 7.5	7.32±0.10	6.43	5.4– 8.1	7.25±0.10	12.34
alt. A	5.9– 8.6	7.45±0.14	6.34	4.2–10.3	7.21±0.13	6.52
long. A	16.0–19.1	17.54±0.22	9.57	12.7–17.8	15.45±0.11	16.12
long. D	19.1–25.4	22.20±0.29	10.02	17.6–25.0	21.41±0.19	9.38
alt. D	9.4–14.1	12.46±0.25	6.63	9.1–15.0	12.02±0.13	7.78
long. ped. caudae	18.4–25.4	21.28±0.33	7.70	18.0–26.8	21.81±0.20	8.26
altitudo corporis	16.5–21.7	19.57±0.29	7.48	13.1–21.1	16.89±0.20	10.24
min. alt. corporis	5.1–10.6	8.89±0.15	8.48	6.3– 9.0	7.63±0.10	11.24
dist. praedors.	44.4–50.0	46.80±0.31	3.34	43.2–46.7	44.89±0.23	4.44
in % longitudinis capitis						
diameter oculi	16.3–23.3	19.48±0.38	9.66	16.0–32.0	23.88±0.33	12.33
long. cirri	24.6–33.2	27.78±0.42	7.64	12.3–30.0	19.71±0.37	16.69
in % altitudinis corporis						
min. alt. corporis	36.8–60.0	45.69±1.12	12.23	36.8–60.0	45.69±1.12	12.23
in % distantionis interorbitalis						
diameter oculi	54.3–84.0	64.14±1.45	11.28	55.0–127	77.25±1.53	17.43
long. cirri	75.7–105	91.51±1.72	9.41	42.5–118	63.79±1.53	21.13
in % longitudinis pedunculi caudae						
min. alt. corporis	35.0–50.0	41.94±0.87	10.34	25.0–44.4	35.26±0.58	14.44
alt. ped. caudae	43.7–62.5	51.52±0.93	9.02	33.3–57.1	45.84±0.59	11.32

Body height in % of the body length – Berg (1945) states a range from 18.18 to 22.22; Mahen (1931) records 21.73–23.80 for the gudgeons from the ČSSR (so called "high form"); Vladykov (1931) states 20.0–21.27 (22.22). Mean values for the gudgeons from Albania (Oliva, 1959) are high, x = 24.33. Mean values for the gudgeons from Kazachstan are lower in this character (21.40). Mean values for the gudgeons from Rumania conform with those recorded by Berg (1945). Mean values for the gudgeons from the river Thames are 22.33 (Banarescu, 1962). The gudgeons from the Dněpr R. (Žukov, 1965; Alexandrova, Smir-

from Czechoslovakia (author's results)

Bečva			Dyje			Morava		
78			55			22		
min–max	$\bar{x} \pm s_x$	V	min–max	$\bar{x} \pm s_x$	V	min–max	$\bar{x} \pm s_x$	V
88–135	105.35		82–143	109.13		74–128	98.45	
22.3–26.7	24.91±0.11	3.75	22.6–28.0	24.95±0.15	4.36	22.7–27.1	25.56±0.19	3.48
14.9–17.0	15.66±0.11	6.15	14.7–15.1	14.76±0.11	5.44	13.4–16.8	15.00±0.20	6.13
9.5–11.3	10.40±0.09	7.30	9.5–11.1	10.32±0.10	7.21	9.2–10.9	10.38±0.13	5.72
10.4–11.3	10.77±0.07	5.62	9.6–11.6	10.51±0.09	6.11	10.4–11.8	11.03±0.11	4.74
4.3– 6.5	5.30±0.05	7.47	4.3– 6.2	5.10±0.05	7.91	4.7– 6.0	5.23±0.06	5.80
4.7– 7.4	6.25±0.09	12.01	5.1– 6.5	5.90±0.10	12.91	5.7– 7.1	6.32±0.12	9.02
6.8– 8.3	7.50±0.06	7.62	6.8– 7.7	7.41±0.07	6.73	7.9– 8.2	7.98±0.11	6.71
3.7– 8.8	6.93±0.10	6.82	5.3– 8.6	7.25±0.11	7.36	5.9– 8.0	7.06±0.13	8.48
14.8–19.1	17.25±0.11	13.03	13.9–19.1	16.35±0.16	10.88	12.5–19.0	16.59±0.30	8.91
19.6–25.0	22.01±0.13	7.49	17.4–24.7	21.27±0.19	8.91	18.6–23.5	21.69±0.29	8.31
9.8–14.4	12.03±0.10	5.03	10.3–16.5	12.58±0.15	6.66	10.4–14.1	12.47±0.22	6.30
17.0–25.6	20.74±0.18	7.80	17.4–24.8	20.45±0.16	5.91	18.5–23.3	20.88±0.25	5.51
16.2–21.8	19.60±0.13	6.07	16.8–22.7	19.01±0.18	6.84	19.4–23.7	21.40±0.22	4.75
8.0– 8.7	8.60±0.07	7.31	7.4– 9.4	8.63±0.09	7.50	8.9– 9.1	8.96±0.09	4.79
44.6–50.0	46.87±0.16	3.00	45.2–46.8	46.33±0.21	3.40	45.5–49.5	48.00±0.29	2.85
16.4–27.1	21.30±0.20	8.25	17.5–23.7	20.46±0.21	7.58	18.3–23.6	20.49±0.29	6.63
17.9–32.2	25.10±0.34	11.99	16.9–30.9	23.66±0.40	12.50	20.7–27.9	24.73±0.48	9.18
36.8–53.3	45.02±0.41	7.95	38.5–56.3	45.30±0.45	7.32	36.4–47.4	41.95±0.60	6.65
55.6–100	71.05±0.88	10.92	58.8–90.0	69.18±1.01	10.81	55.0–75.0	65.80±1.08	7.69
60.0–108	83.60±1.23	12.95	54.4–113	79.91±1.51	14.05	63.3–95.7	79.44±1.76	10.37
33.3–60.0	42.76±0.59	12.10	35.7–52.9	42.33±0.51	8.94	35.0–50.0	43.07±0.77	8.38
40.0–73.2	52.46±0.68	11.47	42.9–62.0	52.86±0.65	9.05	42.9–59.1	50.95±0.94	8.61

nov. 1969) and from Poland (Rolik, 1967) exhibit the same range as recorded by Berg (1945). Mean values for our gudgeons (except to those from the Výrovka Cr. $\bar{x} = 16.89$) are in accord with Berg in this feature.

The shortest body height in % of the body length – the lowest mean values are in the gudgeons from the Upper Dněpr R. $\bar{x} = 7.75$ (Žukov, 1965) and from the Výrovka Cr. $\bar{x} = 7.63$. The gudgeons from Kazachstan attain the highest mean values $\bar{x} = 10.45$ (Banarescu, 1962).

Predorsal length in % of the body length – the lowest values are to be

found in the gudgeons from the Výrovka Cr. $\bar{x} = 48.50$ (Banarescu, 1962).

Diameter of eye in % of the head length — Mahen (1931) states a range from 17.54 to 21.27; Vladykov (1931) records 17.85—23.80; Oliva (1959) 19—20. Banarescu (1954) records lower values for the gudgeons from Rumania (15.6—22.2). The gudgeons taken from our waters also exhibit lower values in this feature. Higher values are recorded by Žukov (1965) and Alexandrova, Smirnov (1969) in the gudgeons taken from the Dněpr River.

Length of barbels in % of the head length — Vladykov (1931) records high values 28.57—38.46; Banarescu (1954) records 20.0—35.4 in the gudgeons from Rumania. The range in our gudgeons, except in those from the Výrovka Cr., is from 16.9 to 27.9 in this feature.

The shortest body height in % of the body height — Mahen (1931) records values (21.73) 45.45—47.61 for the ČSSR. Vladykov (1931) records 43.47—52.63 in the gudgeons from the river Tisa. Other authors do not state values in this feature. In our gudgeons the mean values are lower, but the total range is higher (36.8—60.0).

Diameter of eye in % of the interorbital length — Berg (1945) records rather high values 66.66—90.9; Vladykov (1931) states 62.50—82.4. The gudgeons from Poland exhibit lower values (Rolik, 1967) — 50.6—82.4. Our gudgeons exhibit considerable variability (54.29—126.7).

Length of barbels in % of the interorbital length — none of the above mentioned authors refers to this feature. The range of this feature is large (42.5—117.5) in fishes from our waters.

The shortest body height in % of the length of caudal peduncle — in this feature, the values are recorded nearly by all above mantioned authors, except by Žukov and Alexandrova, Smirnov. Berg (1945) states a range from 34.48 to 43.47 (50.0); Mahen (1931) 38.46—47.61; Vladykov (1931) 35.71—47.61. Oliva (1959) records mean values 47.3 with a range from 45 to 50 in 3 specimens from Albania. The gudgeons from the river Thames, $\bar{x} = 41.96$ (Banarescu, 1962) and from Poland, $x = 40.30$ (Rolik, 1967) attain lower means values. Our gudgeons possess avarage values, except those from the Výrovka Cr. 42—43.

Height of caudal peduncle in % of the length of caudal peduncle — this feature was described only by Oliva (1962), and thus in the fishes from the river Prut — Poland. The recorded values are higher than those in our gudgeons.

1.3. Statistical differences among plastic features our and other Euroasian localities

Comparing our gudgeons with those from Rumania (Somesul Mic, Banarescu, 1954) CD coeffs. attain higher values than 1.28 in 3 cases. Higher values are found in the gudgeons from the Výrovka Cr. in all cases (length of barbels and body height in % of the body length, length of barbels in % of the head length). Gudgeons from Rumanian river Aries differ from those from our water bodies in the following features: head length, postorbital length, diameter of eye, length of barbels and the shortest body height in % of the body length; length of barbels in % of

the head length. The significant differences between our and Rumanian gudgeons from Lower Timis were observed in the following features: head length, postorbital length, diameter of eye, length of barbels and the shortest body height in % of the body length.

At the following 3 Rumanian localities, there is a striking difference in comparing our gudgeons with those from the rivers Lower Timis and Aries (13 features). CD coeffs are only in 3 cases higher than 1.28 between our localities and at the river Somesul Mic. At the river Aries, they are 20 times and in the gudgeons from the river Lower Timis, 11 times. Out of this, the values are conformable between the rivers Lower Timis and Aries in 11 cases, between the rivers Somesul Mic and Lower Timis only 1 case, and between the rivers Somesul Mic and Aries in 2 cases.

In comparing our gudgeons with those taken from the river Thames (Banarescu, 1962), CD coeffs exceed the value 1.28 8 times in general (11 features).

Body height in % of the body length — there are striking differences between the gudgeons from the river Thames and those of ČSSR as to this feature. Banarescu (1962) records a difference between the gudgeons from the river Thames (which he considers the limnophilic form) and those taken from the river Roading in Essex (the reophilic form). The mean values of the body height in % of the body length are lower in our gudgeons than in those taken from the river Thames: that is why our gudgeons cannot be ranged with the limnophilic form. I could not compare the gudgeons from the river Roading with my specimens as Banarescu does not state necessary values for these calculations. Only the data of mean values necessitate the fact that the body height in % of the body length attains similar values as are those in our gudgeons. The values of the length of the caudal peduncle do not confirm expressively the reophilic form in our case. Our gudgeons and those from Kazachstan (River Ču) show significant differences in the following features: body height, the shortest body height, head length, diameter of eye and length of barbels in % of the body length.

Comparing our gudgeons with those from Kazachstan (River Tallas) the significant differences are in the following features: body height, the shortest body height, head length and postorbital length in % of the body length.

In general, CD coeffs attain higher values than 1.28 (10 features) — 15 times in comparing the gudgeons from the river Ču with those from our localities, and 24 times in comparing the gudgeons from the river Talass with those taken from our localities. Out of this, they accordingly differentiate 14 times.

Žukov (1965) studied the gudgeons from the Upper Dněpr River. Comparing the gudgeons from the Upper Dněpr R. with those of our localities, CD coeffs attain higher values than 1.28 in only one case. The gudgeons from the Upper Dněpr River are morphologically identical with those taken from our localities.

Rolik (1967) has described gudgeon *Gobio gobio sarmaticus* from Poland. As to the CD coeffs., there are considerable differences in comparing our gudgeons with those of Poland.

Head length in % of the body length — CD coeffs are high, they exhibit

values 1.44 in the gudgeons from the Výrovka Cr. As to this feature, the mean values is higher (26.50) in the gudgeons of Poland, than in ours (23.20).

Head height in % of the body length – mean values are lower in our gudgeons. CD coeffs., except to the river Bečva, attain higher values than 1.28.

Preorbital length in % of the body length – CD coeffs attain higher values than 1.28 in all cases.

Postorbital length in % of the body length – in contrast to the preceding feature, CD coeffs attain lower values. There are not marked differences between the gudgeons from Poland and ours.

Diameter of eye in % of the body length – there are not evident differences there.

Length of barbels in % of the body length – CD coeffs attain higher values than 1.28 only in the gudgeons from the Výrovka Cr. As to this feature, only the gudgeons from the Výrovka Cr. differ from those of Poland, and thus very outstandingly.

Height of anal fin and height of dorsal fin in % of the body length CD coeffs are higher only at the rivers Orava and Bečva.

In the following 4 features (length of caudal peduncle, body height, the shortest body height, predorsal length – in % of the body length) the values of CD coeffs are low. The gudgeons from Poland and from the ČSSR do not evidently differentiate in this feature. The same concerns the diameter of eye in % of the interorbital length and the shortest body height in % of the length of caudal peduncle. CD coeffs attain higher values than 1.28 – 14 times in general. Such is the case in these features: head length (the Výrovka Cr.), head height (the Výrovka Cr., the rivers Orava, Dyje, Morava), preorbital length (at all localities), length of barbels (the Výrovka Cr.), height of the anal fin (the river Bečva). All above mentioned feature are stated in % of the body length.

Alexandrova, Smirnov (1969) have divided the gudgeons taken from the Middle Dněpr R. into 2 groups. In the first group, CD coeffs attain higher values than 1.28 in the following feature: height of the anal fin in % of the body length in the gudgeons from the rivers Orava, Bečva, Dyje, Morava and Middle Dněpr. In the other group CD coeffs attain higher values than 1.28 only in the gudgeons from the rivers Orava and Bečva in this feature. The gudgeons from the Middle Dněpr R. substantially differ from those of the ČSSR with an exception to the Výrovka Cr.

In the height of the dorsal fin in % of the body length, CD coeffs attain higher values than 1.28 in the gudgeons from the rivers Bečva, and Middle Dněpr, and that in either groups. In other observed features CD coeffs do not attain higher values than 1.28 – consequently, there are no evident differences between the gudgeons from the Middle Dněpr R. and those of the ČSSR as regards these features.

CONCLUSION

In general, I have measured 258 specimens of the gudgeon – *Gobio gobio* (L.) taken from 5 bodies of water. The measurements of the various morphological features have been made in accordance with the definitions of Holčík, Hensel (1972). In evaluation, the statistics method has

been applied — Reisenauer (1965), Holčík, Skořepa (1971). In the frame of Eurasia, the results have been compared with the elaborations of the following authors: Berg (1956), Mahen (1931), Vladykov (1931), Albertová, Suchomelová (1953), Oliva (1959, 1962), Banarescu (1954, 1961, 1962), Lohniský (1961), Žukov (1965), Dorko (1966), Michailova (1966), Rolik (1967), Alexandrova, Smirnov (1969) and Krupka (1969). I have come to the following conclusion:

1. The relative growth variability of the selected plastic features can be divided into 3 groups:

a) Features relatively diminishing during the growth (diameter of eye, height of dorsal fin, length of caudal peduncle — in % of the body length).

b) Features relatively enlarging during the growth (head length, head height, preorbital length, length of dorsal fin — in % of the body length).

c) Features not varying or fluctuating during the growth (length of barbels, interorbital length, body height, predorsal length — in % of the body length).

2. The measured gudgeons from various bodies of water in Czechoslovakia evidently differentiate only in 3 cases (CD coeffs) the gudgeons from the river Orava and from the Výrovka Cr. differentiate in the length of barbels in % of the head length and body length; the gudgeons from the Výrovka Cr. and from the river Morava differentiate in the length of barbels and in the body height in % of the body length). Therefore, they cannot be systematically separated, they are subspecifically identical and represent typical *Gobio gobio gobio*.

3. Differences between our and Eurasian gudgeons (CD coeffs):

a) Our gudgeons and those from Kazachstan *(Gobio gobio lepidolaemus)* evidently differentiate in 25 cases (out of 10 observed features). They show subspecific differentiations.

b) The gudgeons from our bodies of water and the described subspecies *Gobio gobio sarmaticus* from Poland evidently differentiate in 14 cases (out of 15 observed features). They show subspecific differentiations.

c) The gudgeons from our bodies of water and from Rumanian localities evidently differentiate in 21 cases (out of 13 observed features). They show obvious subspecific differentiations.

d) The gudgeons from our bodies of water and from the river Thames evidently differentiate only in 8 cases (out of 13 observed features). They cannot be differentiated subspecifically.

e) The gudgeons from our localities and from the Middle and Upper Dněpr Rivers do not evidently differentiate, they are subspecifically identical — *Gobio gobio gobio*.

LITERATURE

Albertová O. — Suchomelová K., 1953: K ekologické variabilitě hrouzka (Gobio gobio [LINNAEUS] 1758). *Věst. Čs. spol. zool.*, 17(1): 1—7.

Alexandrova A. J. — Smirnov A. J., 1969: Peskar Gobio gobio (Linné) Srednego Dnepra. *Vop. icht.*, 9, 5(58): 941—944.

Banarescu P., 1954: Biometrische und systematische Studien an Gobio gobio aus Rumänien. *Věst. Čs. spol. zool.*, 18 (1): 6—40.

Banarescu P., 1961: Weitere systematische Studien über die Gattung Gobio (Pisces, Cyprinidae), insbesondere im Donaubecken. *Věst. Čs. spol. zool.*, 25(4): 318–346.
Banarescu P., 1962: Phylletische Beziehungen der Arten und Artbildung bei der Gattung Gobio (Pisces, Cyprinidae) *Věst. Čs. spol. zool.*, 26(1): 38–64.
Berg L. C., 1923: Ryby presnych vod Rossii, 2. vyd.: 202–206, Moskva.
Dorko J., 1966: Morfologicko systematická charakteristika hrúza obyčajného (Gobio gobio L.) z Ondavy a jej pritokov. *Sb. biol. a geol. věd Ped. fak.*, 2: 137–147
Holčík J., Skořepa V., 1971: Revision of the roach, Rutilus rutilus (Linnaeus, 1758) with regard. Ti its subspecies. *Annot. zool. et bot.*, 64: 1–60, Bratislava.
Holčík J., Hensel K., 1972: Ichtyologická príručka. Malá kniž. ryb., Bratislava
Hrabě S., Oliva O., Opatrný E., 1973: Klíč našich ryb, obojživelníků a plazů SPN Praha.
Krupka J., 1969: To the contribution of the variability of meristic features and ecology of some species of Cyprinoid fish in the River Turiec. *Práce lab. ryb*, 1969 (2): 121–158.
Lohniský K., 1961: Ökologische Variabilität des Gründlings (Gobio gobio [Linnaeus], 1758) in böhmischen Gewässern. *Věst. Čs. spol. zool.*, 26 (2): 160–173.
Mahen J., 1931: Příspěvek k systematice ryb kaprovitých I. a II. *Sb. klubu přírodověd.*, 14: 9–11, Brno.
Michailova L., 1966: Beitrag zu der systematischen Lage der Art Gobio gobio L in Bulgarien. *Fragmenta Balcanica*, 6 (2): 17–30.
Oliva O., 1959: Bemerkungen über einige Fischarten aus Albanien. *Věst Čs. spol. zool.*, 25 (1): 39–54.
Oliva O., 1962: Kilka slow o kielbiu Prutu. *Przeglad zoologiczny*, 6 (1): 51–53.
Rolik H., 1967: Materialy do ichtiofauny Strwiaza (doplyw Dniestru) ze szczególnym uwzglednieniem Gobio gobio (L.) i Cobitis (Sobanejewia) aurata (Fil.). *Fragm. faun.*, 14 (5): 133–151, Varšava.
Reisenauer R., 1965: Metody matematické statistiky. Polytechn. knižnice, Praha
Vladykov V., 1931: Poissons de la Russie Sous-Carpathique (Tschécoslovaquie). *Mém. Soc. zool. France*, 29 (4): 217–374.

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MORPHOLOGY OF CYSTICERCOID OF THE CESTODE RODENTOTAENIA CRASSISCOLEX

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Abstract: The cysticercoid of *R. crassiscolex* (Linstow, 1890) is located in a capsule consisting of muscle and connective tissue and formed from the organism of the snail. The space between the capsule and the cyst is filled with a dense liquid with numerous granules and connective tissue fibres. The cyst contains the scolex and neck of the cestode which develop to adult stage after excystation in the definitive host. The outer part of the cyst tegument contains fine circular and longitudinal connective tissue fibres and the outer part of the tegument of scolex and proximal part of neck contain microtriches. The inner part of tegument of cyst, neck and scolex is filled with an amorphous substance. The subtegument of cyst, neck and scolex has an identical structure. The outer part is formed from circular and longitudinal muscle and connective tissue fibres, the inner part consists of pyriform and bladder-like cells. These cells are surrouded by fine muscle and connective tissue fibres running from the outer part of subtegument. The structure of parenchyma of neck and scolex is the same as in adult cestodes

Cysticercoids of the cestode *R. crassiscolex*, the adult stages of which are parasitic in Soricidae, have been described only on the basis of whole mounts from various species of terrestrial snails in the papers by Kisielewska (1958), Prokopič and Žďárská (1958), Rawson and Rigby (1960), Kisielewska and Prokopič (1963), Prokopič et al. (1970) and Jourdan (1972).

The morphology and structure of *R. crassiscolex* cysticercoid studied on section material stained with histological methods is described for the first time in the present paper. Histochemical studies of the cysticercoid will be the subject of our next paper.

MATERIAL AND METHODS

Cysticercoid of *R. crassiscolex* were obtained from the snails, *Deroceras agreste* (Müller, 1774) and *Semilimax semilimax* (Férrusac, 1802). They were located under the epithelium of respiratory and body cavity, in hepatopancreas and in kidney. These tissues, together with the cysticercoids, were fixed in Baker's neutral formaldehyde (Pearse, 1960)

The morphology and structure of the cysticercoid was studied on a series of 6 μm thick paraffin sections stained with Mayer's, Bohmer's or Weigert's haematoxylin-eosin, Mallory's phosphowolfram haematoxylin, van Gieson's method, trichrome after Masson and Goldner, Gomori's method and PAS method for the detection of reticular fibres and method for the detection of calcium after Kossa.

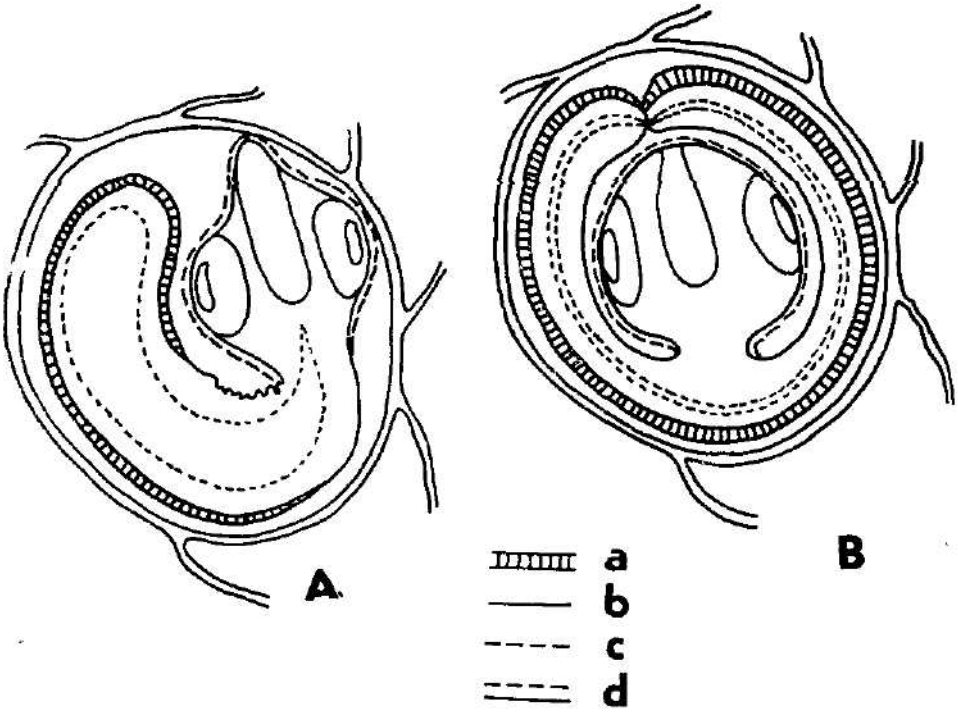

Fig. 1. Invagination of scolex and neck into cyst cavity. A — morphologically fully differentiated larva before invagination, B — invaginated larva, cysticercoid; a — outer margin of cyst, b — outer margin of neck, c — inner margin of cyst and neck, d — outer margin of scolex.

RESULTS

The larval stage of *R. crassiscolex* is a cysticercoid without tail (Fig. 1), consisting of a cyst with neck and scolex inside. The space between the capsule and cyst is filled with a dense fluid. The capsules observed were both solitary and clustered, but in no case two capsules were touching by their walls, they were always separated by at least 1 μ thick layer of host tissue.

Capsule (Fig. 2; Plate I, Fig. 2). The capsule is a spherical to oval sac consisting of muscle and connective tissue fibres and measuring 320–400 $\times$ 290–382 μm. Inside the capsule is the cyst and the space between the capsule and cyst is filled with a dense fluid containing muscle and connective tissue fibres and granules. The capsule is connected with the host tissue by bundles of muscle and connective tissue fibres running from the outer layer of the capsule into the surrounding tissue. The wall of the capsule is up to 9 μ thick. The applied staining methods showed that it consists of four layer: outer, middle and inner layer, and inner limiting layer. Outer and inner layer consists of connective tissue and middle layer consists of muscle and connective tissue. The inner limiting layer borders the inner margin of the capsule towards

its cavity. No outer limiting layer has been demonstrated. The outer connective tissue layer measures 1 μm. The middle muscle and connective tissue layer measures 4—5 μm. The inner connective tissue layer is of aproximately the same thicknees as the inner limiting layer, reaching 1,5 μm. Fine connective tissue fibres of the outer and inner layer are stained pink with haematoxylin-eosin and van Gieson's method, red-violet with Masson's and Goldner's trichrome, black with Gomoriś method and

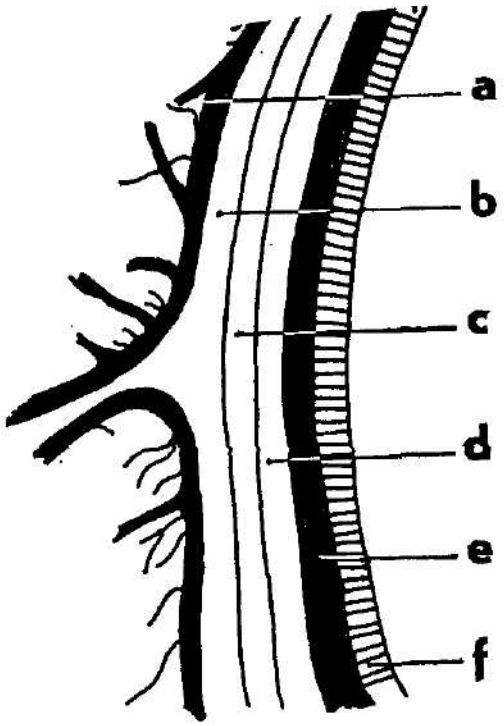

Fig. 2. Structure of capsule. a — connective tissue outer layer, b — muscle and connective tissue middle layer, c — muscle fibres prevailing in the central part of the muscle and connective tissue middle layer, d — muscle and connective tissue middle layer, e — connective tissue inner layer, f — inner limiting layer.

red with PAS method. The muscle fibres of middle layer are stained red haematoxylin-eosin, Masson's and Goldner's trichrome, yellow with van Gieson's method and faint red with PAS method. The muscle fibres prevail in the central part of this layer. The connective tissue fibres of middle layer are stained pink with haematoxylin-eosin, red with van Gieson's method, blue with Masson's trichrome, green with Goldnerś trichrome, gray- black with Gomori's method and pink with PAS method. The inner limiting layer is not stained by any of the methods used and is discernible only by its refractivity.

C y s t (Figs. 1,3; Plate I, Figs 1,2; Plate II, Fig. 1). The cyst surround the invaginated neck and scolex and measures 290—360 × 190—280 μm.

Its wall is 11—16 μm thick. An outer limiting layer was observed on its surface. This layer is often damaged or teared off. It is 1 μm thick and discernible by its refractivity. The tegument forms a 1 μm thick layer and its amorphous substance is stained deep pink by Gomori's method. Fine connective tissue fibres (Plate I, Figs 1,2; Plate II, Fig. 1) measure about $^1/_4$ μm and are situated in outer part of the tegument. The outer fibres are circularly and the inner ones longitudinally oriented. They are stained pink by haematoxylin-eosin and van Gieson's method, red-violet with Masson's and Goldner's trichrome, black with Gomoriś method and red with PAS method. A 1 μm thick basement layer was observed under the tegument. It was not stained by any of the methods used.

The subtegument consists of outer and inner muscle and connective tissue layers. The muscle and connective tissue fibres in the outer layer are circular and those in the inner layer are longitudinal oriented. They are regularly arranged in both layers (Fig. 3). The connective tissue fibres are oval in section and measure 4—6 × 2—3 μm. The distance between them was found to be 4—7 μm, according to the stage of dilatation or contraction of the cyst. These fibres are stained pink with haematoxylin--eosin and van Gieson's method, blue with Masson's trichrome, green with Goldner's trichrome, faint pink (ground substance) and gray-black (fibrills) with Gomoriś method and pink with PAS method. The muscle fibres measuring 1—2 μm in diameter run in parallel with connective tissue fibres both in the circular and longitudinal layer. These fibres are situated approximately half the distance between two neighbouring connective tissue fibres. They are stained red with haematoxylin-eosin and Masson's and Goldner's trichrome, yellow with van Gieson's method and faint red with PAS method. Pyriform and bladder-like cells are situated under the longitudinal muscle and connective tissue layer. The pyriform cells touch the tegument with their anterior attenuated part and their posterior widened part containing nucleus is tucked under the longitudinal muscle and connective tissue layer. They occur separately in the spaces formed by regularly arranged circular and longitudinal connective tissue fibres of the subtegument, which is well visible in tangential sections (Plate II, Fig. 1). Fine connective tissue fibres running from the tegument surround the pyriform cells. The size of these cells is 7—13 × 4—6 μm. the light plasma is stained pink with Gomori's method. The nucleus is dark, picnotic, it measures 3—5 × 2—3 μm and is stained black with Gomori's method. The bladder-like cells measure 3—5 μm, their nucleus is indistinct and plasma very granulated. Calcareous bodies are situated between the cells of both types. They measure 2—4 μm and occur mostly at the place of invagination and in the opposite part of the cysticercoid. They are stained brown-black with Kossa's method. Fine muscle and connective tissue fibres were observed between the cellular elements of the subtegument in some sections at high magnification (× 1000). They ran from circular and longitudinal muscle and connective tissue layer and formed a continuous thin layer on the inner margin of subtegument. The inner margin of the cyst is bordered by an inner limiting layer which is 1 μm thick and discernible by its refractivity.

N e c k (Fig. 1). The neck is located in the cyst cavity, freely adhering to its inner wall. It is connected with the cyst wall only at the site of

invagination. The neck is situated in such a manner that it surrounds the scolex and the neck tegument is turned to the tegument of scolex (Fig. 1). The neck forms a 6–11 μm thick layer. The outer limiting layer of the neck is refractive and 1 μm thick. The tegument in the proximal part of neck measures about 1 μm and is divided into two layers. The outer layer consists of microtriches which are stained red by haematoxylin--eosin, and Masson's and Goldner's trichrome, and yellow by van Gieson's method. The inner layer consists of an amorphous substance which is

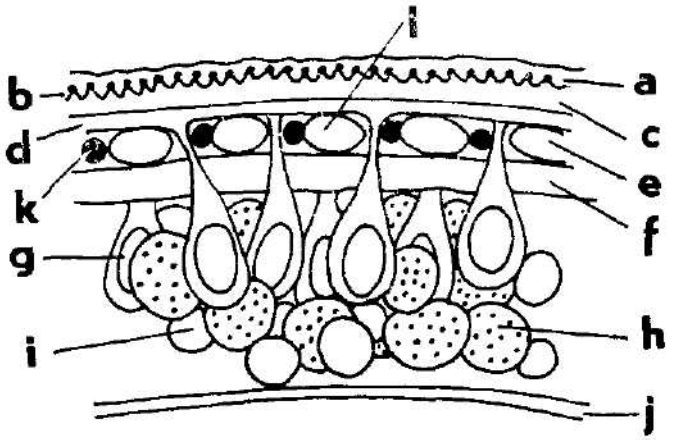

Fig. 3. Longitudinal section through cyst wall. a — outer limiting layer, b — circular and longitudinal connective tissue fibres of outer part of tegument, c — inner part of tegument, d — basement layer, e — circular muscle and connective tissue layer of subtegument, f — longitudinal muscle and connective tissue layer of subtegument, g — pyriform cell, h — bladder-like cell, i — calcareous body, j — inner limiting layer, k — transverse section throuh circular muscle fibre, l — transverse section through circular connective tissue fibre.

stained deep pink by Gomori's method, similarly as in the tegument of cyst. In the distal part of neck, the microtriches are gradually shorter and then disappear and the tegument consists of an amorphous substance only. In parallel with decreasing lengt of microtriches the tegument of this part becomes lower till it reaches half of the height of tegument of the proximal part. The microtriches occur approximately at $^1/_4$–$^1/_2$ of length of the neck. The basement layer in the proximal and distal parts of the neck is of almost the same thickness as the tegument.

The subtegument consists of circular and longitudinal muscle and connective tissue layer which is stained with histological methods in the same way as analogous layers in the cyst wall. Each of them is 1 μm thick. The pyriform cells measure 4 × 2 μm. The bladder-like cells were observed only rarely and their size was 2–3 μm. The calcareous bodies measure 2–4 μm. Muscle and connective tissue fibres running from the muscle and connective tissue layers of subtegument were observed among the cells. In the proximal part of neck, under the subtegument, there was a 1–5 μm high layer of parenchyma. The wall of neck is closed by a 1 μm thick inner limiting layer.

S c o l e x (Fig. 1; Plate II, Fig. 2). The scolex is surrounded by neck and measures 270—330 × 150—254 xm (Fig. 1). The outer limiting layer on the scolex surface is 1 μm thick and is often damaged, especially on the surface of suckers. The tegument is 3—4 μm high and its outer part consists of microtriches, which are visible on the whole surface of scolex. The longest ones are on suckers where they reach 3 μm, somewhat shorter microtriches are on the surface of rostellum, and on the remaining parts of scolex they measure 2 μm in length. At the border between the scolex and neck the microtriches become gradually shorter (see description of neck). The inner part of the tegument consists of an amorphous substance measuring 1 μm. On the top of rostellum, the inner part of the tegument is thickened (4—6 μm) and hooks are growing from it. The cysticercoids were found to possess 20 hooks arranged in two rows. Their length is 40—47 μm in anterior and 46—52 μm in posterior row. Both the microtriches and the amorphous substance of the tegument are stained in the same way as in the neck wall. The basement layer is 1 μm thick and has the same properties as the basement layer of neck and cyst.

The subtegument measures 8—11 μm in height. The subtegumental muscle and connective tissue layer is 4—6 μm thick and its structure does not differ from analogous layers in the wall of cyst and neck. The pyriform cells measure 4 × 2 μm. The bladder-like cells measure 2—3 μm and are much more numerous than in the wall of neck and cyst. Between the pyriform and bladder-like cells were again found fine muscle and connective tissue fibres running from the upper muscle and connective tissue layers and forming a continuous layer on the inner side of subtegument. This layer consists mostly of connective tissue fibres and is well visible in the suckers, whereas in other parts of scolex it can be seen only in some sections. Under the subtegument lies a layer of parenchyma which does not differ from that of adult cestodes. The cellular part of subtegument, and parenchyma of the distal part of scolex, comprise numerous calcareous bodies which reach the size of 3—5 μm and are stained brown-black by the Kossa's method.

DISCUSSION

During processing the material by histological techniques the tissue is considerably contracted so that the measurements of the cyst and scolex are lower than if living cysticercoids in whole mounts are measured. The size of the capsule, however, is practically the same both in section material and in whole mounts. Consequently, the space between the capsule and the cyst in section material is larger than in living cysticercoids.

The capsule of *R. crassiscolex* cysticercoids has not yet been described in the literature. U b e l a k e r et al. (1970) use the term "capsule" for the cyst of *Hymenolepis diminuta* (Rudolphi, 1819). The structure of the capsule differs from the structure of the remaining parts of cysticercoid. The outer limiting layer was not found on the outer side of the capsule, but there were numerous muscle and connective tissue fibres penetrating from the outer and middle layer of the capsule 15—25 μm deep in the snail tissue. During the isolation of cysticercoids the capsule remains

connected with the snail tissue. These facts suggest that the capsule is formed from the host organism.

The outer limiting layer covering the tegument corresponds to the "hyaline coat" described by Voge (1960 a, b) in the cysticercoids of *Raillietina cesticillus* (Molin, 1858) and *H. diminuta*. Baron (1971) in his electron microscopic (EM) studies of *R. cesticillus* cysticercoid observed undulated tubules running in radial direction in the outer limiting layer.

The structure of tegument is almost identical in the cyst, neck and scolex, because the body covering of the non-invaginated larva (younger phase of development) arises as a single layer on the whole surface. The outer part of the tegument is distinguished according to the function of individual parst of the cysticercoid. The cyst wall was found to contain circular and longitudinal connective tissue fibres making the cysticercoid firm and elastic. The scolex and proximal part of neck contained microtriches having a nutritional function. The inner parts of the tegument of cyst, neck and scolex have the same structure.

The longest microtriches are on the surface of scolex, in the proximal part of neck they become gradually shorter, and in the distal part of neck and in the cyst disappear. In the EM studies of *H. diminuta*, Ubelaker et al. (1970) described fine projection on the surface of cyst tegument. They resembled microtriches of the scolex and neck and were termed "microvilli" by the authors. Similar projections were described also by Baron (1971) in *R. cesticillus* cysticercoids and were termed "microtrix--like projections". The occurrence of microvilli in the cyst tegument is probably due to the fact that the whole surface of the non-invaginated larva performs a nutritional function. The circular and longitudinal connective tissue fibres in the outer part of cyst tegument are formed only in the second half of larval development. Ubelaker et al. (1970) described a dense net of filaments in the cyst tegument of *H. diminuta* which they called "terminal filamentous web". In principle identical with our results was also the description of tegument structure of *Proteocephalus pollanicola* Greeson, 1952 published by Threadgold (1965). In contrast to our observations, Baron (1971) did not found any structures in the cyst wall of *R. cesticillus* which might be identified as muscle fibres.

The subtegument, similarly as the tegument, arises as a single continuous layer during the development of non- invaginated larva. Its structure is identical in the cyst, neck and scolex. The circular and longitudinal muscle fibres of the subtegument have not a character both smooth and striated muscle fibres. The ultrastructure of the muscle fibres of *Calliobothrium verticillatum* (Rudolphi, 1819), *Phyllobothrium foliatum* Linton, 1890, *Lacistorhynchus tenuis* (v. Beneden, 1858) and *H. diminuta* was described by Lumsden and Byram (1967). The pyriform cells of the subtegument correspond to "flask-shaped cells" described by Lumsden (1966) in his cytological study of *H. diminuta*, *L. tenuis* and *C. verticillatum*. According to his description, these cells are connected with the "matrix cuticle" (inner part of the tegument). In the light microscope, we have observed the pyriform cells also beneath the tegument, and they were found to have a similar chemical composition as the amorphous substance of the tegument. In younger phases of larval development,

when the tegument is formed, the size of these cells on the whole surface of non-invaginated larva is 10×6 μm, their plasm is very granulated and the nucleus is saccular. In the invaginated cysticercoid, when the tegument is already fully formed these cells are smaller, measuring 7×4 μm in the cyst and 4×2 μm in the scolex and neck. Their plasm is light, without granules and their nucleus is pycnotic. According to the mentioned properties, the pyriform cells seem to participate in the structure of tegument.

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REFERENCES

Baron P. J., 1971: On the histology, histochemistry and ultrastructure of the cysticercoid of Raillietina cesticillus (Molin, 1858) Fuhrmann, 1920 (Cestoda, Cyclophyllidea). *Parasitology*, **62**: 233–245.

Jourdane J., 1972: Etude expérimentale du cycle biologique de deux espèces de Choanotaenia intestinaux des Soricidae. *Z. Parasitenkde*, **38**: 333–343.

Kisielewska K., 1958: The life cycle of Choanotaenia crassiscolex (Linstow, 1890) (Dilepididae) and some data relating to the formation of its cysticercoids. *Bull. Acad. Pol. Sci.*, **2**: 29–84.

Kisielewska K., Prokopič J., 1963: Příspěvek k vývojovým cyklům některých druhů tasemnic rejskovitých (Soricidae) na Šumavě a srovnání jejich vývoje na dvou různých biotopech. *Čs. parasitol.*, **10**: 111–112.

Lumsden R. D, 1966: Cytological studies on the absorbtive surface of cestodes. *Z. Parasitenkde*, **27**: 355–382.

Lumsden R. D., Byram J., 1967: The ultrastructure of cestode muscle. *J. Parasitol.*, **53**: 326–342.

Pearse, A G. E, 1960: Histochemistry. Theoretical and applied. 2nd Edition. J. and A. Churchill. London.

Prokopič J., Dimitrova E., Genov T., Karapčanski I., 1970: Cisticerkoidi na cestodi ot masekomojadni bozjanici v Blgarija. *Izv. Centr. chelm. labor.*, **11**: 173–184.

Prokopič J., Žďárská Z., 1958: Suchozemští plži Arion rufus (Linné, 1758) a Vitrina pellucida (Muller, 1774) mezihostitelé tasemnice Anomotaenia subterranea Cholodkowsky, 1906. *Věst Čs. spol. zool.*, **22**: 1–5.

Rawson D., Rigby J. E., 1960: The functional anatomy of cysticercoid of Choanotaenia crassiscolex (Linstow, 1890) (Dilepididae) from the digestive gland of Oxychilus cellarius (Mull.) – Stylommatophora with some observations on development stages. *Parasitology*, **50**: 453–463.

Threadgold L. T, 1965: An electron microscope study of the tegument and associated structures of Proteocephalus pollanicoli. *Parasitology*, **55**: 467–472.

Ubelaker J E., Cooper N. B., Allison V. F.: 1970: The fine structure of the cysticercoid of Hymenolepis diminuta. I. The outer wall of the capsule. *Z. Parasitenkde*, **34**: 258–270.

Voge M.: 1960a: Studies in cysticercoid histology. III. Observations on the fully developed cysticercoid of Raillietina cesticillus (Cestoda: Cyclophyllidea). *Proc. Helminthol. Soc. Wash.*, **27**: 271–274.

Voge M., 1960b: Studies in cysticercoid histology. IV. Observations on histogenesis in the cysticercoid of Hymenolepis diminuta (Cestoda: Cyclophyllidea). *J. Parasitol.*, **46**: 717–725

Žďárská Z., 1960: Larvální stadia cizopasných červů z našich suchozemských plžů. *Čs. parasitol.*, **7**: 355–379.

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

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TRANSMISSION OF MICROSPORIDIA TO INSECTS VIA INJECTION

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Abstract: With *Galleria mellonella* larvae positive transfers were achieved by injection of spores of *Variimorpha (Nosema) plodiae, V. (N.) heterosporum, N. noctuidae* and *Thelohania (V.) ephestiae* which were infectious also *per os*. Negative were injections of *Plistophora schubergi, Thelohania bracteata, T. fibrata, Plistophora simulii, P. debaisieuxi* and *Nosema bombycis* which do not infect *Galleria* per os. *P. schubergi* injected into *Barathra brassicae* did not infect it although spores are infectious for that host when given per os There was no mortality after injection of sterile doses from 3000 to 100 000 spores. Infected last larvae do not pupate and they survive without feeding 30 to 60 days in webs.

The transmission of microsporidia from host to host by injection is a rare yet existing way of infection in nature. Parasitic Hymenoptera transport on and in their ovipositors a droplet of host hemolymph with hemocytes or fragments of tissues and during next oviposition they transfer the inoculum. This situation was described as the reason of three types of infestation caused by *Nosema mesnili* in the cabbage white butterfly, *Pieris brassicae*. (Weiser, 1966). The infection introduced with food differs from distribution of the parasite when injected by *Apanteles glomeratus* and a third type is a combination of both ways. In experimental simulations of such infections we used injections of spores and vegetative stages isolated from the hemolymph of dissected infected caterpillars. Subsequent experimentation with *Variimorpha (Nosema) plodiae, V. (N.) heterosporum* and *Plistophora schubergi* transmited by injection was reported later (Weiser, 1973). Transmission by injection was used by Undeen and Maddox (1973) in experiments with *Nosema algerae*. They used a non-sterile homogenate and separated and activated spores with a gradient centrifugation method.

This paper will deal with the sterile transmission of microsporidian spores and vegetative stages by injection, the host reactions and some quatitative data on resulting infections.

MATERIAL AND METHODS

Insect hosts: Larvae of the wax moth, *Galleria mellonella* L. were reared in flasks with Haydak medium (Haydak, 1936), each flask starting with a 24 h egg-mass. Uniform larvae of the late prepupa, after formation of their first web, were collected from the colony and used for injections. *Barathra brassicae L.* larvae were produced on artificial medium of Shorey and Hale (1965) in continuous laboratory rearings. Larvae were kept after infection in separate glass vials on

special stands, with a supply of food for the whole development till pupation Infected larvae were used for preparation of sterile suspensions for injections

Microsporidia used *Nosema plodiae* and *Nosema heterosporum*, original isolates of Kellen and Lindegren (1968, 1969) were obtained from the authors and were maintained on *Barathra brassicae* in continuous lines by feeding starved 3rd instar larvae with a droplet (1 mm^3) of spore suspension in water on a loop The reception of the whole droplet was controled under the dissecting microscope Every larva developed the infection They were kept at 26 °C and 95 % RH at a 12 hours day light In 15 days the infection was visibly apparent, producing white spots under the cuticle, after that time the caterpillars were used for the inoculum Both microsporidia belong to the genus *Varimorpha* Pilley

Plistophora schubergi Zwolfer was originally isolated from infected *Lymantria dispar* L where it infects the gut wall It was maintained by serial transmission on *B brassicae*

Thelohania ephestiae Mattes was isolated from infected *Ephestia kuhniella* larvae and transmited to *B brassicae* where it was maintained This microsporidian belongs also to the genus *Varimorpha* Pilley

Nosema mesnili (Paillot) and *Nosema bombycis* Nageli were isolated from infected *Pieris brassicae* and *Bombyx mori* in rearings and used for some experiments *N noctuidae* Issi was isolated by Issi in Leningrad and used in this series of experiments

Thelohania bracteata (Strickland), *T fibrata* (Strickland), *Plistophora simulii* (Lutz and Splendore) and *P debaisieuxi* Jirovec were collected in infected larval *Odagmia ornata* in the field Cysts in their fat body were dissected under the microscope and their suspensions were used for injections

Isolation of sterile material Caterpillars of *Barathra brassicae* or *Galleria mellonella* with well developed infections in their fat bodies were anesthetised by CO_2 and aseptically cut open The gut was moved to one side and the whole fat body with spores was teared out with a forceps Fragments of infected tissues were squeezed between two sterile slides and the liberated spores were washed into a sterile vial by sterile saline

The infected gut of *Barathra brassicae* with *Plistophora schubergi* was removed during a dissection of the larva On a sterile slide the protruding peritrophic membrane was extracted together with the gut content the gut wall was removed, cut longitudinally and was washed by shaking two times in sterile saline Parts of the gut were squeezed between two slides and free spores washed into sterile saline

Blackfly larvae with white cysts of microsporidia were removed from the colonies on leaves, were brought individually on sterile slides and their gut was removed after cutting the last segment The cysts with microsporidian spores were removed and washed by shaking in sterile saline They were then suspended in saline during this process the species involved was identified

Adjustment of the suspensions The content of spores and vegetative stages in each suspension was counted in a Burker hemocytometer and the sample was diluted with sterile saline to the requested concentration without use of any antibiotics In the hemocytometer mature spores are more refringent than sporoblasts Sporonts are spherical to irregular The stages could be compared with stages on dry smears of the same material, stained by Giemsa

Injections Suspensions were injected with the use of tuberculine syringes and an injector enabling the injection of variable amounts of 0 1 to 10 mm^3 in each injection For the procedure larvae were treated with CO_2 in a Buchner funnel inserted in a Erlenmayer flask with dry ice Anesthetized caterpillars were injected with 2–3 mm^3 of spore suspension and deposed on filter paper in a Petri dish There their wounds dried closed in 1–2 min and regained activity in 3 to 5 minutes Because they built new webs during 24 hours they did not need any food (which could contaminate their wounds)

The progress of the infection was followed from the 7th day on watermounts and Giemsa stained smears Spore contents were counted from suspensions of desintegrated bodies of larvae suspended in adequate volume of water

RESULTS

Transmission by injection Positive transmissions were achieved with all microsporidia which were infectious for *Galleria mello-*

Tab 1 Development of injected *Galleria mellonella* L_5 larvae Dosage 3 mm^3/larva, 22°C, without food

Days	Saline only			Fat body and saline			*V ephestiae* and saline		
	L	P	I	L	P	I	L	P	I
2	(5) 95	—	—	100	—	—	(2) 96	—)—	— —
7	(10) 5	85	—	(6) 68	26	—	(3) 97	— —	— —
16	(10) —	5	85	(6)	60	34	(3) 97	—	—
20	(10) —	5	85	(6)	*) —	94	(3) 94	3	—
32	(10)	*)	(85) 5	(6)	*)	(94)	(45) 52	(3)	—
38	(10)	*)	(90)				(54) 43	(3)	—
43							(67) 30	(3)	—
49							(75) 22	(3)	—
57							(95) 2	(3)	—
64							(96) 1	(3)	—

Numbers in parentheses = dead individuals
*) eggs, larvae developed before death of adults

nella by feeding *Varimorpha plodiae*, *V heterosporum*, *V ephestiae*, *N. noctuidae* (minimum development) Exception was in the case of *Plistophora schubergi* which did not infect *Galleria* nor *Barathra* by injection into the body cavity Negative were injections with *Nosema mesnili*, *N bombycis*, *Plistophora simulii*, *P debaisieuxi*, *Thelohania bracteata* and *T fibrata* in last larvae of *Galleria mellonella*

The injection site was not important sofar, if the gut was not affected To exclude eventual complications the region over the lateral stigmatal line was chosen All caterpillars contaminated with bacteria died during the next three days If antibiotics were used with the spores, the mortality was protracted for a week and more and it affected the general picture of the microsporidian infection The tissues infected after injection were the same as by feeding

The infection, germs from open empty spores, were absorbed first by lymphocytes and oenocytes and multiplied in many subsequent divisions, as shown in water mounts and Giemsa smears, without direct sporulation during the first 6 days After that the vegetative stages invaded the fat

Tab. 2 Development of injected *Galleria mellonella* L_5 larvae with *Variimorpha plodiae*, *V. heterosporum* and *Nos. noctuidae*. Dosage 40 000 spores in 3 mm³/larva, 22°C, without food

Days	*V. plodiae*			*V. heterosporum*			*N. noctuidae*		
	L	P	I	L	P.	I.	L.	P.	I.
2	(4) 96	—	—	(6) 94	—	—	100	—	—
9	(4) 96	—	—	(6) 94	—	—	50	50	—
12	(4) 96	—	—				25	75	—
25	(4) 96	—	—	(28) 72	—	—	— —	90	10
32	(20) 80	—	—				—	78	(22)
42	(46) 54	—	—	(50) 50	—	—	—	(78)	(22)
61	(91) 9	—	—	(96) 4	—	—		no eggs	

Numbers in parentheses = dead individuals

body and on the eight day the spores appeared in large quantities. During this vegetative growth all differences in injected amounts of parasites were wiped off.

Injected doses: The reactions of infected caterpillars to the infective dosage which are visible in feedings and which are interpreted in many cases as dose-responses of different stages, overdoses causing septicaemias or dose under the infective threshold, ho not exist in injected caterpillars. Doses from 50 spores of *V. plodiae* or 40 of *V. heterosporum* produced infections with final spore counts of 5×18^8 in the same way as doses of 2000, 20.000 or 100.000 spores. Mortality resulted only after the whole fat body was filled with spores. *Galleria mellonella* caterpillars injected with spores changed their further development.

Development of injected larvae: As shown in Tab. 1, from parallel series of injections of saline only, of saline with fat body suspension and of saline with *V. ephestiae*, only caterpillars with the microsporidian stop further development and remain larvae till death. The other two series show pupae in 7 to 16 days and produce adults after another two weeks. Later here the only mortality was physiological mortality of adults after oviposition and production of their progeny The larvae with microsporidia formed pupae only as exception and these were not viable. Their fat body was filled with spores. All other larvae remained larvae, produced large amounts of spores and died in their webs between the 30th and 60th day. They surpassed the life of the control larvae almost 10 times. The same results were in experimental injections of larvae of the same group with two of three other germs, *V. plodiae*, *V. heterospora* and *N. noctuidae*, as shown in Tab. 2. Micro-

Tab. 3 Production of spores of Microsporidia after infection by feeding and by injection in *Barathra brassicae* and *Galleria mellonella* caterpillars

Microsporidian	Infection *B. brassicae* L_4	Injection *G. mellonella* L_5
Variimorpha heterosporum	dose: 2000 sp. result: 5×10^8	30 000 sp. 5×10^8 sp.
Variimorpha plodiae	dose: 2000 sp. result: 23×10^8	50 000 sp. 8×10^8 sp.
Variimorpha ephestiae	dose: 3000 sp. result: 5×10^8	25 000 sp. 4.6×10^8 sp.

The resulting counts are average counts from groups of 10 caterpillars in each experiment.

sporidia of the genus *Variimorpha* produced again dormant larvae with the infection. *N. noctuidae,* in contrary, infected the larvae but these pupated after the 9th day and whereas 78% died subsequently as pupae, another 22% hatched and lived as adults, mating and ovipositing. They all got the same doses of spores.

Production of spores: A comparison of infections of *Barathra brassicae* by feeding and *Galleria mellonella* by injection (Tab. 3) show that final amounts of spores in both groups of infected hosts were very close to 5×10^8 spores. In all these cases the spores filled all available space of the fat body. In other series, *Barathra* with large last caterpillars, produced several times more spores.

As mentioned, there is no direct relation between the injected dose of spores and the produced amount of parasites in days after infection. On the other side, the injected dose when very high will influence to some extent the final spore count, as it is shown in Tab. 4 in *V. plodiae.* At the same time it is evident that most of the spores are deposed in the fat body during the first 20 days and after the 25th day the whole accessible body is filled up and there is no more increase, only survival of the stored material.

Tab 4. Amounts of spores produced during the survival of injected *Galleria mellonella* caterpillars

Day	*V. plodiae*		*V. heterosporum*
1	inj. 50 000 sp.	100 000	inj. 30 000 sp.
9			162×10^6 sp.
25	800×10^6	73×10^6	420×10^6 sp.
38	260×10^6	98×10^6	670×10^6 sp.
43			500×10^6 sp.
63	800×10^6		520×10^6 sp.

Spore counts from dissected single caterpillars, the last number in each collon is average count of the rest of a 20 caterpillar group in each experiment.

Tab. 5. Participation of the spores and vegetative stages of *Varimorpha heterosporum* in the infection of *Galleria mellonella* after injection into the body cavity

I. Isolate on Sept. 9, infection from Sept. 2:					
	1 mm³ contains:	spores	600	injected	3 000
		sporoblasts	600		3 000
		diplokarya	3200		16 000
		all stages injected			22 000
II.	1 mm³ contains:	spores	3700	injected	18 500
		sporoblasts	200		1 000
		diplokarya	200		1 000
					20 500

Resulting infection after 17 days:

		I.	II.
in averrage pro larva:	spores	153×10^6	146×10^6
	sporoblasts	9×10^6	7×10^6
	diplokarya	5×10^6	12×10^6
	total	167×10^6	165×10^6

III. Infections with spores dried on sterile slides, washed and injected after days of dry storage at 20°C, 30 000 spores/injection

Days	1	2	3	4	10	20	30
Infected	+++	+++	+++	+++	+++	+++	+++
All dead after	35	37	32	28	25	27	23 days

Infection with spores and vegetative stages: If only 40 or 50 stages (spores), were adequate to initiate an infection, it was important to know if by any chance vegetative stages did not mediate the transmission as an unobserved admixture of the spore material. A series of experiments with suspensions where vegetative stages have been counted beside of mature spores is sumarized in Tab. 5. Suspenzions with a majority of spores produced the same mass of spores after 17 days as a series where spores surpassed vegetative stages. Long lasting dry storage of mixed material where vegetative stages have been killed by storage, brought the same infections as fresh injections. The stored material produced higher mortality in shorter term.

DISCUSSION

The injection technics in transmission of a series of microsporidia to last larvae of *Galleria mellonella* brought evidence of the activation of spores and germ extrusion in case when a major change of the osmotic values of the medium was provided. It shows that any activation by alkaline solutions (Ludox) or acids is not needed. Only this osmotic step protects the microsporidian in the host against steady autoinfection which may work against its conservation. For continuation of the invasion of new cells with the microsporidia some vegetative stages remain active among the spores and they react with new divisions and sporoblast

formations as soon as some new susceptible cells are formed. This is not the case in the infections of the gut and most probably the digestive juices avoid spore openings and re-invasions.

The dosage responses to different quantities of spores fed with the food to different stages of larvae reflect the losses of active stages during their passage in the host gut and their concentration in some regions of the gut. Mortality reflects the amount of bacteria introduced into affected cells. When sterile material is injected, all dosage / infection and dosage / mortality responses are changed. The main response in the genus *Variimorpha* is the interruption of the larval molts and pupation which (Fisher and Sanborn, 1964) was characterized as production of a juvenile hormone by the microsporidian. The effects of injections do not similate the juvenile hormone action and have to be explained in another way.

The injection method is a good way for maintaining and production of spore material for laboratory experimentation. The resulting amount of spores is close to the product of per os infections of *Barathra brassicae*.

REFERENCES

Fisher, F. M., Sanborn, R. C., 1964: Nosema as a source of juvenile hormone in parasitized insects. *Biol. Bull.*, **126**: 235–252.

Haydak, M. H., 1936: A food for rearing laboratory insects. *J. Econom. Entomol.* **29**: 1026.

Kellen, W R., Lindegren, J. E., 1968: Biology of Nosema plodiae sp. n., a microsporodian pathogen of the indian meal moth, Plodia interpunctella (Hbn.) (Lepid., Phycitidae). *J. Invertebr. Pathol*, **11**: 104–111.

Kellen, E. R., Lindegren, J. R., 1969: Host pathogen relationships of two previously undescribed microsporidia from the Indian meal moth, Plodia interpunctella (Hübn.) (Lepid., Phycitidae). *J. Invertebr. Pathol.*, **14**: 328–335.

Mattes, O., 1928: Ueber den Entwicklungsgang der Microsporidie Thelohania ephestiae und die von ihr hervorgerufenen Krankheitserscheinungen *Zschr. wiss. Zool.*, **132**: 526–582.

Pilley, B. M., 1976: A new genus Vairimorpha (Protozoa: Microsporidia), for Nosema necatrix Kramer 1965; Pathogenicity and life cycle in Spodoptera exempta (Lepidoptera, Noctuidae). *J. Invertebr. Pathol*, **28**: 177–184.

Shorey, H. H., Hale, R. L., 1965: Mass rearing of the larvae of nine noctuid species on a simple artificial medium. *J. Econom. Entomol.*, **58**: 522–524.

Undeen, A. H., Madox, J. V., 1973: The infection of nonmosquito hosts by injection with spores of the microsporidian Nosema algerae. *J. Invertebr. Pathol.*, **22**: 258–265.

Weiser, J., 1966: Nemoci hmyzu. 550 pp. Academia, Praha.

Weiser, J., 1973: Transmission of microsporidia via injection. Proc. Vth Int. Conf. Insect Pathology, Oxford, p. 13.

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Limnofauna Europaea — herausgegeben von J. Illies, 2. Auflage, 1978, 532 pp., DM 186,—, Gustav Fischer Verlag, Stuttgart, New York.

Etwa zehn Jahre nach Erscheinen der ersten Auflage dieses grundlegenden Werkes über die Faunistik der limnischen Metazoen Europas erscheint die zweite, überarbeitete und ergänzte Fassung, die die neuen Kenntnisse über die Limnofauna bis zum Jahre 1977 beinhaltet. Auf dieser neuen Auflage, die nun 14.457 Tierarten aller im Wasser lebenden Gruppen enthält, haben schon 73 Fachleute aus 15 Nationalitäten (aus der Tschechoslowakei Doz. Hrbáček, Dr. Kořínek und Doz. Rozkošný) teilgenommen. Die Zahl der aus den europäischen Binnengewässern bekannten Arten hat sich also um mehr als 2050 erhöht. Das geschah besonders Dank der intensiven faunistischen Erforschung in vielen Gebieten Europas, vor allem auf dem Balkan. Neue ökologische und taxonomische Studien haben in manchen Gruppen zu einem erheblichen Aufstieg der Artenzahl geführt; den Extremfall stellt die Dipterenfamilie Limoniidae dar, mit dem Zugang von den vorherigen 73 bis zu den derzeitigen 403 Arten. In anderen Gruppen haben aber diese Studien auch Rückgänge der Artenzahl bereitet, wie z. B. bei den Chironomiden (1404 statt früher 1523 Arten) oder sogar bei den Vögeln (135 statt 138 Arten).

Die kurze Einleitung bringt, neben den Erläuterungen der einig verwendeten faunistischen und ökologischen Symbole, die Einteilung des Gesamtgebietes von Europa in 25 mehr oder weniger natürlichen biogeographischen Regionen. Die einzigen höheren Taxa der Wassertiere wurden, im Einklang mit der Artenzahl der Gruppe und damit auch in bezug auf die Spezialisten, auf verschiedenem taxonomischen Niveau bearbeitet: von der Familie bei den manchen Insekten bis zur Klasse bei den niedrigeren Protostomien und bei den Deuterostomien. Jede Gruppe wird kürzlich charakterisiert, besonders was die Bionomie, Chorologie und Taxonomie bettrift, und die wichtigste Literatur wird angegeben. Dann folgt die Liste der in den europäischen Binnengewässern gefundenen Species, in der Form einer einheitlichen Tabelle, die übersichtlich das Vorkommen der Arten in den 25 biogeographischen Gebieten, samt den chorologischen Bemerkungen, zeigt.

Das Buch ist natürlich besonders den Hydrobiologen-Limnologen, die sowohl in den theoretischen als auch in den angewandten Forschungsrichtungen, sowie in der Praxis arbeiten, bestimmt. Es ist jedoch auch allen Zoologen verschiedener Einstellung nützlich und auch für die Biogeographen und für die Fachleute auf dem Gebiet der Naturschutz sehr brauchbar. Das Werk ist für seine gedrängte Form und für einen hoch informativen Inhalt auch für die Lehrer und Studenten der Biologie bestimmt nicht ohne Interesse.

K. Hůrka

M. D. Udvardy: **A Classification of the Biogeographical Provinces of the World.** IUCN Occasional Paper No. 18, 48 pp., 10 maps. International Union for Conservation of Nature and Natural Resources, Morges, Switzerland; 1975. Mimeographed; price $ 4.50.

This is one of the IUCN reports submitted to UNESCO with the object to provide a hierarchical system of geographical areas serving for the cataloguing of species distributions as well as distributions of ecosystems units to be conserved. A compromise between zoological and botanical approaches is attempted and theoretical foundations of the concept of biogeographical provinces are laid down.

The terrestrial and freshwater biotic areas of the world are subdivided into biogeographical realms and these into provinces. Altogether 8 realms with 193 provinces are recognized, named, mapped, and when non-traditionally conceived, also discussed with ample references to modern literature. The accepted realms are, as follows: 1. Palaearctic (44 provinces), 2. Nearctic (22 provinces), 3. Africotropical (29 provinces), 4. Indomalayan (27 provinces), 5. Oceanian (provinces: 5.1. Papuan, 5.2. Micronesian, 5.3. Hawaiian, 5.4. Southeastern Polynesian, 5.5 Central Polynesian, 5.6. New Caledonian, 5.7. East Melanesian), 6. Australian, 7. Antarctic (provinces: 7.1. Neozealandia, 7.2. Maudlandia, 7.3. Marielandia, 7.4. Insulantarctia), 8. Neotropical (47 provinces).

An index number of each province also shows its inclusion into one of the 14 major biomes (i. e. physiognomical plant formations) recognized; e. g., the last number of index 8.26.8 of the Patagonian Province indicates that it belongs to the cold-winter desert biome.

In addition to new category names and new, mostly reasonably formed, names of biogeographical taxa, some major innovations against the traditional variations of Sclater-Wallace zoogeographical system are introduced. Independent Oceanian (including also the broadly conceived Papuan and New Caledonian Provinces) and Antarctic (including New Zealand) Realms are recognized: I believe that while the former action is debatable and the inclusion of the mentioned provinces is dubious, the suggested solution of the New Zealand problem is well founded. The Palaearctic and Nearctic Realms are extended southwards; from the faunistical viewpoint it is hardly defensible as far as the western Palaearctic is concerned.

Generally, the suggested provinces are well founded and their boundaries are reasonably delimited. As emphasized in the foreword to Prof. Udvardy's report, no final solution to the problem of biogeographical classification is presented and further modifications are surely required. Several weak points are obvious, namely: 1) Inclusion of southern Arabia into the Palaearctic instead of Africotropical Realm. 2) Rather bizarre subdivision of Central Europe into two main provinces, namely the Middle European Forest (2.11.5 — boundaries differently shown on the two Palaearctic maps!) including, among others, a large part of the North European Plain and all of the Carpathians, while Bohemia together with the Alps and Apennines are included into Central European Highlands (2.32.12). 3) Delimitation of the Arabian desert (2.19.7) including such heterogeneous biotas as the diversified and typically Mediterranean ones of Jordan and Israel, those of the Arabian Desert proper, and those of Yemen and Aden with predominantly Africotropical affinities. 4) General disregard of the marshes and swamps of the Eastern Hemisphere, however extensive and distinctive they may be; e. g. Mesopotamian marshes are included into the Anatolian-Iranian Desert (2.20.8), the Sudd area into Eastern Sahel (3.13.7), and none of the Mangrove Swamp Forests is recognized. 5) Inclusion of the Main Nile Valley and Delta into the Sahara Province (2.18.7). 6) Inclusion of Norfolk I. and Lord Howe I. into the New Caledonian Province (5.6.13). 7) Lumping of the whole of New Zealand into a single province, Neozealandia (7.2.9).

Probably every biogeographer will have some objections against the proposed system. However, a stimulative and integrative framework for further discussion has been provided, and this is not a small achievement.

P. Štys

POKYNY PRO AUTORY

Věstník Československé společnosti zoologické uveřejňuje původní vědecké práce členů společnosti v rozsahu nejvýše 30 stran rukopisu, napsané v některé z kongresových řečí, a dále články, hodnotící životní dílo našich zoologů, vyžádané redakcí. Práce autorů, kteří nejsou členy společnosti, budou přijímány jen výjimečně.

Formální úprava prací:

Rukopis (originál a 1 kopie) musí být psán na stroji s většími typy obřádek, na stránce 30 řádek, řádky po 60 úhozech, bez větších oprav. Rukopisy, které by neodpovídaly těmto formálním požadavkům, budou vráceny k přepsání.

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

Vlastní práce: 1. Velmi stručný abstrakt, v rozsahu nejvýše 15 řádek, v angličtině. 2. Úvod do problematiky (stručně). 3. Materiál a metodika (u známých metod pouze odkaz). 4. Vlastní část experimentální nebo popisná. 5. Diskuse. 6. Závěr. 7. Seznam citované literatury (nikoliv bibliografie!). 8. Adresa autora. 9. Tabulky, texty k obrázkům a grafům. Celý rukopis je průběžně stránkován.

Citace prací proveďte podle jednotného vzoru: autor, rok, název, časopis (mezinárodními bibliografickými zkratkami), ročník, sešit pouze v případě, že ročník není průběžně stránkován, stránky. U knižních titulů nakladatel a místo vydání. Např.: Hrabě S., 1975: Second contribution to the knowledge of marine Tubificidae (Oligochaeta) from the Adriatic Sea. *Věst. Čs. spol. zool.*, 39 : 111—119.

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

Obrázky a grafy kreslete černou tuší na kladívkový nebo pausovací papír v poměru 1 : 1 až maximálně 1 : 3, u taxonomických prací musí mít obrázky měřítko. Obrázky kreslete pokud možno tak, aby mohly být všechny stejným způsobem zmenšeny. Fotografie musí být ostré, kontrastní, na lesklém papíře. Obrázky sestavte do tabulí, které by bylo možno reprodukovat na šíři strany (126 mm), nebo s textem na celé zrcadlo (126 × 188 mm). Obrázky nebo obrazové tabule průběžně očíslujte a v rukopise vyznačte místo, kam mají být zalomeny.

Tabulky jsou tištěny jako otevřené, tj. bez svislý chlinek. V tabulkách oddělte vodorovnými linkami jen záhlaví tabulky a dolní okraj. Tabulky protokolárního charakteru nebo opakující údaje z textu, případně tak velké, že by je nebylo možné vytisknout na dvě protilehlé strany, nebudou přijímány.

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

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

Práce zasílejte na adresu: Doc. Dr. K. Hůrka, CSc., výkonný redaktor Věstníku Čs. spol. zool. Viničná 7, 128 44 Praha 2.

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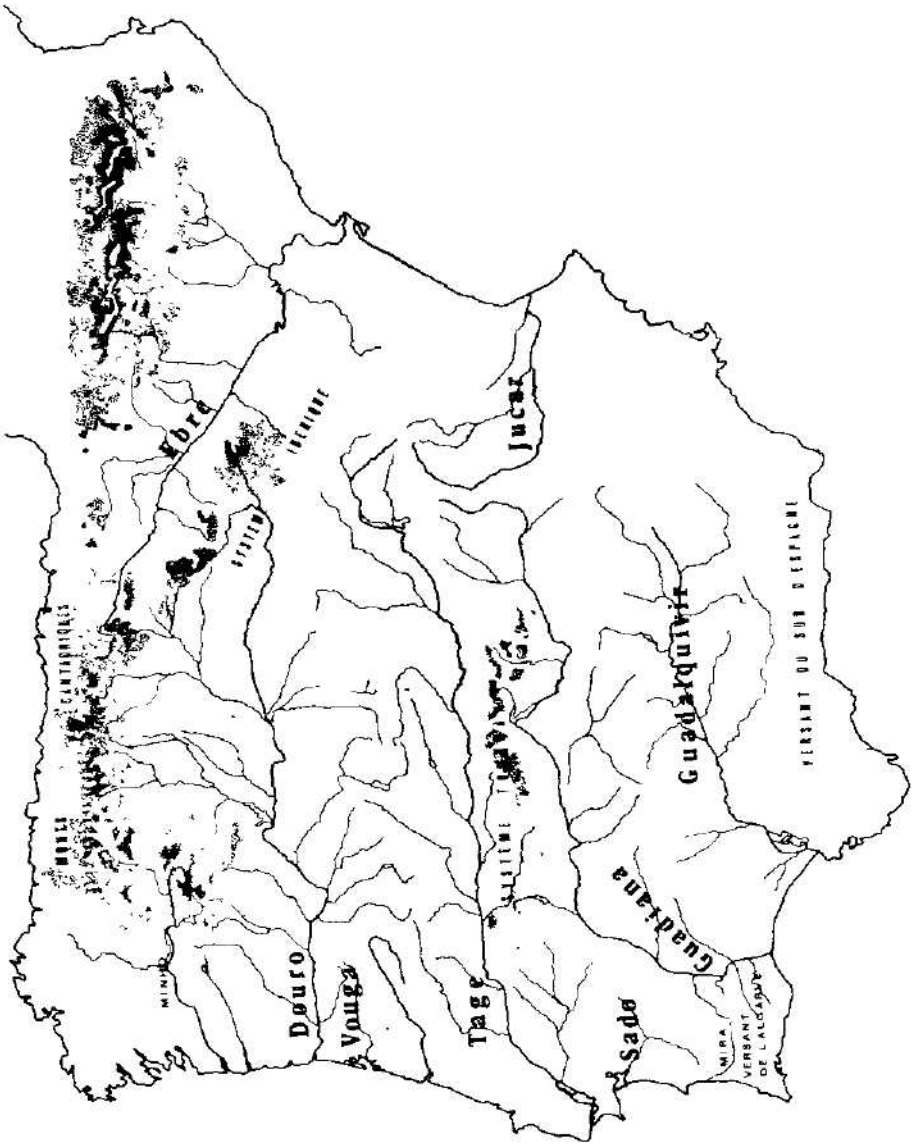


Fig. 1 — Principaux bassins et versants hydrographiques de la Péninsule Ibérique. Barrières géographiques principales: Monts Cantabriques, et Système Ibérique, d'une part, et Système Tolédan, de l'autre.

Almaça C.: Répartition géographique des Cyprinidae ibériques et secteurs ichthyogéographiques de la Péninsule Ibérique

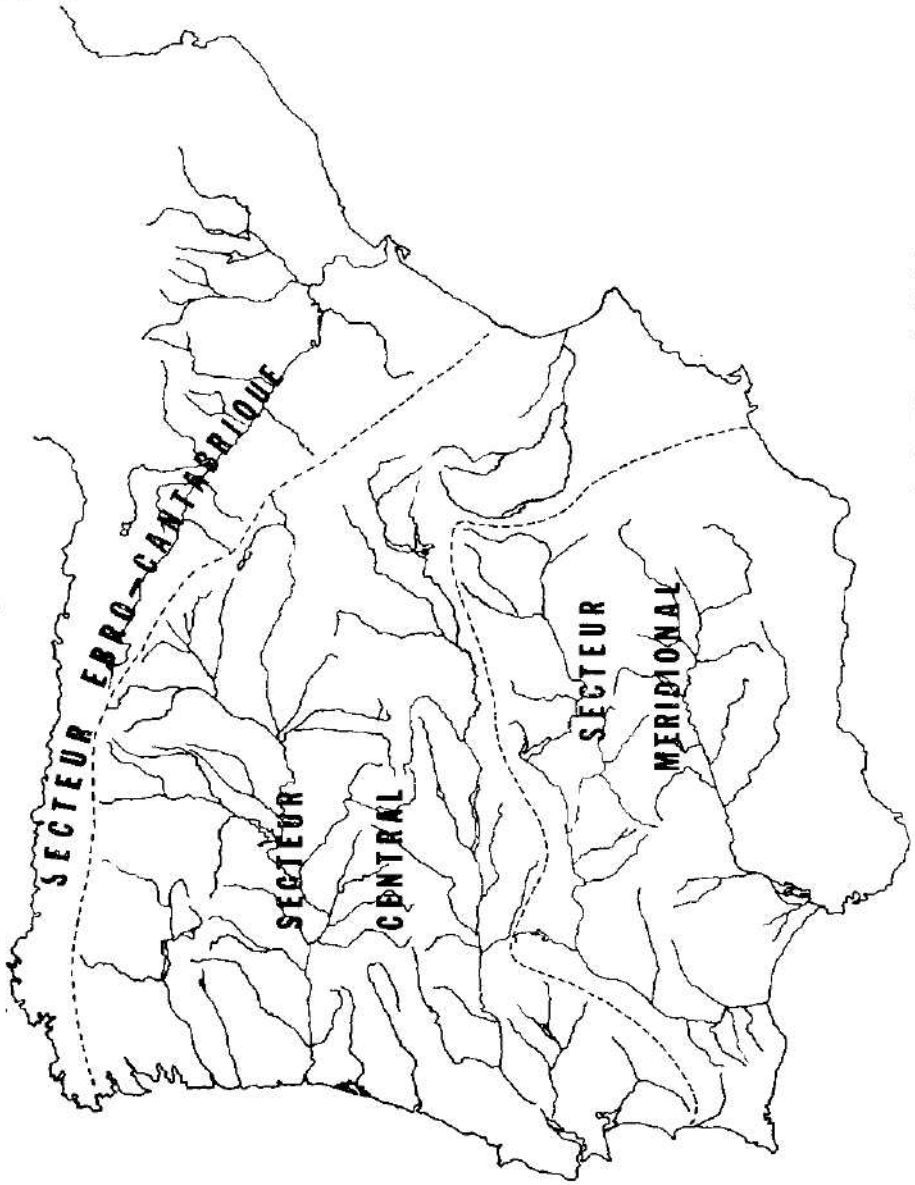


Fig. 2 — Secteurs, ou sous-districts, ichthyogéographiques de la Péninsule Ibérique

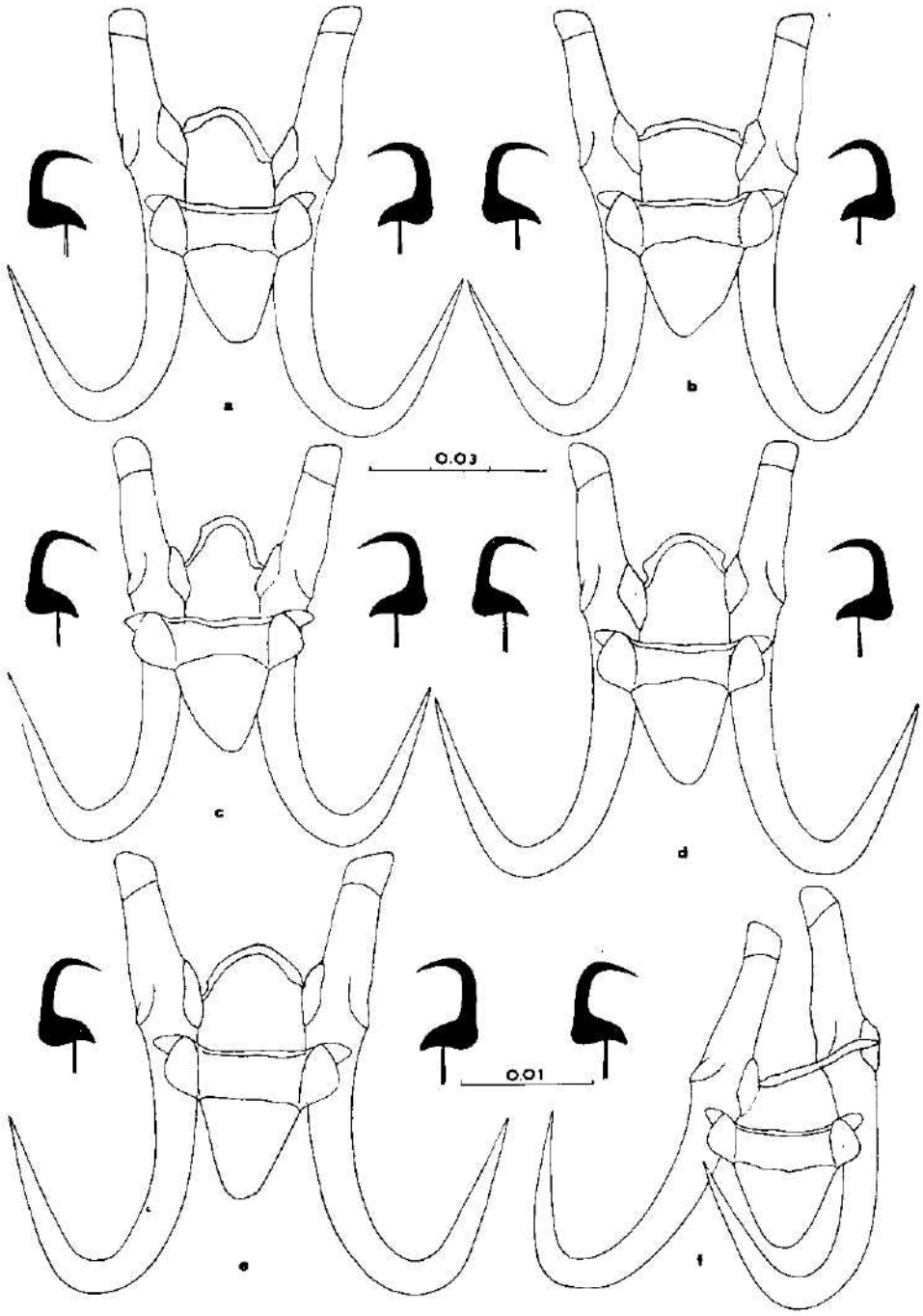


Fig. 1. Hard parts of opisthaptor of *G. luciopercae* Gussev, 1962. a, b — syntypes from the fins of *Stizostedion luciopercae* (Volga River near Zelenga, USSR, legit. Gussev, June 3, 1954); c — specimen from the fin of *S. lucioperca* (Vranov Reservoir, Czechoslovakia, legit. author, September 24, 1956); d — specimen from the fin of *S. lucioperca* (Ural River, USSR, legit. Roytman, May 11, 1974); e — specimen from the fin of *Perca fluviatilis* (Luzhnice River, Czechoslovakia, legit. author, May 21,

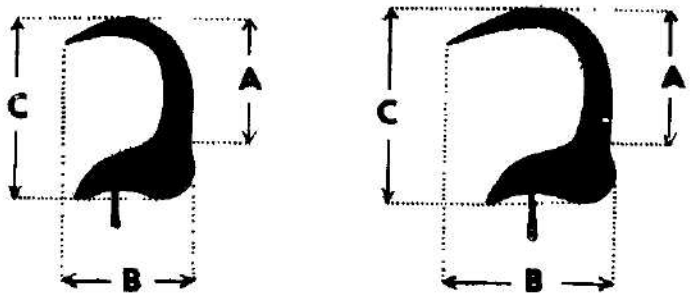


Fig. 2. Scheme of measurements of the hook proper of the marginal hooks. A – lenght of the part designated as "Krallenhaken" by Glaser (1974) and "blade" by Gussev (1976); B – maximum width; C – maximum length.

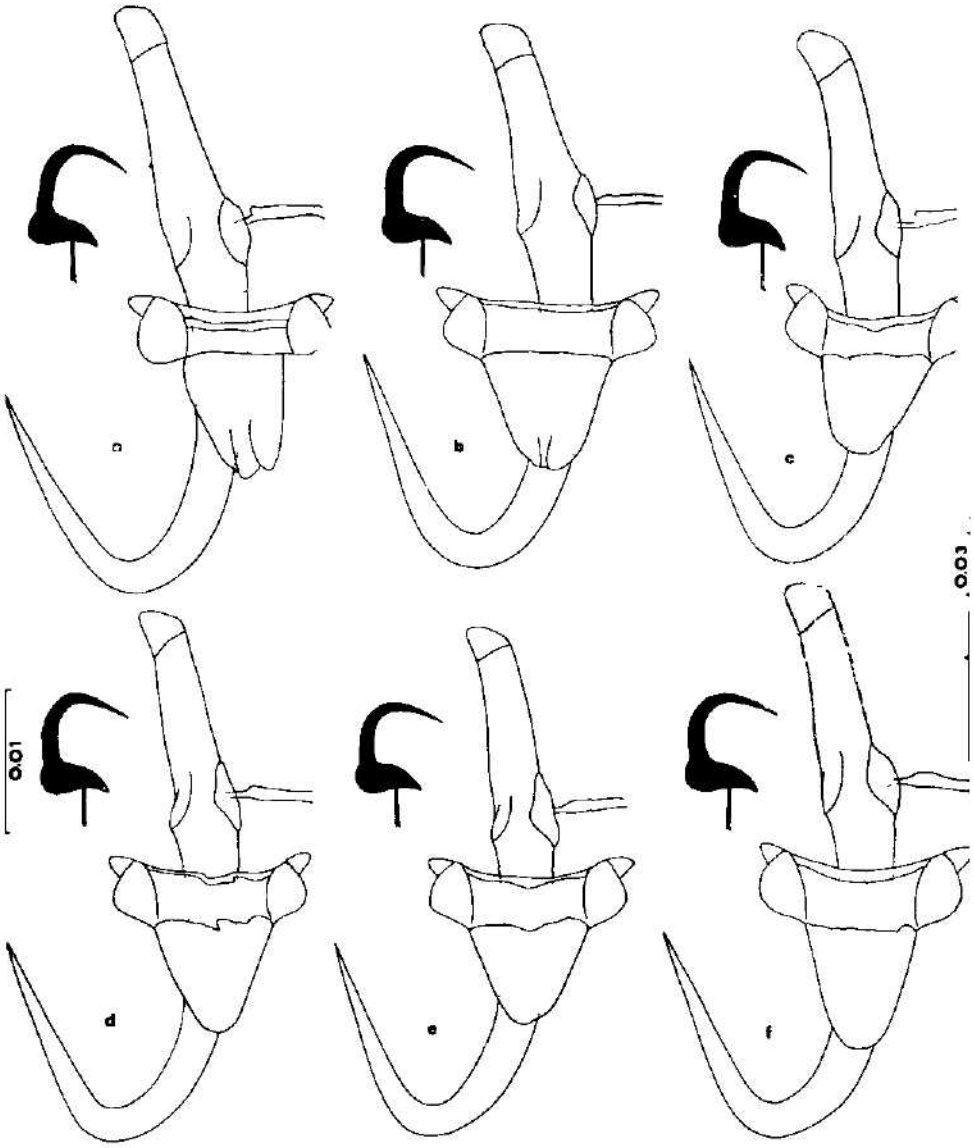


Fig. 3. Hard parts of opisthaptor of *G. longiradix* Malmberg, 1957. a — syntype (adapted from Malmberg 1957); b — specimen from the gills of *Acerina cernua* Lake Tavatuy, USSR, legit. Kashkovsky, May 21, 1967); c — specimen from the fin of *Acerina cernua* (Vasyugan River, USSR, legit. Bocharova, June 11, 1973); d, e — specimens from the fins of *Acerina cernua* (Luzhnice River, Czechoslovakia, legit. author, May 20, 1964); f — specimen from the skin of *Perca fluviatilis* (Lake Bolshoye Kasli, USSR, legit. Kashkovsky, May 17, 1970).

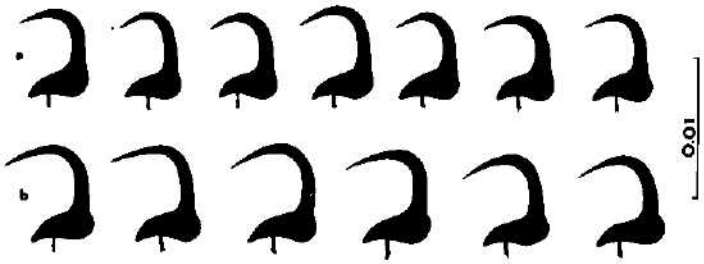
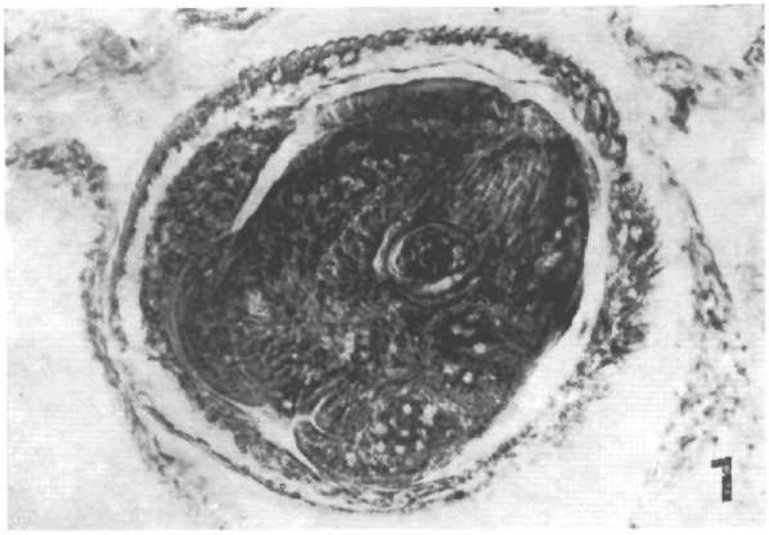


Fig. 4. Comparison of the shape of hook proper of marginal hooks of *G. luciopercae* Gussev, 1962 (a) and *G. longiradix* Malmberg, 1957 (b).



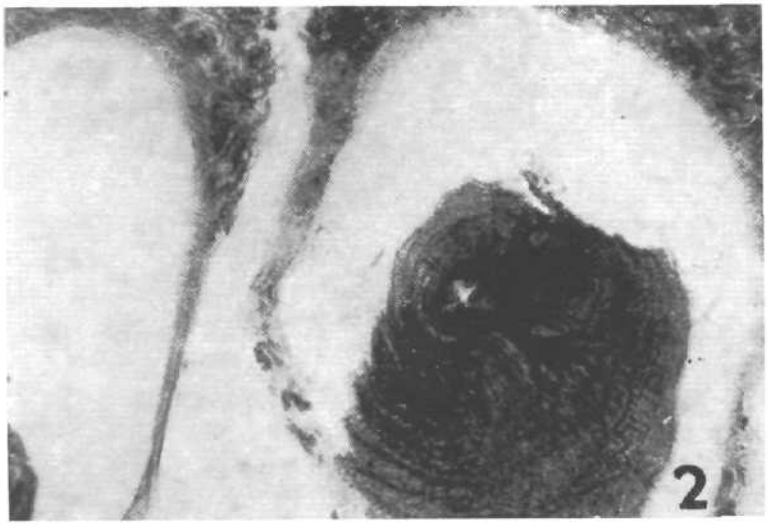


Plate I
Fig. 1. Longitudinal section through cysticercoid. Longitudinal connective tissue fibres are visible in the cyst tegument. Haematoxylin-eosin. (× 200).
Fig. 2. Tangential section through tegument at place of cyst invagination. Gomori. (× 300).

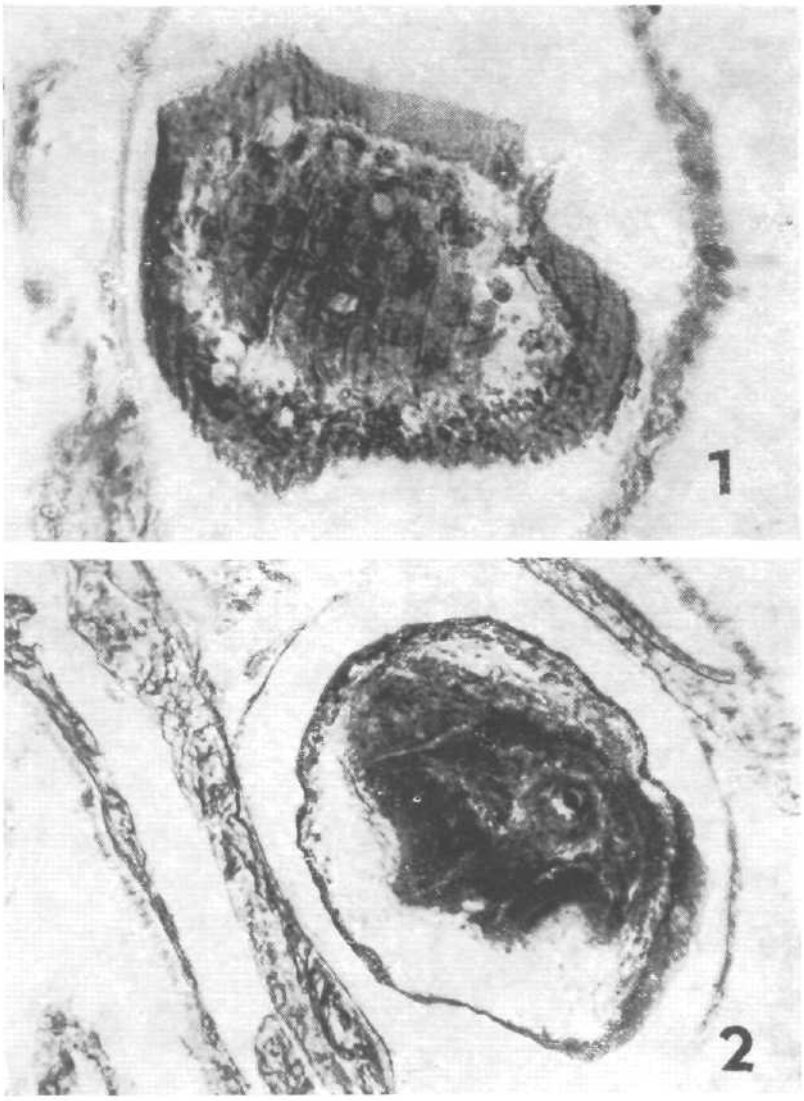


Plate II
Fig. 1. Tangential section through cyst. Connective tissue fibres of tegument on margins, circular and longitudinal connective tissue fibres of subtegument in the middle. Gomori. (× 370).
Fig. 2. Tangential section at place of rostellum invagination. Gomori. (× 220).