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ZUR KENNTNIS DER TESTACEEN (RHIZOPODA, TESTACEA) ALGERIENS

Vladimír BALÍK

Eingegangen am 20. Juni 1985

Abstract. In 5 samples of soil and 1 sample of mosses from Algeria 53 species, varieties and forms of Testacea were found. 32 out of them are new for Algeria and 5 for Africa. The representatives of Euglyphidae and Centropyxidae were most common

EINLEITUNG

Im Jahr 1983 gewann ich von Ing. V. Krištůfek aus unserem Institut 5 Bodenproben und 1 Moosprobe aus Algerien. In diesem Beitrag werden die Testaceen aus diesen Proben bearbeitet.

Es wurden viele Arbeiten über die Testaceen Afrikas veröffentlicht, die Fauna bleibt aber noch wenig bekannt. Die erste Arbeit über die Rhizopoden aus Afrika stammt von Penard (1911). Van Oye (1931) publizierte eine Arbeit über die Rhizopoden aus Südafrika und im Jahr 1944 eine weitere über die geographische Verbreitung der Rhizopoden in Afrika. Decloitre hat den grössten Anteil an der Kenntnis der Testaceen aus diesem Kontinent. In der Zeitspanne von 1947 bis 1970 publizierte er zahlreiche Arbeiten über die Rhizopoden aus verschiedenen Regionen dieses Kontinents (z. B. Decloitre 1947; 1970 a, b; usw.). Weiter beschäftigten sich mit dieser Tiergruppe in Afrika z. B. Bonnet (1960), Couteaux (1975; 1976; 1978), Golemansky (1962 a, b; 1963 a, b), Štěpánek (1963) und weitere Verfasser.

Mit der Testaceenfauna Nordafrikas haben sich Bonnet (1960), Decloitre (1961; 1970 a, b), Gauthier-Lievre (1953), Gauthier-Lievre und Thomas (1958; 1960) und Thomas (1958) befasst.

MATERIAL UND FUNDORTEN

Probe Nr. I: Nord Algerien, Kabyli (Küsten Atlas), Djurdjura, 1800 — 1900 m ü. S., junger Zederwald mit starker Streuschicht, Rendsinaboden 0 — 5 cm tief, 21. 4. 1983.

Probe Nr. II: Ibid., Rendsinaboden 5 — 10 cm tief, 21. 4 1983.

Probe Nr. III: Ibid., Moosprobe von Felsenoberfläche, 21. 4. 1983.

Probe Nr. IV: Zentral Algerien, etwa 700 km südlich von Alger, Oase El Golea, am Ufer des Bewässerungskanals in der Palmerie, Bodenprobe unter *Juncus* sp., 2 5. 1983.

Probe Nr. V: Nord Algerien, etwa 450 km südostlich von Alger, Oase Toughou am Ufer eines ungepflegten Bewässerungskanals in der Palmarie, Probe von Sandboden mit *Juncus* sp., 5. 5. 1983.

Tabelle 1. Die Vertretung einzelner Arten in den untersuchten Proben
($^{+}$ neu für Algerien, $^{++}$ neu für Afrika)

	Probe Nr.					
Art	I	II	III	IV	V	VI
Thecamoeba terricola Greeff, 1866	—	5	—	—	—	—
Microcorycia corona Penard, 1902^{+}	4	—	—	—	—	—
Microcorycia corona var. *simplex* Penard, 1902^{+}	5	—	—	—	—	—
Microcorycia flava (Greeff) Cockerell, 1866	3	—	—	—	—	—
Arcella catinus Penard, 1890	2	—	—	—	—	—
Arcella rotundata var. *aplanata* Deflandre, 1928^{+}	3	—	—	—	—	—
Centropyxis aerophila Deflandre, 1929	1	2	2	—	—	—
Centropyxis aerophila var. *constricta* Decloitre, 1961^{+}	—	—	—	—	—	4
Centropyxis minuta Deflandre, 1929^{+}	3	—	—	—	—	—
Centropyxis orbicularis Deflandre, 1929^{+}	—	3	—	—	—	—
Centropyxis plagiostoma Bonnet et Thomas, 1955^{+}	—	2	2	—	—	—
Centropyxis sylvatica v . *minor* Bonnet et Thomas, 1955^{+}	—	3	—	—	—	—
Centropyxis vandeli Bonnet, 1958^{+}	4	—	—	—	—	—
Centropyxis ventricosa Bartoš, 1963^{++}	5	—	—	—	—	—
Cyclopyxis kahli Deflandre, 1929	2	3	—	—	—	—
Cyclopyxis kahli var. *cyclostoma* Bonnet at Thomas, 1960^{+}	—	4	4	—	—	—
Cyclopyxis sexangularis Decloitre^{+}	—	—	—	—	5	—
Bullinularia indica (Penard, 1907)$^{+}$	3	3	3	—	—	—
Schwabia robusta Chardez, 1964^{++}	—	4	5	—	—	—
Pseudawerinzewia calcicola Bonnet, 1959^{+}	—	3	4	—	—	—
Plagiopyxis callida Penard, 1910	3	3	3	—	—	—
Plagiopyxis labiata Penard, 1910^{+}	—	3	4	—	—	—
Difflugia lucida (Penard) Jung, 1942	2	—	—	—	—	—
Difflugia rubescens Penard, 1891^{+}	4	—	—	—	—	—
Nebela collaris (Ehrenberg) Leidy, 1879	3	—	—	—	—	—
Nebela tincta f. *stenostoma* Jung, 1942^{+}	3	—	—	—	—	—
Nebela wailesi Deflandre, 1936^{+}	2	—	—	—	—	—
Quadrulella symmetrica (Schulz) Wallich, 1863	3	—	—	—	—	4
Heleopera petricola var. humicola Bonnet et Thomas, 1960	—	3	4	—	—	4
Heleopera sylvatica Penard, 1902^{+}	2	—	—	—	—	—
Phryganella acropodia (Hertwig et Lesser) Hopkinson, 1909	—	1	1	—	—	1
Phryganella acropodia var. *penardi* f. *alta* Schönborn, 1964^{++}	—	—	—	—	4	—
Wailesella eboracensis (Wailes) Deflandre, 1928^{+}	4	—	—	—	—	—
Euglypha compressa Carter, 1864	3	—	—	—	—	—
Euglypha denticulata Brown, 1912^{+}	—	4	—	—	—	—
Euglypha laevis (Ehrenberg) Perty, 1840	1	—	—	2	2	1
Euglypha rotunda Wailes et Penard, 1911	1	1	2	2	1	1
Euglypha strigosa var. *glabra* Wailes, 1911^{+}	2	—	—	3	3	2
Euglypha strigosa var. *muscorum* Wailes, 1911^{++}	3	—	—	—	—	—
Euglypha tuberculata Dujardin, 1841	—	3	3	—	4	—
Assulina muscorum Greeff, 1888	1	2	—	—	—	—
Assulina muscorum var. *denticulata* Chardez, 1964^{+}	3	—	—	—	—	—
Assulina seminulum (Ehrenberg) Leidy, 1848	2	—	—	—	—	—
Trinema complanatum Penard, 1890	1	1	2	1	1	2
Trinema complanatum var. *aerophila* f. *punctata* Decloitre 1961^{+}	4	—	—	—	—	—
Trinema complanatum var. *globulosa* Chardez, 1959^{+}	—	4	5	—	—	—
Trinema cornuta Decloitre, 1961^{+}	—	5	5	—	—	—

Art	Probe Nr.					
	I	II	III	IV	V	VI
Trinema enchelys (Ehrenberg) Leidy, 1878	1	1	1	—	—	—
Trinema grandis (Chardez) Golemansky, 1963^{+}	4	—	—	—	—	—
Trinema lineare Penard, 1899	—	2	2	2	—	—
Trinema lineare var. *terricola* Decloitre, 1962^{+}	—	4	5	—	—	—
Corythion dubium Taránek, 1881	1	3	3	—	—	4
Corythion renistoma Decloitre, 1970^{++}	—	—	—	5	—	—
Insgesamt	33	25	19	6	7	9

Probe Nr. VI: Nord Algerien, Kabyli (Küsten Atlas), Djurdjura, der Teil von Tela Gilef, 1900 m ü. S., sehr nasse Bodenprobe von dem Rande eines Schneetälchen, 28. 4. 1983.

FAUNISTISCH — ÖKOLOGISCHER TEIL

In Tab. 1 ist die Verteilung einzelner Arten in den untersuchten Proben angegeben. Die Reichlichkeit einzelner Arten wird in den Proben wie folgt angegeben: 1 — sehr häufig, 2 — häufig, 3 — vereinzelt, 4 — selten, 5 — sehr selten.

Tabelle 2. Die Vertretung der Familien in den untersuchten Proben

Familie	Probe Nr.					
	I	II	III	IV	V	VI
Thecamoebidae	—	+	—	—	—	—
Cochliopodiidae	+	—	—	—	—	—
Arcellidae	+	—	—	—	—	—
Centropyxidae	+	+	+	—	+	+
Plagiopyxidae	+	+	+	—	—	—
Difflugiidae	+	—	—	—	—	—
Nebelidae	+	+	+	—	—	+
Reticulobosa	+	+	+	—	—	+
Euglyphidae	+	+	+	+	+	+

Tabelle 2 bietet einen Überblick über die Vetretung von Testaceenfamilien in den Proben.

Insgesamt wurden in allen Proben 53 Testaceenarten, Varietäten und Formen festgestellt. Von diesen Arten sind 32 neu für Algerien.

Die Arten *Centropyxis ventricosa, Corythion renistoma, Euglypha strigosa* var. *muscorum, Phryganella acropodia* var. *penardi* f. *alta* und *Schwabia robusta* sind neu für Afrika.

Von den festgestellten Familien waren Euglyphidae mit 20 Arten und Centropyxidae mit 14 Arten am reichsten.

Die grösste Anzahl der Arten wurde in den Proben I, II und III (stark humosen Bergrendsinen) festgestellt. Die ärmste war die Probe IV (Sandboden). Diese Probe war am artenarmsten und hat die niedrigste Individuenzahl gehabt.

TAXONOMISCHER TEIL

Hier sind nur die für Afrika neue und einige weitere, interessante Arten beschrieben.

Centropyxis ventricosa Bartoš, 1963 (Abb. 1 a, b)

Beschreibung: Schale von unten oval, aus groben Mineralmaterial gebaut. Hinterende fast kugelig. Pseudostom oval mit zackigem Rand. Aus der Hinterseite greift in das Pseudostom eine Platte von feinen Mineralmaterial ein.

Dimensionen: Länge 96—103 μm, Breite 58—60 μm, Höhe des Hinterendes 65—70 μm, Höhe des Verderendes 20—23 μm.

Geographische Verbreitung: Java (Bartoš), neu für Algerien.

Ökologie: Lebt in Moos auf festem Grund (Felsen, grosse Steine, Baumstämme).

Corythion renistoma Decloitre, 1970 (Abb. 2)

Beschreibung: Schale wie bei *Corythion dubium*. Unterschied lediglich durch die Pseudostomgestalt, die bei *C. renistoma* nieren- oder bohnenförmig ist.

Dimensionen: Länge 29—31 μm, Breite 11—13 μm.

Geographische Verbreitung: Frankreich (Decloitre), neu für Algerien.

Ökologie: stehendes Wasser, untergetauchte oder sehr nasse Moose und Sphagnen.

Euglypha strigosa var. *muscorum* Wailes, 1911 (Abb. 3)

Beschreibung: Breitovale oder eiförmige Schale durch ovale Plättchen gebaut. Pseudostom ringherum durch 10—14 Plättchen mit 5—7 Zähnen gesaumt. Schale dünn mit kurzen Stacheln bedeckt.

Dimensionen: Länge 45—58 μm, Breite 35—50 μm, Stachelnlänge 2—4 μm.

Geographische Verbreitung: England (Wailes), U.S.A. (Leidy), Brasilien (Wailes), Seychelln (Wailes), neu für Algerien.

Ökologie: Moosart.

Phryganella acropodia var. *penardi* f. *alta* Schönborn, 1964 (Abb. 4 a, b)

Beschreibung: Schalen rund (von unten), bei Seitenansicht kegel- oder hutförmig, vom feinen Mineralmaterial gebaut, lediglich beim Pseudostom grössere flache Mineralsplitterchen, braun-gelblich bis braun.

Dimensionen: Schalendurchmesser 26—29 μm, Höhe 72—79 μm, Pseudostomdurchmesser 14—16 μm.

Geographische Verbreitung: Deutschland (Schönborn), neu für Algerien.

Ökologie: Bodenart.

Schwabia robusta Chardez, 1964 (Abb. 5)

Beschreibung: Eiförmige regelmässige Schale im Querschnitt rund mit verschiedenen grossen Mineralsplitterchen bedeckt. Pseudostom relativ klein, unregelmässig lappig und am engeren Pol angebracht.

Dimensionen: Länge 147—152 μm, Schalendurchmesser 75—80 μm.

Geographische Verbreitung: Belgien (Chardez), neu für Algerien.
Ökologie: Bodenart.

Cyclopyxis sexangularis Decloitre, 1961 (Abb. 6a, b)

Beschreibung: Schale von unten hexagonal, im Querschnitt halbkugelig, von der organischen Kittmasse gebildet. An dieser Kittmasse kleine Mineralfragmente und Detritus angebracht, braunlich bis hellbraun. Pseudostom rund mit expressivem Besatz.

Dimensionen: Länge der Hexagonkante 17—19 μm, Pseudostomdurchmesser 21—22 μm, Höhe 26—29 μm.

Geographische Verbreitung: Tunis — Insel Djerba, Portugal (Decloitre), neu für Algerien.

Ökologie: Moosart.

Trinema cornuta Decloitre, 1961 (Abb. 7)

Beschreibung: Schalen charakteristisch für Gattung Trinema, farblos bis gelblich gefärbt und mit ovalen Plättchen bedeckt. Für die Schalen dieser Art kurze starke Stacheln am Schalenrand charakteristisch. Pseudostom fast rund.

Dimensionen: Länge 60—64 μm, Breite 32—37 μm.

Geographische Vebreitung: Marokko, Frankreich (Decloitre), Antarktis (Sudzuki), neu für Algerien.

Ökologie: Boden- und Moosart.

ZUSSAMENFASSUNG

Insgesamt wurden in den 6 Proben 53 Testaceenarten, Varietäten und Formen gefunden, davon 32 Arten neu für Algerien und 5 Arten neu für Afrika. Am häufigstem wurden die Familien Euglyphidae und Centropyxidae vertreten.

Danksagung

Für die mir zur Verfügung gestellten Proben aus Algerien bin ich Herrn Kollegen Ing. V. Krištůfekk (České Budějovice) sehr verbunden.

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Die Abbbildungen sind am Ende des Heftes zu finden.

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TAXONOMIC STUDY ON THE GREY WAGTAIL, MOTACILLA CINEREA (AVES, PASSERIFORMES)

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Received June 29, 1985

Abstract. This paper deals with the intraspecific systematic division of the species *Motacilla cinerea* Tunstall, 1771, and tries to solve the question of the subspecific separation of its easternmost populations. Using modern statistic methods (regression analysis, cluster analysis, ordination), it summarizes characteristics of 530 prepared specimens (355 adult males, 175 adult females) from the whole area of distribution.

Throughout the area of the incidence of *Motacilla cinerea*, i. e. from the British Isles to the shores of the Pacific and adjoining islands, a clinal variability has been recorded of morphological signs characterized by their uninterrupted diminition from west to east. Thus, finishing the solution outlined by Vaurie (1959), this conclusion suggests that the area under consideration is inhabited by members of a single, nominate subspecies, *Motacilla cinerea cinerea* Tunstall, 1771. The subspecies *M. c. caspica* (Gmelin, 1774), *M. c. melanope* Pallas, 1776, and *M. c. robusta* (Brehm, 1857) are regarded as synonyms of the nominate subspecies. The population from the Azores and the Canary Islands form the independent subspecies, *M. c. patriciae* Vaurie, 1957, and *M. c. canariensis* Hartert, 1901. The birds from Madeira (*M. c. schmitzi* Tschusi, 1900) were not evaluated in this paper.

INTRODUCTION

Numerous authors have studied the taxonomic position of the species *Motacilla cinerea*, but it is still considerably doubtful as to how a systematic separation of the species should be made. The Grey Wagtail, of the order Passeriformes, is listed to the family Motacillidae comprizing 48 wagtail- and pipit species (Mayr and Amadon 1951). Its arrangement to this category is undoubtedly correct.

A problem in need of solution is the intraspecific separation of the species *Motacilla cinerea* into subspecific categories, of which opinions are often greatly divergent. A good example is the Mountain Grey Wagtail, an African species. Hartert (1933) regards it as a true subspecies with scientific name *Motacilla cinerea clara*, while Vaurie (1957) regards it as a good (valid) species. Similar differences exist in opinions on the geographical distribution of the individual subspecies.

Considerable confusion, with regard to a systematic separation of the Grey Wagtail, was caused by descriptions of several subspecies of an unclearly defined distribution, made in the 18th and the beginning of the 19th century (P. S. Pallas, S. G. Gmelin, Ch. L. Brehm). Later, various authors with differing views of the subject suggested in their revisions a large number of synonyms, and, moreover, described new subspecies on the basis of insignificant characters observed in a small number of specimens.

All data available on the intraspecific systematic position of the species *Motacilla cinerea* were summarized by Hartert (1910, 1933) and Vaurie (1959). Especially the latter author's paper brought results evaluated in great detail and based on the large material he obtained. A partial treatment of the individual subspecies was made by Kleinschmidt (1931), Bates (1934), Dementjev (1936), Witherby (1936), Vaurie (1957) and Irwin (1960).

The purpose of the present study is to amend and complement knowledge of the intraspecific classification of the species *Motacilla cinerea* on the basis of exact analysis of biometric data.

MATERIALS AND METHODS

Our treatment of the intraspecific systematics of the Grey Wagtail was made on the basis of a biometric evaluation of the morphological characters. Measurements were made of 530 skins of adult specimens of *Motacilla cinerea* (355 males, 175 females) collected during the nesting period over the entire area of its distribution, i. e. from the Azores to Japan, except the Madeira Island. The skins of treated specimens were obtained by courtesy of the following museums and institutions:

The British Museum, London
Forschungsinstitut Senckenberg, Frankfurt am Main
Naturhistoriska riksmuseet, Stockholm
Zoological institute AN SSSR, Leningrad
Zoological museum MGU, Moscow
Zoologische Staatssammlung des bayrischen Staates, München
Zoologisches Forschungsinstitut und Museum Alexander Koenig, Bonn
Transvaal Museum, Pretoria.

The most important characters used in a systematic evaluation of the Grey Wagtail were the following:

Wing length — measured from the a. carpometacarpi to the tip of the longest primary (Hudec 1963), whereby the wing was straightened out to its full length and pressed to the ruler in order to obtain maximum wing length. In my opinion this way of measurement renders the most accurate data for comparing these with a large set of data.

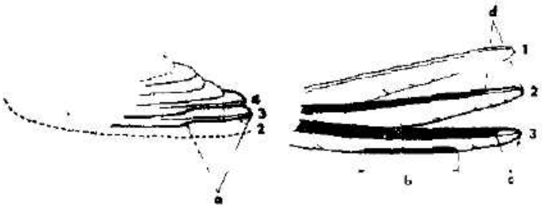

Fig. 1. Biometric characteristics of the wing and tail
a — length of emargination of outer web of 3rd primary,
b — length of dark border on inner web of 3rd rectrice,
c (d) — length of white tip of 3rd (2nd) rectrice.

Tail length — measured with a classical method (Záruba 1975) by using tail feathers in their natural position (in direction of body axis). They were measured from the base of the central pair of rectrices to the tip of the longest ones. Measurements were made of both wing- and tail length in range of accuracy up to 1 mm. Length of tarsus, first (posterior) toe and claw, length of bill from feathering and nostrils, depth and width of bill at the posterior end of nostrils. These all were measured with a method suggested by Hudec (1963) using a slide ruler (range of accuracy up to 0.1 mm).

Additional measurements were made of the length of the emargination of the outer web of the third and fourth primaries (Fig. 1 a), the length of the dark border on the inner web to the third (or first and second) restrice (Fig. 1 b), the length of the white tip of second and third rectrices (Fig. 1 c, d), also using a slide ruler (accuracy 0.1 mm).

Measurements of all paired organs were made on the left side of the bird's body. If damaged, we used the right side. If the whole skin was heavily damaged, we measured all undamaged organs only.

Three statistical methods were used for a complex data processing: regression analysis, cluster analysis and ordination, favoured mainly by the phytocoenological practice. For data processing, we used a set of programmes BMDP (Dixon et Brown 1977), and an IBM 370/135 computer.

The individual biometric characteristics and also a complex evaluation of all characters were related to the geographical longitude or to characteristic geographical units. Relationships with geographical latitude were not evaluated because of a relative narrowness of the area of distribution; the most northern parts of its area of distribution had been occupied fairly recently, within the last 50 to 100 years which is too short time for the development of more marked morphological differences.

For an interpretation of the results of the cluster analysis and ordination, the area of distribution of *Motacilla cinerea* was divided into nine subareas:

A — Azores (26 °W): 36 males and 14 females elaborated
C — Canaries (16—18 °W): 24 males, 13 females
GB — Great Britain (0—6 °W): 17 males, 4 females
C1 — Europe except GB ($<$28 °E): 86 males, 38 females
C2 — Near East, Ural Mts. (28—60 °E): 50 males, 29 females
C3 — Asian mountain systems (60—85 °E): 61 males, 31 females
C4 — Central Asia (85—110 °E): 28 males, 20 females
C5 — Asia from the Baikal Lake to the Pacific shores (110—139 °E) 37 m., 21 f.
C6 — Kamchatka, Kuriles, Sakhalin, Japan ($>$139 °E): 16 m., 5 f.

Relationship between the individual biometric characteristics and geographical longitude could well be assessed with a calculation of linear regression (BMDP 1R) characterized by these values:
b — regression coefficient, r — correlation coefficient, s — standard deviation. The significance of regression was testified with Student's t-test against the zero hypothesis ($b = 0$). Regression was calculated for specimens from the continent (including Great Britain and the Pacific islands), island populations (Azores and Canary Isles) were evaluated separately.

Further basic statistical symbols used were these: $\bar{x}$ — arithmetic mean, $s_{\bar{x}}$ = standard error, v — coefficient of variance (in %), min. — minimum, max. — maximum; the significance of differences in the two sets was tested with Student's t-test (significant for $P < 0.05$, highly significant for $P < 0.01$).
Indices at t-values (t_C, t_{GB} etc.) refer to the individual subareas (see above) with which the group of birds under consideration is being compared. Whenever statistically significant differences occurred in both sexes, characteristics (n, b, r, t) were given for the more numerous and, hence, more significant sets of males.

The cluster analysis (BMDP 2M) was used for determining the degree of similarity among specimens from various geographical regions of the area of distribution. Similarity measure (Fig. 3) was expressed in standardized Euclidean distances.

The influence of the individual biometric characteristics (signs) on a variability of the specimens in the area of distribution was determined with the ordination technique. An ordination of the individual objects was made on the basis of the principal component analysis (BMDP 4M).

AREA OF DISTRIBUTION

From the zoogeographical point of view the Grey Wagtail inhabits boreal, temperate, Mediterranean- and steppe zones of the Palearctic region, mountainous areas of NW-Africa, Europe (except central- and north Scandinavia), Asia Minor, the Near East, a wide strip of Siberia (roughly between 50—70 °N);

it covers the area from the Ural to the shores of the Pacific, with two projections into Nepal and China. The northernmost border passes through the July isotherm 12 °C (Voous 1962) (Fig. 2).

Its sole, confirmed nesting sites in Africa are the Atlas Mts. in N-Morocco and Algeria (Schütz et Weigold 1931, Dementjev et Gladkov 1954).

Reports on the incidence of the species cover the Pyrenean Peninsula (Boxberger 1934), the whole of Europe including Jutland (Jørgensen 1970), the Apennine Peninsula to about the western border of the U.S.S.R. which it enters, apparently, along the Carpathian Mts. in the SW-part of the Ukraine. In spite of a lack of factual data on the nesting of the species in the Ukraine (Dementjev 1936), summer records are available from this area (Zoological Museum, Moscow State University, Moscow). In the north, the species inhabits the southern part of the Scandinavian Peninsula up to 60 °N in Norway and 58 °N in Sweden (Dementjev et Gladkov l. c.). The southern border of its area of distribution in Europe is formed by the entire Balkan Peninsula (Niethammer 1950, Lieder et Luther 1969, Kanellis 1969) including the Peloponnesus (Niethammer 1943).

It continues through Asia Minor (Kummerlöwe et Niethammer 1934) to the Near East where the Tigris River provides the southern border of its area of distribution. Northwards, the Grey Wagtail inhabits the area between the Black- and the Caspian Sea, from the Lesser and High Caucasus Mts. to their northern piedmonts, and the isolated Crimean Mts. (Dementjev l. c., Stepanjan 1978). The most interesting part of the area of distribution of the Grey Wagtail is Iran. Owing to unsatisfactory climatic conditions (central Iranian desert), the distribution of the Grey Wagtail is most patchy. It occurs in the Zagross Mts. on the shore of the Persian Gulf (Paludan 1938), in the northern Elborz Mts. (Gmelin 1774, Stresemann 1928), and at Kopet-dag, a narrow "bridge" connecting the European and Asia Minor part of its area of distribution with the central- and east Asian part (Moreau 1972). Eastwards, the bridge widens into the mountain ranges of the Pamirs, Hindu-Kush, Tian-Shan and Ala-Tau (Ivanov 1976) thus including N-Afghanistan, the Soviet republics Tadzhikistan and SE-Kazakhstan, and the W-Chinese part of Turkestan (Vaurie 1959). In the south, it extends to Nepal along a projection of the Himalayas (up to 27 °N) (summer findings from the Zoologisches Forschungsinstitut Bonn) and to N-India through Kashmir and the Punjab (records of the British Museum, London). The area of distribution widens again beyond the Tarba-Gataj Mts. at the Balkhash Lake.

Its northern border passes through the western piedmont of the Altai, through the towns of Bijsk, Barnaul, Tomsk, Taru and Tobolsk, from where it turns back to the Ural Mts. and continues along its western piedmont to 68 °N to the Jamal Peninsula (Dementjev 1936). Then, the border turns eastwards, traverses the valley of the Taz River at 64 °N (Stepanjan 1978), covers the Putoran Mts. at 70 °N of the peninsula Taimyr (Ivanov 1976), crosses the valley of the Lena River, the Verkhojansk Mts. (at 68 °N), the valley of the rivers Indigirka and Kolyma (to 67 °N) and descends across the Kolyma Mts. to the Shelekhov Gulf of the Okhotsk Sea. According to Stepanjan (1978), the Kazakh part of the northern border lies more to the south (at 50 °N) including also the Balkhash Lake, while Shnitnikov (1949) maintains that the Grey Wagtail does not reach the Balkhash Lake, but the mountain range east of this lake. Another fact opposed to Stepanjan's (1978) statement are unsatisfactory geomorphological and climatic conditions (extensive semideserts) in N-Kazakhstan. On the other hand, Steinbacher (1927) suggests a complete isolation of the Ural population from that of W-Siberia, and regards an occasional summer incidence of Mountain Grey Wagtails along the rivers Small and Northern Sosna as a population connecting the Ural Mts. with central Siberia, in contrast to authors whom I gave preference in the layout of the areas of distribution (Ivanov 1976, Stepanjan 1978).

In Kamchatka, the nesting area of the Grey Wagtail reaches 60 °N. (Stepanjan 1978, Lobkov 1978). It does not reach the American Continent over a relatively narrow strip of the Pacific and the chain of the Aleutian Islands (Irving 1960).

The southern border passes through N-Mongolia (a system of the Altai- and Sayan mountain ranges) up to the upper reaches of the Amur River (Stegmann 1931) and along it up to 130 °E, then turning southwards to the Yellow Sea. Included in this area is the entire Korean Peninsula (Ivanov 1976). Opinions of the distribution of the Grey Wagtail on this peninsula differ. According to Vaurie (1959), the bird species colonizes solely its northern mountain ranges.

From the area of the Gulf of Liao-tung, the border is formed by a narrow promontory into China up to the mid-reaches of the Yang-tse-tiang River (26 °N) in the province S'tchuan (Dementjev et Gladkov l. c., Steinbacher 1927), including the Liao-ning Mts., the N-Chinese Uplands and the eastern part of the Chin-ling-shan. Since climatic and geomorphological conditions are satisfactory, the two projections of the area of distribution (the Himalayan and the Chinese) appear to contact each other roughly along the Brahmaputra River, thus encompassing the upper Tibetian plain. In contrast to this opinion, Voous (1962) regards the heavy competition of various species of the genus *Enicurus* (birds of the family *Turdidae* which are similar to the wagtails) colonizing in these parts the habitat of the Grey Wagtail, as a serious obstacle preventing its colonization of the strip along the southern piedmont of the Tibet.

Data on the distribution of the species throughout the continents of Africa, Furope and Asia have been complemented with those on island populations. The westernmost nesting sites are the Azores (25—30 °W), then follow the Madeira Island, the west- and central Canary Islands, Great Britain (Sharrock 1971), Ireland and the Orkney Islands (Steinbacher 1927), Corsica and Sicily (Orlando 1940), and apparently Sardinia (Vaurie 1959, Dementjev et Gladkov 1954), although Stresemann (1955) did not find them there.

In the east, the Grey Wagtail inhabits the Sakhalin Island (Stepanjan l. c.), the Kuriles and Japan (Dementjev et Gladkov l. c., Portenko 1960). The easternmost nesting sites are the Commander Islands (Dementjev 1936).

Other islands reported as nesting sites of the Grey Wagtail are: the Åland Island in the Gulf of Bothnia (Vaurie 1959), and even the Varanger Peninsula (71 °N) in northern Norway (Essen 1941). Dementjev et Gladkov (l. c.) suggest that the species nests on Taiwan.

WINTERING LOCALITIES AND MIGRATION

There is a rule of general validity for the migration of the Grey Wagtail: the higher up north the species nests, the lower down south it migrates (Tyler 1979). The rule does not apply to populations of Great Britain, Ireland and the Orkneys because these migrate only within the British Isles (Sharrock 1969) except for an occasional cross-Channel flight to the Continent (Zink 1975). A similar situation occurs, apparently, on the Azores, the Canary- and Madeira Islands (Hartert 1910, Vaurie 1959). Tyler (l. c.) reports non-migrating populations even from Belgium and the Mediterranean (Fig. 2).

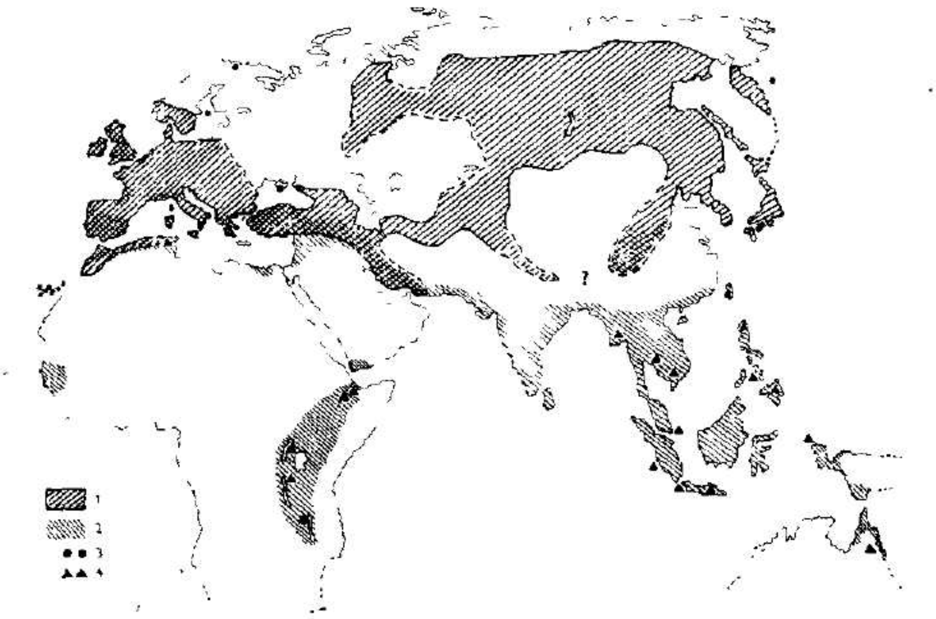

Fig. 2. Area of the distribution of *Motacilla cinerea* and its winter localities (reconstruction made on the basis of the cited literature and specimens from the collections of the museums listed in text)
1 — breeding area, 2 — winter localities, 3 — solitary breeding reports, 4 — winter findings.

The migratory routes of the Grey Wagtail nesting in Europe are to the southwest and southeast. However, the border between the two different migratory routes are not known.

The Czechoslovak populations follow the SW-route. They overwinter in the south and the southwest of France, and on the Pyrenean peninsula. Of Czechoslovak origin are the two solitary European records of an overwintering on the African Continent (Algeria). Of an unknown origin are the birds overwintering in Senegal and Gambia (Moreau 1972). According to Zink (1975), birds may occasionally fly deep into the Sahara.

The assumed SE-route of migration has been confirmed by observations of the spring migration of the Grey Wagtail from the shores of Asia Minor to the Black Sea-islands in the Danube delta (Drost 1930), and on a regular throughflight and overwintering in Greece (Kanellis 1969). This migratory route seems to be preferred by populations from the Balkan Peninsula.

According to Dementjev et Gladkov (1954), birds from Asia Minor or the Near East either do not migrate, or migrate only to the valleys of the rivers Tigris and Euphrates. Heuglin (1869) observed birds, both in spring and in autumn, in Egypt. Moreau (1972), having observed also a migration of the birds across the southern tip of the Red Sea, suggests that these populations overwinter in E-Africa, from Somaliland to the big African lakes (to about 15 °S). This has been supported by reports of several birds shot in Ethiopia (regarded as a wintering place by Schütz et Weigold 1931), Eritrea (in the collection of the Naturhistoriska riksmuseet, Stockholm and the Zoologisches Forschungsinstitut, Senckenberg), and by observations from African lakes in W-Uganda (Friedmann et Williams 1970), in NE-Congo (Verheynen 1956), the NE-bank of Lake Tanganyika (Sclater et Moreau 1932) and N-Malawi (Dent et Benson 1966). Also Zink (1975) suggests a possible overwintering of birds from SE-Europe in this area. Also the wintering place in the SW-Yemen in the Arabian Peninsula lies on the migratory route: Near East-Somaliland (Grote 1930).

There is nothing known of the migratory routes of the W-Siberian populations. According to Dementjev et Gladkov (1954), they overwinter on the Indian Peninsula (also suggested by Hutton 1948) and in Ceylon. Whistler (1923) maintains that also birds from the Himalayas migrate to the lowlands of India. Absolutely nothing is known of the Ural populations but their migratory flight may be confined to these mountain ranges only.

The migratory routes of wagtails from E-Siberia and the Pacific shore Portenko 1960) can be derived from an evaluation of records of winter-shot birds in SE-Asia and the Sunda Islands. Their wide, migratory route leads from Thailand, Cambodia, Vietnam (records from the NR, Stockholm) and the Philippines (FI, Bonn) via Sumatra (NR. Stockholm) and adjacent islands (Gill 1969), Java (FI, Bonn), Borneo and New Guinea (NR, Stockholm) to the N-Australian Queensland (confirmed by Gill 1970 only at the town of Innisfail −17 °S). Yen (1934) regards part of the Chinese population as non-migratory.

However, a small part of the population overwinters always either in, or close to, the nesting site (Lunde 1968, Zink 1975) which accounts for an extremely wide range of wintering places (about 70 °), extending from S-Scandinavia to the African state of Malawi.

SYSTEMATIC POSITION OF THE SPECIES MOTACILLA CINEREA

The first description of the Grey Wagtail was made by the English ornithologist M. Tunstall in 1771 (Ornithologia Britannica; p. 2), and the species was given the scientific name *Motacilla cinerea:* type specimen from the British Isles (Wyclife, Yorkshire). The name is one of the four valid names in the cited volume of Ornithologia Britannica (Salomonsen 1964). In older papers, the name has often been replaced by nowadays invalid synonyms:

Motacilla boarula Linnaeus, 1771 (Mant. Plantarum; p. 527)
Parus caspicus Gmelin, 1774 (Reise durch Russland 3; p. 104)
Motacilla grisea Müller, 1776 (Natursystem, suppl ; p. 175)
Motacilla melanope Pallas, 1776 (Reise durch versch. Prov. des Russ. Reichs; p 606)

Motacilla sulphurea Bechstein, 1807 (Gemein. Naturgesch. Deutschlands, 3; p. 459)
Motacilla bistrigata Raffles, 1820 (Trans. Lin. Soc. London, 13; p. 312)
Motacilla montium Brehm, 1831 (Handb. Naturgesch. Vögel Deutschlands; p. 345)
Motacilla xantoschista Hodgson, 1844 (Zool Misc.; p. 83)
Motacilla lindermayeri Brehm, 1845 (Okens Isis; p. 341)
Pallenura javensis Bonaparte, 1850 (Consp. Av. 1; p. 250)
Motacilla montana Brehm, 1855 (Vogelfang; p 143)
Motacilla rivalis Brehm, 1855 (Vogelfang; p. 143)
Pallenura robusta Brehm, 1857 (J. Orn., 5; p 32)
Budytes novaeguineae Meyer, 1857 (Sitzungsber. Isis Dresden; p. 74)

Owing to the morphological variation of the polytypical species *Motacilla cinerea* in the various geographical regions of its area of distribution, the species has been divided into a number of subspecies, of which three, i. e. *M. cinerea canariensis, M. c. schmitzi* and *M. c. patriciae* are typical insular subspecies. A major part of the other subspecies occur mostly on the continent: *M. c. cinerea, M. c. caspica, M. c. melanope* and *M. c. robusta.*

Mountain Grey Wagtails from the Ethiopian zoogeographical zone, which Hartert (1933) regards as a subspecies of the Palearctic Grey Wagtail, *M. cinerea clara* (central and S-Africa), and *M. c. flaviventris* (Madagascar), have later (Vaurie 1957) received the statute of independent species under the names *Motacilla clara* Sharpe, 1908 (Ibis; p. 341) and *Motacilla flaviventris* Hartlaub, 1860 (J. Orn.; p. 94).

The concepts of the various authors vary considerably with regard to the distribution of the subspecies:

Motacilla cinerea cinerea Tunstall, 1771
Terra typica — Great Britain (Wyclife, Yorkshire).

Synonyms — *Motacilla boarula boarula* Linnaeus, 1771 (Sweden); *Motacilla grisea* Müller, 1776 (Great Britain); *Motacilla sulphurea* Bechstein, 1807 (Germany), *Motacilla lindermayeri* Brehm, 1845 (Greece); *Motacilla montana* Brehm, 1855 (Germany); *Motacilla rivalis* Brehm, 1855 (Germany).

According to Bates (1934), the subspecies is confined in its incidence to the British Isles and Ireland; winter migrations occur solely within these isles.

Dementjev et Gladkov (1954) and Portenko (1960) placed the eastern border of distribution of this subspecies into the Elborz Mts. at the southern tip of the Caspian Sea. Hence, the area of distribution of the subspecies is formed by N-Africa, Europe, Asia Minor, the Crimean Peninsula and the Caucasus Mts. Vaurie (1959) regards the Hentey Mts. in N-Mongolia (roughly at the level of the Baikal Lake) as the eastern border of its distribution.

Motacilla cinerea caspica (Gmelin, 1774)
Terra typica — N-Iran (Enzeli, Gilan).

Synonym — *Parus caspicus* Gmelin, 1774

Bates (1934) regards this subspecies as a transitory form between *M. c. cinerea* and *M. c. melanope*, with a distribution area starting in N-Africa, covering Europe (except the British Isles), Asia Minor and the Caucasus, and from there to W- and Central Asia, where it merges smoothly with *M. c. melanope.*

Vaurie (1959) and Dementjev (1936) have placed this in synonymy with the nominate race *M. c. cinerea.*

Motacilla cinerea melanope Pallas, 1776
Terra typica — U.S.S.R. (Daurie, upper Amur region).

Synonyms — ***Motacilla melanope*** Pallas, 1776, ***Motacilla bistrigata*** Raffles, 1820 (Sumatra); ***Motacilla xantoschısta*** Hodgson, 1844 (Nepal); ***Pallenura javensis*** Bonaparte, 1850 (Java); ***Budytes novaeguineae*** Meyer, 1857 (New Guinea).

According to Bates (1934), the subspecies colonizes E-Siberia and the Pacific shore including all adjacent islands. Dementjev et Gladkov (1954) and Hartert (1910) maintain that the area of distribution of this subspecies covers all populated areas east of the Elborz Mts. in N-Iran. Dementjev et Gladkov (l. c.) have listed the Ural population to this subspecies, Hartert (1910) has added also birds from the Caucasus. Portenko's (1960) description of the area of distribution of the subspecies is in agreement with that given by the afore mentioned authors, with the exception of the shore of the Pacific and the adjacent islands which he regards as the area of distribution of another subspecies, i. e. *M. c. robusta*. Vaurie (1959) again lists this subspecies to the synonyms of *M. c. cinerea*.

Motacilla cinerea robusta (Brehm, 1857)
Terra typica — Japan.

Synonyms — *Pallenura robusta* Brehm, 1857.

Although Vaurie (1959) regards this subspecies as "less good" than the foregoing subspecies *M. c. cinerea*, he recognizes its validity. According to this author, the distribution area of the subspecies stretches over Kamchatka, E-Siberia (area of the Okhotsk Sea), Sakhalin, E-Amur region, N-China and Korea, the Kuriles and Japan. Vaurie's (1959) opinion is shared by Portenko (1960).

All the afore-mentioned subspecies differ from the type specimen (Great Britain) in tail length: the more eastwards, the shorter the tail. An exception, in term of coloration, are the two subspecies — *M. c. melanope* and *M. c. robusta*. For the former, Hartert (1910) reports a high frequency of a brown colour on the inner web of the third rectrice, for the latter both Vaurie (1959) and Portenko (1960) report a richer yellow colour on the ventral side of the body and deeper black spots on the throat of the male, in comparision with those of European birds. Dementjev (1936) observed a similar caloration in some specimens of the European subspecies *M. c. cinerea*.

Motacilla cinerea canariensis Hartert, 1901
Terra typica — Canary Islands (Esperanza, Tenerife)

Synonym — ***Motacilla boarula canariensis*** Hartert, 1901 (Novit. Zool., 8; p. 322).

The subspecies inhabits west- and central parts of the Canary Islands. Hartert (1910) later expressed doubts about the validity of his original description and placed it again in the nominate subspecies *M. c. cinerea*, in contrast to Vaurie (1959) who recognized its independent subspecific statute. Characteristic of the race is a brightly white supercilium, a slate-grey colour of the mantle, a darker and richer yellow colour of the ventral body side (Vaurie 1959).

Motacilla cinerea schmitzi Tschusi, 1900
Terra typica — Madeira Island

Synonym — *Motacilla boarula schmitzi* Tschusi, 1900 (Ornit. Jahrb.; p. 223).

The subspecies inhabits the Madeira Island. Hartert (1910) lists to it also the population from the Azores which Vaurie (1957) owing to some difference (see following description) regards as a valid subspecies. In terms of its bright body colours (mantle grey, ventral side yellow), the subspecies *M. c. schmitzi* forms a transitory link between *M. c. canariensis* and *M. c. patriciae* It differs from the nominate subspecies *M. c. cinerea* in a darker colour only around the ears. The two marginal rectrices are almost always completely white, the third rectrice is bordered mostly by a wide, dark rim on the inner web (Hartert 1910).

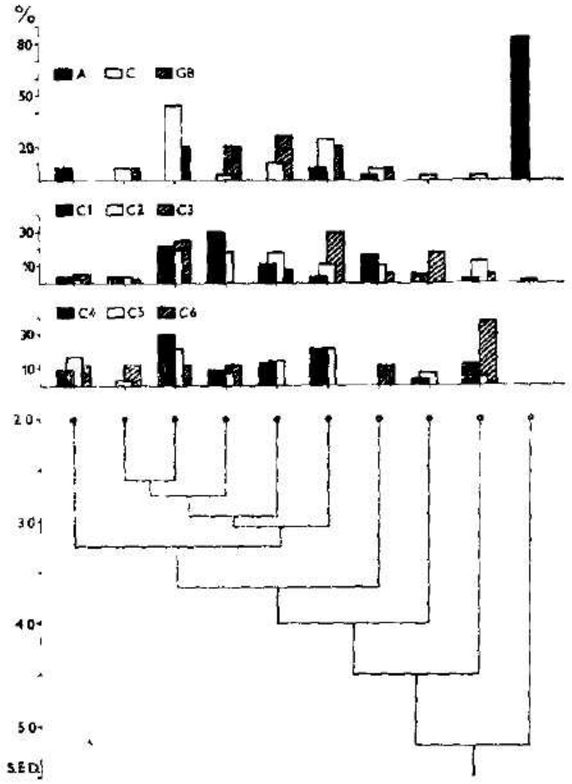

Fig 3. Dendrogram obtained from the cluster analysis of the treated specimens (histograms showing percentage of specimens of individual groups of birds on each branch of the dendrogram)
A, C, GB, etc. — see chapter Materials and Methods.

Motacilla cinerea patriciae Vaurie, 1957
Terra typica — The Azores (Furnas, Sao Miguel)

The subspecies inhabits the entire Azores. The basic coloration (grey, yellow)

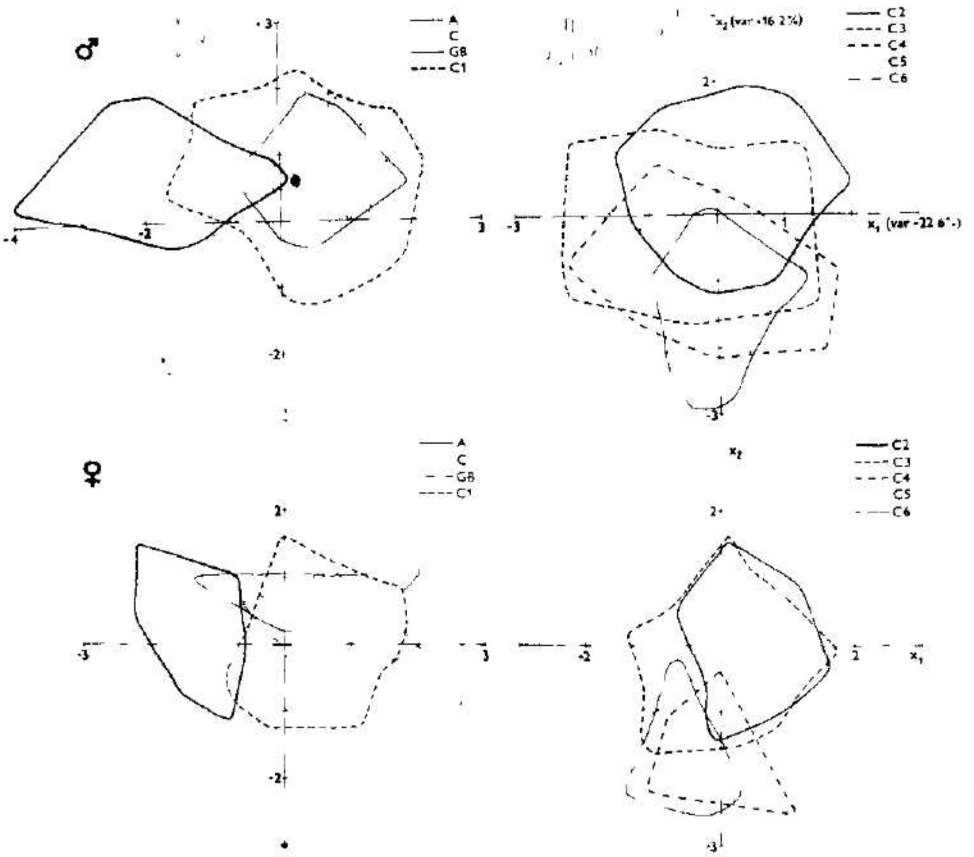

Fig. 4. Ordination of all treated specimens of *Motacilla cinerea* (The ranking of individual specimens — A, C, GB, etc. — carried out in relation to longitude of the pertinent site. Axes x_1, x_2 reflect direction of the highest variability in cluster of samples. In addition variation proportions are shown.)

is the lightest of the three insular subspecies. The inner web of the 2nd and 3rd rectrices has mostly a dark border (it was found to be narrow on the second rectrice in 37 out of 38 specimens, very wide on the third rectrice of all specimens examined). A longer bill is another important diagnostic character (Vaurie 1957).

RESULTS

The Azores

The population of the Azores forms an exceptional group among the populations from the remaining area of distribution (Table 1).

According to the results of the cluster analysis, both the males and females from the Azores are completely different from all other specimens. The independent cluster (Fig. 3) comprises as many as 83.3 % of members of the Azorian population.

Also ordination indicates similar important differences between the population from the Azores and the remaining birds. For an evaluation of all specimens throughout their area of distribution, I selected the two most important factors determining the direction of the greatest variability. Responsible for variation of the first factor (Fig. 4 — axis x_1) is the size of the bill together with characteristics measured on the tail; variability of the second factor (Fig. 4—axis x_2), is determined by the length of emargination of rectrices 3 and 4, and the length of the tail. The remaining biometric signs participate minimally in total variability.

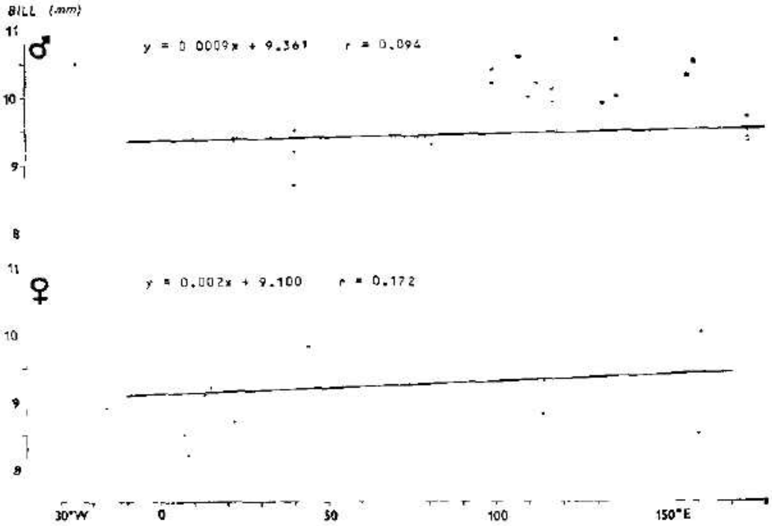

Fig. 5. Length of bill from nostrils in relation to longitude (30 °W — 180 °E).

Using the ordination technique (Fig. 4), a separation of the Azorian population occurs in direction of the axis x_1 which means that the main responsibility in terms of variability rests with the size of the bill, that of the white tips of rectrices 2 and 3, the size and mainly the frequency of marginal borders on rectrices 1—3.

Specific of the population from the Azores is a notably longer bill when compared with its length in birds from other areas (Fig. 5). The differences in all four measurements are statistically highly significant when plotted against populations from the Canary- and the British Isles and from Europe (of all t-values range from 4.11 — 18.13; thus, $P < 0.01$). Owing to a change in bill size, the birds from the Azores are probably specialized in different types of flying- and water insects.

Another remarkable character is a common incidence of a long, dark border on the inner web of rectrices 2 and 3 (up to 100 % in frequency — Table 1, Figs 6,7). Differences in the length of these borders are statistically highly significant (all t-values > 3.55, hence $P < 0.01$). The existence of a completely dark third rectrice recorded solely for the Azorian population occurred in 11.4 % of the birds examined.

Table 1 — Biometric characteristics of the population from the Azores (all measurements in mm) b — bill, n. - length from nostrils, f. - length from the feathering, 3rd (4th) prim. - length of emargination of outer web of 3rd (4th) primary, 2nd (3rd) rect. - length of the white tip of 2nd (3rd) rectrice

		n	$\bar{x}$	min.	max.	s	$s_{\bar{x}}$	v
wing	♂	36	82.72	80	86	1.649	0.275	1.99
	♀	14	79.57	76	82	1.604	0.429	2.02
tail	♂	35	92.14	87	96	2.439	0.412	2.65
	♀	14	91.14	87	98	2.713	0.725	2.98
tarsus	♂	33	20.45	19.0	21.8	0.724	0.126	3.54
	♀	14	20 52	19.1	21.5	0.643	0.172	3.13
1st toe	♂	36	16.89	6.3	7.3	0.269	0.045	3.90
	♀	14	6.82	6.4	7.2	0.255	0.068	3.74
1st claw	♂	36	6.66	6.1	7.2	0.286	0 048	4.29
	♀	14	6.69	5.9	8.0	0.511	0.137	7.64
b-depth	♂	35	3.29	3.0	3.7	0.152	0.026	4.62
	♀	14	3.29	3 1	3.6	0.141	0.038	4.29
b-width	♂	35	3.83	3.5	4.1	0.149	0.025	3.89
	♀	14	3.86	3.4	4 1	0.227	0.061	5.88
b-length n.	♂	35	10.15	9.4	10.8	0.375	0.063	3 69
	♀	14	10.04	9.2	10.9	0.392	0 105	3.90
b-length f.	♂	35	13.08	12.2	14.1	0.582	0.098	4.45
	♀	14	12.97	12.0	13.7	0.601	0.161	4.63
3rd prim.	♂	36	22.41	20.5	24.5	1.046	0.174	4.67
	♀	14	21.96	19.4	24.2	1.621	0.433	7.38
4th prim.	♂	36	19.89	17.2	22.0	1.061	0.179	5.33
	♀	14	19.44	16.6	21.9	1.696	0.453	8.72
2nd rect.	♂	24	14.10	9.0	18.3	2.466	0.503	17.49
	♀	10	13.76	9.8	17.4	2.825	0.893	20 53
3rd rect.	♂	24	6.09	0.0	9.9	3.082	0.629	50.61
	♀	9	5.96	1.8	8.7	2.338	0.779	39.23
border:								
1st rect.	♂	36	13.70	5.5	26.3	36.1 %	of specimens	
	♀	14	8.50	5.0	12.0	14.3 %		
2nd rect.	♂	36	23.29	8.3	35.9	91.7 %		
	♀	14	20.62	8.4	29.5	71.4 %		
3rd rect.	♂	35	41.37	15.3	93.0	100 %		
	♀	14	30.38	17.0	48.1	92.9 %		

A similar, specific character (with the exception of two findings in birds from the continent), is a dark border on the inner web of rectrice 1, present in 36.1 % of the birds examined.

The size of the white tips of rectrices 2 and 3 is roughly one half of that of specimens from the remaining distribution area (Fig. 8; differences statistically highly significant: values t ranging from 4.76 – 9.39; $P < 0.01$).

Another important difference occurs in the tail length ($t_C = 5.46$, $t_{GB} = 6.46$, $t_{C1} = 10.30$; everywhere $P < 0.01$). Owing to the westernmost geographical situation of the population, tail length is relatively small, and close to that of populations from the Alatau Mts. and the Tian-Shan mountain system (Figs. 9, 10).

All these differences in characters of the population from the Azores confirm the validity of the described subspecies *Motacilla cinerea patriciae* Vaurie, 1957.

Canary Islands

The population from the Canary Islands does not differ notably from populations inhabiting the western, continental parts of the area of distribution (Table 2).

The cluster analysis has not produced an independent cluster for the population from these islands. In terms of total morphology, there is a close resemblance of the Canarian population to birds from the central and eastern parts of the area of distribution (east of about 60° E). This is in agreement with the frequency of distribution of birds in the individual clusters (Fig. 3).

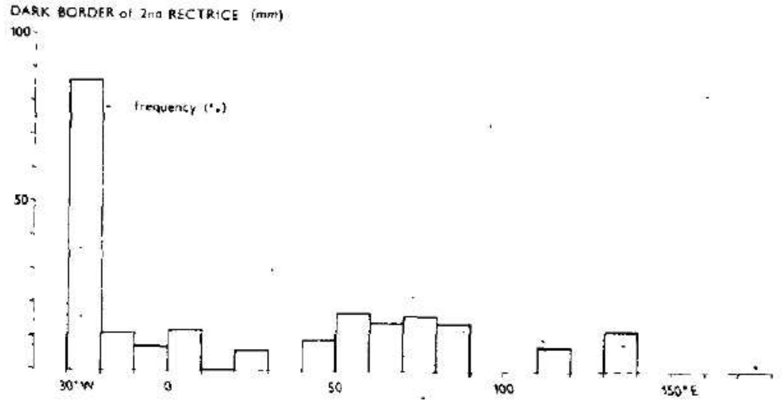

Fig. 6. Length of dark border on inner web of 2nd rectrice and the frequency of its incidence in the specimens examined in relation to logitude (30 °W — 180 °E). Both sexes evaluated together. Histograms — frequency of incidence of a border in % (no columns available for cases of an insufficient number of specimens).

Similarly, the result of the ordination technique does not separate the Grey Wagtails of the Canary Islands from populations of the adjacent parts of the

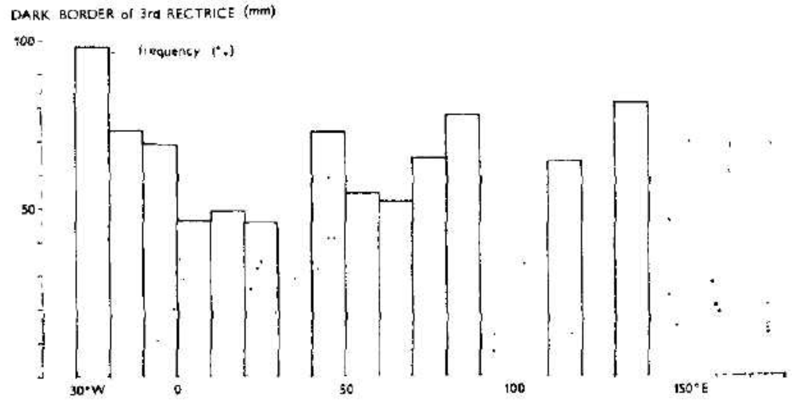

Fig. 7. Length of dark border on inner web of 3rd rectrice and the frequency of its incidence in the specimens examined in relation to longitude (30 °W — 180 °E). Both sexes evaluated together (for explanations see Fig. 6).

area of distribution, i. e. British (GB) and European (C1) birds in spite of certain differences.

Birds of the population from the Canaries are smaller than the specimens from the Azores, the British Isles and the European area of distribution. Their wings are shorter than those of surrounding populations ($t_A = 2.98$, $t_{GB} = 3.32$, $t_{C1} = 4.80$; everywhere $P < 0.01$), and in the wing length they are similar to specimens from the W-Asian mountain systems. The tail is shorter than that of the European population ($t_{C1} = 5.42$; $P < 0.01$) and, with regard to the values, they form a transition between populations, from the Azores ($t_A = 5.64$; $P < 0.01$) and those from the British Isles ($t_{GB} = 3.34$; $P < 0.01$). Of statistical significance are also differences in the length of the tarsus (Fig. 11) and first toe. Both values are smaller than those of the remaining populations from the Canary Islands do not differ from those of the populations from the British Isles and from Europe, and are in complete agreement with the conclusions of a regression analysis of the specimens from the continent.

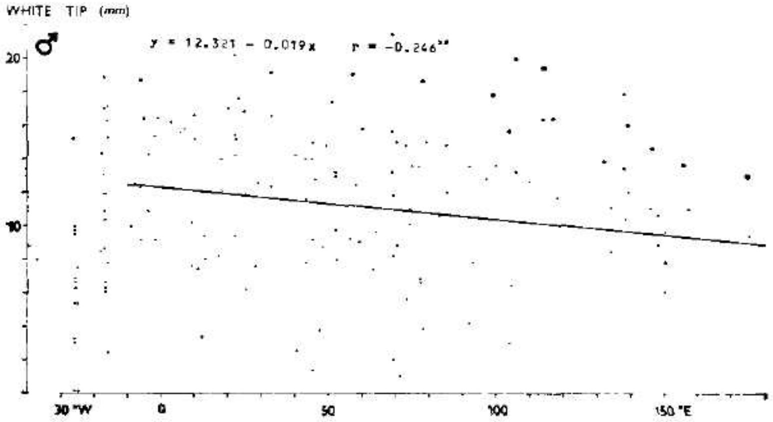

Fig. 8. Length of white tip of 3rd rectrice (males only) in relation to longitude (30 °W — 180 °E).

The presence of a dark border on the inner web of rectrice 3 is not unusual, but it is shorter in length and does not attain the frequency of 100 % as it does in the Azorian population (Table 2, fig. 7). The incidence of a border on rectrice 2 is rare The coloration of the body (one of the major characters when decribing a subspecies) has been found to be of a darker shade of yellow on the ventral side of the body; also the black spot on the neck of the male is darker. Males of a similar coloration occur also in European populations, but in lower numbers. The coloration of the Grey Wagtails from the Canary Islands is most similar to that of birds from E-Asia.

The insular population mentioned is in good fit with the clinal variability of birds from the continental part of the area of distribution (see later). However, with regard to the already existing differences (a relatively smaller size of both tail and tarsus, still a frequent incidence of a border on the tail rectrices, differences in colour) and an increased isolation from the remaining populations, a further differentiation of the Grey Wagtails from the Canary

Table 2 — Biometric characteristics of the population from the Canaries (all measurements in mm) (for explanations see Table 1)

		n	x̄	min.	max.	s	$s_{\bar{x}}$	v
wing	♂	24	81.54	79	85	1.351	0.276	1.66
	♀	13	79.31	78	80	0.751	0.208	0.95
tail	♂	24	95.25	91	98	1.726	0.352	1.81
	♀	13	94.15	88	100	2.968	0.823	3.15
tarsus	♂	24	19.83	18.8	21.0	0.626	0.128	3.16
	♀	13	19.84	18.7	21.1	0.647	0.179	3.26
1st toe	♂	24	6.59	5.9	7.1	0.308	0.063	4.67
	♀	13	6.62	6.2	6.9	0.188	0.052	2.84
1st claw	♂	24	7.00	5.7	7.6	0.434	0.089	6.20
	♀	13	6.52	5.8	7.4	0.505	0.140	7.75
b-depth	♂	24	3.04	2.7	3.3	0.121	0.025	3.98
	♀	13	3.00	2.8	3.2	0.100	0.028	3.33
b-width	♂	24	3.24	3.0	3.5	0.131	0.027	4.04
	♀	13	3.28	3.0	3.6	0.219	0.061	6.68
b-length n.	♂	24	9.40	8.5	10.5	0.493	0.101	5.24
	♀	13	9.25	7.9	10.0	0.597	0.166	6.45
b-length f.	♂	24	11.67	10.3	13.0	0.677	0.138	5.80
	♀	13	11.64	10.1	12.7	0.739	0.205	6.35
3rd prim.	♂	24	22.01	20.2	24.5	1.054	0.215	4.79
	♀	13	20.88	18.3	22.6	1.089	0.302	5.22
4th prim.	♂	24	20.14	18.9	22.7	0.863	0.176	4.29
	♀	13	19.12	17.2	20.5	0.953	0.264	4.98
2nd rect.	♂	24	21.51	12.0	31.0	4.745	0.969	22.06
	♀	10	20.40	16.1	30.0	4.645	1.469	22.77
3rd rect.	♂	24	11.46	2.5	18.9	4.441	0.907	38.75
	♀	10	12.67	7.5	17.5	3.617	1.144	28.55
border:								
2nd rect.	♂	24	14.50	11.0	19.8	16.7 %	of specimens	
	♀	13	0.00	—	—	0.0 %		
3rd rect.	♂	24	27.17	8.2	41.6	87.5 %		
	♀	13	18.50	5.0	24.3	46.2 %		

Islands is to be expected. Therefore, establishing the subspecies *Motacilla cinerea canariensis* Hartert, 1901 for this population seems to be fully justified.

British Isles

The Grey Wagtails of the British Isles are among the largest birds of this species inside their entire area of distribution (Table 3). From this western ("British") extreme onwards the sizes of the birds decreases in eastern direction.

The results of both the cluster analysis (Fig. 3) and the ordination technique (Fig. 4) indicate that the British population can be included to populations from the European area of distribution. In support of this conclusion are also statistically insignificant differences (values $t_{ct} < 1.77$) or nonexisting differences in all biometric characters.

According to the data obtained, there is not reason for creating a further, independent subspecies for the British population of the Grey Wagtail.

Table 3 — Biometric characteristics of the population from Great Britain (all measurements in mm) (for explanations see Table 1)

		n	$\bar{x}$	min.	max.	s	$s_{\bar{x}}$	v
wing	♂	17	83.12	80	85	1.536	0.373	1.85
	♀	4	81.75	81	83	—	—	—
tail	♂	17	98.41	92	105	3.501	0.849	3.56
	♀	4	100.75	98	104	—	—	—
tarsus	♂	17	20.42	19.5	21.5	0.580	0.141	2.84
	♀	4	20.70	20.0	21.4	—	—	—
1st toe	♂	15	6.80	6.5	7.2	0.270	0.070	3.97
	♀	4	6.55	6.2	7.0	—	—	—
1 st claw	♂	16	6.61	5.5	7.5	0.456	0.114	6.90
	♀	4	6.30	6.0	6.8	—	—	—
b-depth	♂	17	3.11	2.9	3.4	0.141	0.034	4.53
	♀	4	2.95	2.9	3.0	—	—	—
b-width	♂	17	3.26	3.0	3.6	0.137	0.033	4.20
	♀	4	3.35	3.2	3.5	—	—	—
b-length n.	♂	16	9.43	8.9	10.0	0.334	0.084	3.63
	♀	4	9.20	8.9	9.5	—	—	—
b-length f.	♂	16	11.58	10.7	12.5	0.520	0.130	4.49
	♀	4	11.50	10.8	12.2	—	—	—
3rd prim.	♂	16	21.09	18.6	23.7	1.461	0.365	6.93
	♀	4	20.73	19.3	21.9	—	—	—
4th prim.	♂	16	19.04	17.4	21.5	1.248	0.312	6.55
	♀	4	18.45	17.8	19.0	—	—	—
2nd rect.	♂	15	22.26	15.3	34.1	5.562	1.436	24.99
	♀	4	23.43	18.9	27.9	—	—	—
3rd rect.	♂	15	12.91	9.3	18.7	2.849	0.736	22.09
	♀	4	11.58	9.6	19.2	—	—	—
border:								
2nd rect.	♂	16	—	14.8	—	6.3 %	of specimens	
	♀	4	—	—	—	0.0 %		
3rd rect.	♂	16	20.80	10.9	41.0	81.3 %		
	♀	4	32.87	14.2	54.4	75.0 %		

The Continent

Biometric data on specimens from the continent, i. e. from Europe (including the British Isles) to the eastern shore of the U.S.S.R. (including adjacent islands) were evaluated by means of the regression analysis related to geographical longitude (for measurements of the European population see Table 4). A number of characters show a statistically significant decline in size in eastern direction with an increasing geographical longitude. The remaining characters either do not change throughout the length of the area of distribution, or changes depending on the geographical longitude are statistically insignificant.

A statistically significant decline in the wing length (Fig. 12) has been recorded for the male only ($n = 295$, $b = -0.011$, $r = -0.243$ $t = 4.29$, $P <$ < 0.01), a shortening of the female wing is statistically insignificant with regard to the zero regression ($n = 127$, $b = -0.006$, $r = -0.125$ $t = 1.41$, $P > 0.05$).

An important relationship has been disclosed between the length of the tail, tarsus or an emargination of primaries 3 and 4, and geographical longitude. The tail length (Fig. 9, 10), a basic character for descriptions of all continental subspecies, decreases continuously from west to east throughout the area of distribution (male: $n = 293$, $b = -0.060$, $r = -0.591$, $t = 12.49$, $P < 0.01$; female: $n = 124$, $b = -0.068$, $r = -0.589$, $t = 8.06$, $P < 0.01$). A regressive relation between the index "wing tail" and geographical longitude (Fig 13)

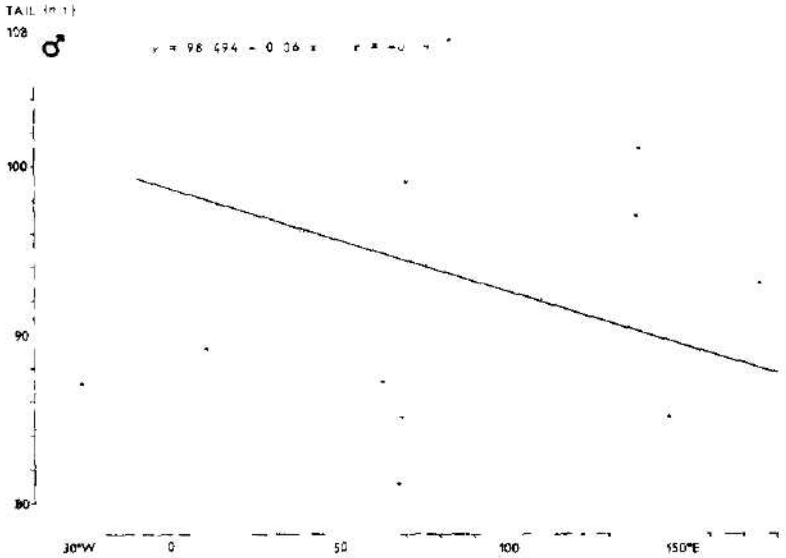

Fig 9. Tail length of males in relation to longitude (30 °W — 180 °E).

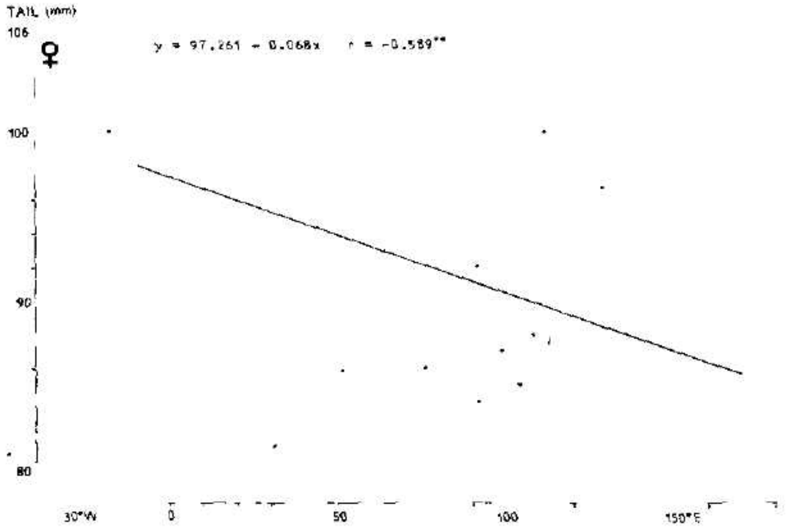

Fig 10. Tail length of females in relation to longitude (30 °W — 180 °E)

indicates an irregularity in the area of the Balkan Peninsula and Asia between 70–75 °E Both deviations are caused by the length of the tail (a longer tail on the Balkan Peninsula, a shorter tail in the mentioned area of Asia), but the differences are minimal and statistically insignificant.

A marked decline occurs in the length of emargination of the 3rd primary (Fig. 14) ($n = 276$, $b = -0.016$, $r = -0.479$, $t = 9.03$, $P < 0.01$) and closely correlated with it ($r = 0.892$) the character of the 4th primary. Similar decline, but in the less steep slope, occurs also in the length of the white tip of 3rd rectrice (Fig. 8) ($n = 259$, $b = -0.019$, $r = -0.246$, $t = 4.06$, $P < 0.01$) and

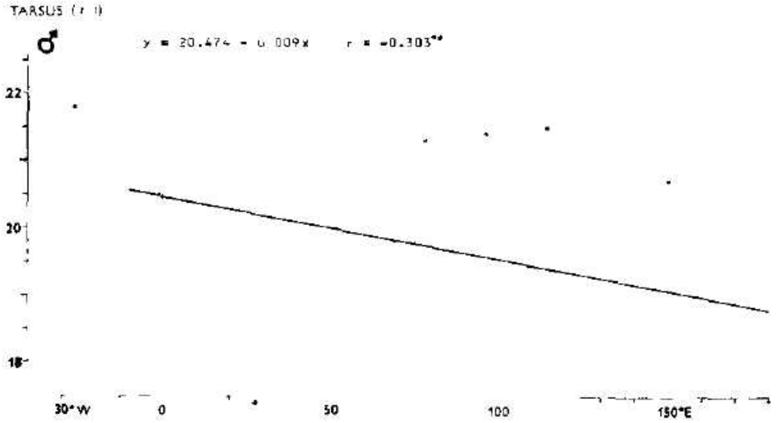

Fig. 11. Length of tarsus (males only) in relation to longitude (30 °W — 180 E).

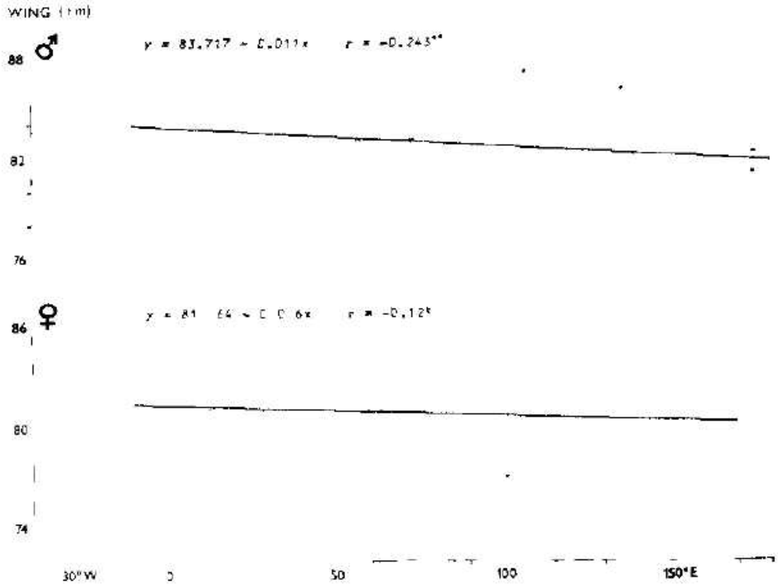

Fig 12 Wing length in relation to longitude (30 °W — 180 °E).

in the tarsus length (Fig. 11) ($n = 293$, $b = -0.009$, $r = -0.303$, $t = 5.43$ $P < 0.01$). Changes in the remaining characters (bill — Fig. 5, first toe, first claw) are statistically insignificant.

A dark border on the third rectrice (Fig. 7) is present in about 50 % of the European population, and in 70 % of the E-Asian populations. However, a difference in the length of the border is insignificant. A border on rectrice 2 (Fig. 6) occurs in about 10 — 15 % of specimens throughout the area of distribution.

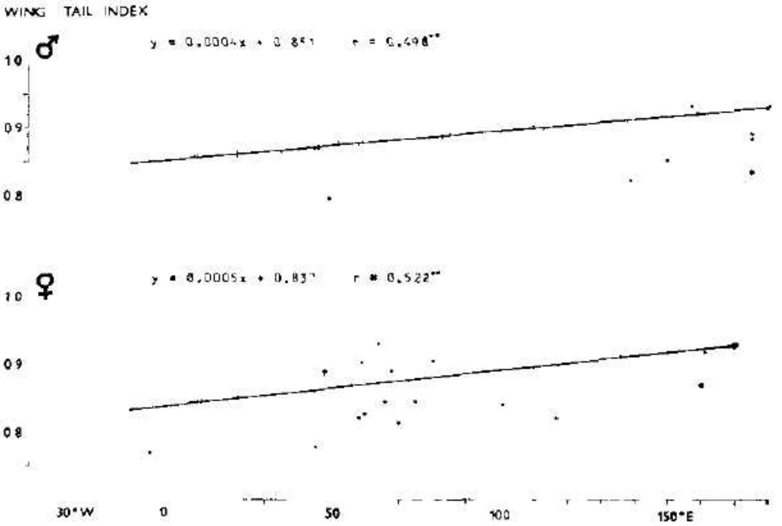

Fig. 13. Changes in wing. tail index in relation to longitude (30 °W — 180 °E).

Another character examined is the coloration of specimens from the individual parts of the area of distribution. Colour purity of the yellow ventral side and the black spot of the male increases from west to east (assessed in a large

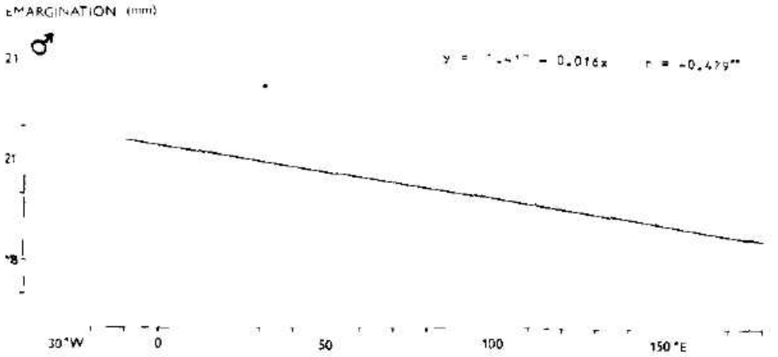

Fig. 14. Length of emargination of outer web of 3rd primary (males only) in relation to longitude (30 °W — 180 °E).

Table 4 — Biometric characteristics of the population from Europe (eastwards up to 28°E) (for explanations see Table 1)

		n	$\bar{x}$	min.	max.	s	$s_{\bar{x}}$	v
wing	♂	86	83.29	78	89	2.130	0.230	2.56
	♀	38	80.89	77	86	2.024	0.328	2.50
tail	♂	84	98.23	89	107	3.788	0.413	3.86
	♀	37	96.08	90	105	3.499	0.575	3.64
tarsus	♂	86	20.43	18.4	22.7	0.788	0.085	3.86
	♀	37	20.25	18.3	21.6	0.812	0.133	4.01
1 st toe	♂	84	6.80	5.8	8.0	0.392	0.043	5.76
	♀	37	6.78	5.9	7.5	0.390	0.064	5.75
1st claw	♂	84	6.39	5.3	7.5	0.460	0.050	7.20
	♀	37	6.17	4.9	7.1	0.558	0.092	9.04
b-depth	♂	76	3.11	2.7	3.7	0.197	0.023	6.33
	♀	36	3.09	2.8	3.4	0.162	0.027	5.24
b-width	♂	80	3.25	2.9	3.8	0.171	0.019	5.26
	♀	38	3.34	2.7	3.8	0.217	0.035	6.50
b-length n.	♂	81	9.36	8.5	10.4	0.413	0.046	4.41
	♀	37	9.12	8.2	10.3	0.446	0.073	4.89
b-length f.	♂	79	11.88	10.4	13.0	0.561	0.063	4.72
	♀	38	11.63	10.3	12.9	0.632	0.103	5.43
3rd prim.	♂	83	20.98	18.0	25.0	1.298	0.142	6.19
	♀	37	20.30	17.6	22.3	0.958	0.157	4.72
4th prim.	♂	81	18.94	15.9	21.3	1.244	0.138	6.57
	♀	37	18.49	16.4	20.9	1.154	0.190	6.24
2nd rect.	♂	72	20.93	9.1	29.2	4.335	0.511	20.71
	♀	30	20.04	10.0	32.2	4.758	0.869	23.74
3rd rect.	♂	72	12.34	3.3	21.4	3.595	0.424	29.13
	♀	31	11.33	2.3	20.0	3.704	0.665	32.69
border:								
2nd rect.	♂	79	15.85	2.8	22.3	7.6 %	of specimens	
	♀	36	0.00	—	—	0.0 %		
3rd rect.	♂	79	*23.15*	*5.5*	*37.6*	*50.6 %*		
	♀	36	22.57	8.6	40.8	33.3 %		

set of birds) However, within the framework of variability, a large number of birds of an identical coloration have been found both in the east and the west of the distribution area.

A separation of any of the continental population has not been suggested by the results of the cluster analysis (Fig. 3). The distribution of specimens suggests these two groups — the European group including Asia Minor (C1, C2), and the Asian group proper (C3, C4, C5). However, overlapping is considerable in the individual clusters showing that the degree of similarity among birds of the two parts of the area of distribution is high. The results obtained for the easternmost population (C6) are inconclusive owing to a small amount of material usable for cluster analysis ($n = 8$).

The ordination technique suggests a moderate shift of the continental populations towards factor 2 (Fig. 4 — axis x_2). Variability in this direction is caused by the length of the tail and an emargination of primaries 3 and 4 thus confirming the above discussed results of the regression analysis. No significant differences have been disclosed in the remaining characters.

DISCUSSION AND CONCLUSIONS

A basic criterion used in describing the "eastern" subspecies of the Grey Wagtail is the length of its tail which is clearly shorter than in other birds from Europe. Although continuous changes in the tail length have been pointed out by Bates (1934) and Dementjev (1936), none of these authors attempted to change the then valid concepts on a subspecific classification of the species *Motacilla cinerea*.

The statement by Bates (1934) that..., the distinction of eastern and western races of the Grey Wagtail must be based entirely on tail-length" has led even to a separation of the independent insular subspecies *Motacilla cinerea cinereo* on the basic of a longer tail-length (x = 99.5; n = 49) of Grey Wagtails from the British Isles. A basic deficiency of Bates' study is a comparison of non-homogeneous sets of Grey Wagtail specimens which he made without paying attention to sex distinctions (mixing males and females) and individual seasons (display attire, normal appearance). In addition, he added 1 – 2 mm to the lengths of worn-off rectrices (otherwise measured with great accuracy). Apparently, all these methodological deficiences may have been responsible for the differences found by Bates between the British Grey Wagtails and those from the European Continent from where also the material available was not too extensive. Only two years later, the mentioned insular subspecies was revised by Witherby (1936) and rejected on the grounds of insignificant differences in tail-length. Both Bates (1934) and Witherby (1936) were aware of a considerable overlap in the tail length of birds from the area of central Asia, but in spite of this, they accepted the validity of the two subspecies *M. c. caspica* and *M. c. melanope*.

Dementjev (1956), supporting Hartert's (1910) concept, divided the whole area of distribution of the Grey Wagtail between two subspecies, the western *Motacilla cinerea cinerea* (syn. *M. c. caspica*), and the eastern *Motacilla cinerea melanope*, with the contact zone in the Elborz Mts. in N-Iran.

The territory mentioned seems ideal for the origin of any morphological differences between the western and eastern populations of the Grey Wagtail. There the incidence of the birds is concentrated in a narrow mountain strip south of the Caspian Sea, which connects the western with the eastern part of their area of distribution (Fig. 2). Geomorphological conditions (rivers emptying into different seas) are in support of Moreau's (1972) suggestion that this area forms the border between populations migrating to the wintering sites in W-Africa and E-Asia. In this area, below the Caspian Sea, meet also the borders of the areas of distribution of various subspecies of other passeriform species – *Motacilla alba, Carduelis carduelis, Lanius collurio,* the genus *Oenanthe,* and others (Haffer 1977).

However, according to my results, morphological differences among populations of the Grey Wagtail are apparently non-existent in this part of Asia (between 50 – 60 °E) and thus there is no reason for creating a separate subspecies for populations east of the Caspian Sea.

According to Vaurie (1959), the border of the area of distribution of the subspecies *Motacilla cinerea cinerea* (syn. *M. c. caspica, M. c. melanope)* lies further to the east reaching the shore of the Baikal Lake. He nevertheless accepts the validity of the "less good" subspecies *Motacilla cinerea robusta,* but only for birds from the shore of the Pacific and the adjacent islands. However, according to my results, the determined clinal variability applies also to birds from the easternmost part of the area of distribution, and the coloration of these birds varies so much that a significant difference from the western population cannot be determined. Dementjev (1936) regards even the type specimens upon which the Japanese species *Pallenura robusta* was described as winter guests from E-Siberia.

Differences in the coloration and the shape of the rectrices of wagtails from various parts of their area of distribution (Kleinschmidt 1931) have been determined for individual specimens only which account for a considerably lower variability of the two characters.

The description of a new species, *Motacilla lindermayeri* Brehm, 1845 was based on a longer tail and bill of the Grey Wagtails from the Balkan Peninsula, and Niethammer (1943, 1950) still regards *Motacilla cinerea lindermayeri* as a valid subspecies. However, no difference in the length of the bill has been observed in birds from this area, and the extreme in tail length does not surpass the framework of the determined clinal variability. This justifies the abolition of the validity of this unsubstantive subspecies.

There is no necessity for discussing the validity of insular subspecies *(Motacilla cinerea canariensis, M. c. patriciae).* The results obtained by Vaurie (1957) from his detailed study of these population are fully supporting my own conclusions pointing to certain differences of the birds from the Canary Islands and some clear differences of the Azorian birds from the continental population of the Grey Wagtail. The remaining subspecies *Motacilla cinerea schmitzi* from the Madeira Island, not discussed in the present study for a lack of material, bears transitory characters between the subspecies from the Azores and those from the Canary Islands. Therefore, the validity of this subspecies may also be considered.

The determined clinal variability and, hence, the existence of a single subspecies *Motacilla cinerea cinerea* Tunstall, 1771 on the continent is supported also by similar ecological requirements of Grey Wagtails throughout their area of distribution. Apart from a certain adaptations to local conditions (location of the nest, etc.), the ecological requirements of the Grey Wagtail are practically identical in Great Britain (Tyler 1972), Czechoslovakia (Flousek, in press), the Tian-Shan Mts. (Kovshar 1979), the Baikal Lake (author's observations) and Japan (Haneda et Ichikawa 1967).

Having summarized my results I have come to the conclusion, that the variability of diagnostic signs of the Grey Wagtail is clinal in the area of its distribution, from the British Isles to the shore of the Okhotsk Sea and adjacent islands. It is characterized by a diminition of several body measurements proceeding uninterrupted from west to east. The conclusion suggests that the whole area mentioned is inhabited by the Grey Wagtail of the nominate subspecies *Motacilla cinerea cinerea* Tunstall, 1771. Therefore, the names of other subspecies such as *Motacilla cinerea caspica* (Gmelin, 1774), *M. cinerea melanope* Pallas, 1776 and *M. cinerea robusta* (Brehm, 1857) described from this area, are regarded as synonyms of the subspecies *Motacilla cinerea cinerea* Tunstall, 1771.

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FISH FAUNA OF SWAI-MADHOPUR DISTRICT — RAJASTHAN STATE, INDIA

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Abstract. Results of the investigations based on intensive collections and study during the years 1970—1972 on the fish and fisheries of district Swai-Madhopur (Latitude 25°45' to 27°0'; Longitude 76°0' to 77°30' E) of Rajasthan State, India are reported. In all sixty seven species representing eight orders, sixteen families and forty genera have been recorded together with observations on their habitats, seasonal availability, breeding habits and maximum size. Out of sixty seven species five species, viz., *Rita rita* (Ham.), *Eutropiichthys vacha* (Ham.), *Gagata viridescens* (Ham.), *Ailia coila* (Ham.) and *Rhinomugil corsula* (Ham.), are reported for the first time from Rajasthan State. Special notes have been added on some species in view of certain new findings. Further, the present fishery resources alongwith their fishery potential have been discussed.

INTRODUCTION

Swai-Madhopur is situated in the south-eastern part of Rajasthan and is a rich source of fish supply and abounds in a variety of species. It is a good area for commercial fisheries. This is borne out by the fact that the total submerged water area is 16,821 hectares and this brings about an annual revenue of five Lakh rupees to the State Government even with the limited effort at the disposal of the fisheries department.

In the past several workers viz., Hora and Mathur (1952), Mathur (1952), Krishna and Menon (1958), Darra Gupta et al., (196 Moona (1963), Dhawan (1969), Datta and Majumdar (1970), Johal and Dhillon (1981), Johal (1982), Sharma and Johal (198 1984), surveyed different areas of Rajasthan State indicating the existence of wide variety of fish fauna. The most comprehensive paper is by Datta and Majumdar (1970) reporting the presence of 75 fish species form the entire State of Rajasthan. The observations of these workers are based on the collections made during the years 1941—63. After 1963, significant ecological changes have taken place due to the implementation of several minor and major irrigation schemes under intensive agriculture cultivation programme, therefore, change in the compositions of fish fauna is obvious. Considering this fact, it is considered appropriate to study the fish fauna of Swai-Madhopur district, very poorly known so far.

So far as district Swai-Madhopur is concerned, no separate report is available and only a few scattered references are made in Datta and Majumdar's report (op. cit.). The present investigation is based on an intensive study and collection for nearly two years. It is noteworthy that all the previous reports made so far are based on stray collections and are not the results of a continuous effort in a limited area. Further none of them makes a mention of Rajasthan as being a rich fishery source. In fact, the fishery aspect has been totally neglected by previous workers. The present investigations have resulted in the discovery of five species which have not been recorded so for from anywhere in Rajasthan State much less from Swai-Madhopur.

Table 1

Name of Tehsil or Sub-Tehsil	No. of reservoirs or tanks	Total submerged water area in acres	Wheather	
			Perennial	Sub-Perennial
Swai-Madhopur	8	5334	3	5
Khandar	4	2427	3	1
Sapotra	10	3000	5	5
Gangapur	16	4485	12	4
Bamanwas	9	3303	8	1
Nadoti	14	3114	8	6
Toda Bhim	3	1419	3	0
Mahua	4	2801	4	0
Hindaun	9	3594	9	0
Karauli	6	316	1	5
Mandval	4	740	1	3
Malavna Char	15	11528	15	0

PHYSICAL FEATURES AND FISHERY RESOURCES

Swai-Madhopur lies on the eastern slope of Arevalli range which runs from north-east to south-west almost across the Rajasthan State, dividing it naturally in to two parts. The south-east of Aravalli is higher, more fertile and diversified in character and contains extensive hill range, long stretches of rocky wood and woodland. The district has two perennial rivers viz., Chambal and Banas and three major seasonal rivers viz., Bans-Ganga, Ghambhir and Morel. The seasonal rivers form cesspools during dry season which contribute a good deal to the fishery resources. The average rainfall of the district is about 820 mm, mostly received during south-west monsoon (July to October). A list of reservoirs and tanks with their nature and total water area is given in Table I. It is noteworthy here that since independence (1947), the water storage capacity has increased by 120 % thus providing greater opportunity for fisheries development.

MATERIAL AND METHODS

Fishing was done with the help of commercial fishermen. The various types of nets used were: drag nets with or without bag, gill nets, cast nets, and baited hooks.

THE FISH FAUNA

A list of fish species collected during this period is given in Table 2 together with their local names, seasonal availability, maximum size observed and other seasonal features. In some of the species, special taxonomic notes have also been added in case of certain new findings. It is noteworthy that sixty-six different species representing 8 orders, 16 families and 41 genera are reported here out of which five species are reported for the first time from Rajasthan State. As a detailed taxonomic study was made of each species collected, a

Table 2

S. No.	Scientific name	Local name	Maximum size	Remarks (Habitat, seasonal availability)
		Superorder: Clupeomorpha Order: Clupeiformes Family: Clupeidae		
1.	*Gadusia chapra* (Ham.)	Chapra	12 cm	Riverine, available throughout the year
		Superorder: Osteoglossomorpha Order: Osteoglossiformes Family: Notopteridae		
2.	*Notopterus chitala* (Ham.)	Chital	23 cm	River Pachwa, very rare
3.	*N. notopterus* (Pallas)	Patola	25 cm	Ponds, rivers and reservoirs; throughout the year
		Superorder: Ostariophysi Order: Cypriniformes Family: Cyprinidae		
4.	*Oxygaster bacaila* (Ham.)	Chilva	20 cm	Riverine; available throughout the year
5.	*Barilius bendelisis* (Ham.)	Ghora machli	28 cm	River Gambhir, Pachwa and Chambal; very common
6.	*B. bola* (Ham.)	Ghora machli	26 cm	Riverine; available throughout the year
7.	*Esomus danricus* (Ham.)	Chal	4 cm	River Banas and Chambal, not very common
8.	*Rasbora daniconius* (Ham.)	Chal	4 cm	Riverine; available throughout the year
9.	*Garra gotyla gotyla* (Ham.)	Pather chat	5 cm	In crevices; throughout the year
10.	*Tor khudree* (Sykes)	Mahaseer, Tor	70 cm	Mansarower band; rivers Kaloseel, Chambal, Banas, available throughout the year, sport fish
11.	*Tor tor* (Ham.)	Mahaseer, Tor	60 cm	Same as above
12.	*Puntius sarana* (Ham.)	Kaharpata	25 cm	Available throuthout the year in ponds, lakes, reservoirs and rivers
13.	*P. sophora* (Ham.)	Chidhu	10 cm	In ponds, rivers and lakes in small numbers
14.	*P. ticto* (Ham.)	Chidhu	3 cm	Available throughout the year in ponds, lakes and rivers
15.	*P. stigma* (Ham.)	Puthi	4 cm	Same as above
16.	*Osteobrama cotio* (Ham.)	Rohtee	7 cm	Riverine, available in large numbers during monsoon
17.	*Amblypharyngodon mola* (Ham.)	—	8 cm	River Pachwa; not very common
18.	*Chagunius chagunio* (Ham.)	—	5 cm	River Pachwa; available during monsoon
19.	*Catla catla* (Ham.)	Katla	110 cm	In ponds, lakes, rivers, reservoirs; highly prized as food; exported to neighbouring States

S. No.	Scientific name	Local name	Maximum size	Remarks (Habitat, seasonal availability)
20.	*Cirrhina mrigala* (Ham.)	Mrigal, Narain	95 cm	In ponds, rivers, lakes reservoirs; exported to neighbouring States
21.	*C. reba* (Ham.)	Bhangan	30 cm	In ponds, lakes, rivers, reservoirs; very common
22.	*C. chaudharyi* Srivastava	Mrigal	20 cm	60 specimens were collected from Mui pond
23.	*Labeo rohita* (Ham)	Rohu	100 cm	In ponds, rivers, lakes, reservoirs; good food fish exported to nearby State
24.	*L. calbasu* (Ham.)	Kalbans	40 cm	All type of water bodies very common; major part of the catches
25.	*L. gonius* (Ham)	Sarsi	35 cm	In ponds, rivers; available throughout the year during monsoon
26.	*L. fimbriatus* (Bl.)	Mamola	40 cm	River Banas; not very common; breeds during monsoon
27.	*L. boggut* (Sykes)	Pathat chapta	30 cm	In stones along the river beds
28.	*L. dyocheilus* (Ham.)	—	20 cm	In river Pachwa
29.	*L. angra* (Ham.)	—	13 cm	In river Gambhir
30.	*L. boga* (Ham.)	Pahari Machii	30 cm	In river Banas
31.	*L bata* (Ham.)	Bata	15 cm	In ponds, lakes, rivers, reservoirs; available throughout the year
32.	*L. rajasthanicus* (Datta & Majumdar)	Sarsi	20 cm	River Banas; available during monsoon in large numbers
33.	*Cyprinus carpio* var. *communis* Linnaeus	Scale sayp	70 cm	Established in village ponds; breeds from January to June; omnivore
34.	*C. carpio specularis* Linnaeus	Mirror carp	75 cm	same as above
35.	*Carassius carassius* (Linnaeus)	Gold fish	13 cm	Aquarium fish; escaped to tanks, ponds; well established
		Family: **Cobitidae**		
36	*Noemacheilus botia* (Ham.)	Botia	4 cm	In rivers Banas, Chambal, Morel, Gambhir; very common during rainy season
37.	*Botia lohachata* Chaudhari	Botia	4 cm	In small rivers and nallah
38.	*Lepidocephalichthys guntea* (Mam.)	Botia	5 cm	Riverine; very common during rainy season
		Order: Siluriformes Family: Siluridae		
39.	*Wallago attu* (Bl. & Sch.)	Lanchi	100 cm	In ponds, lakes, reservoirs, rivers; commercial fish
40.	*Ompak bimaculatus*	Palwa or Pabda	23 cm	In lakes, reservoirs, rivers, lacustrine fish

S. No.	Scientific name	Local name	Maximum size	Remarks (Habitat, seasonal availability)
		Family: Bagridae		
41.	*Mystus cavasius* (Ham.)	Katwa	20 cm	Riverine; available throughout the year
42.	*M. vittatus* (Bl)	Chitkabri	10 cm	In rivers Banas, Chambal, available throughout the year
43.	*M. aor* (Ham.)	Katerna	70 cm	In rivers Banas, Chambal; available throughout the year; good table fish
44.	*M. teengara* (Ham.)	Teengara	20 cm	Riverine, nallahas
45.	*M. bleekeri* (Bleeker)	Teengara	20 cm	In rivers and ponds
46.	*M. seenghala* (Sykes)	Seenghara	60 cm	In rivers, lakes, ponds, reservoirs; good table fish; available throughout the year
47.8	*Rita rita* (Ham.)	Rita or Khagga	50 cm	Riverine; very hardy; mostly available during monsoon
		Family: **Schilbeidae**		
48.*	*Eutropiichthys vacha* (Ham.)	Vacha	40 cm	Riverine; available throughout the year; excellent sport fish
49.	*Silonia silonida*	Silond	75 cm	Only in river Chambal; not very common
50.	*Clupisoma garua* (Ham.)	Bachwa	31 cm	Riverine; available throughout the year; carnivore
51.*	*Ailia coila* (Ham.)	Chal	10 cm	Riverine; available throughout the year
		Family. **Heteropneustidae**		
52.	*Heteropneustes fossilis* (Ham)	Singhi	15 cm	In ponds; available throughout the year
		Family: Sisoridae		
53.	*Bagarius bagarius* (Ham.)	Goonch	130 cm	Restricted to river Chambal
54.*	*Gagata viridescens* (Ham.)	Zebra	10 cm	Purely riverine, more common during monsson
		Order: Perciformes Suborder: Gobiidei Family: Gobiidae		
55.	*Glossogobius gutum* (Ham.)	Gobi	15 cm	Very common in Morel, Mansrover, Bhagwatgarh, Kaliseel bunds
		Suborder: Percoidei		
		Family: Centropomidae		
56.	*Ambassis nama* (Ham)	Seesha Machi	5 cm	Ponds, lakes; Good aquarium fish

S. No.	Scientific name	Local name	Maximum size	Remarks (Habitat seasonal availability)
57.	*A. ranga* (Ham.)	Seesha Machi	5 cm	Same as above
		Suborder: Mugiloidei Family: Mugilidae		
58.*	*Rhinomugil* (*Mugil*) *corsula* (Ham.)		7 cm	Not very common; non commercial
		Superorder: Atherinomorpha Order: Atheriniformes		
		Suborder: Cyprinodontoidei Family: Poecilidae		
59.	*Gambusia affinis patruelis* (Baird & Girard)		5 cm	Exotic fish established well in ponds for the eradication of mosquitoe larvae
		Suborder: Exocoetoidei Family: Belonidae		
60.	*Xenentodon cancila* (Ham.)	Takle Machi	20 cm	Very rare
		Order: Channiformes Suborder: Channoidei Family: Channidae		
61.	*Channa marulia* (Ham.)	Saval	60 cm	Very good table fish; sold in live condition
62.	*C. punctata* (Bloch)	Kabra	40 cm	Very common; good table fish
63.	*C. striata* (Bloch)	—		Not very common
		Order: Mastacembeliformes Suborder: Mastacembeloidei Family: Mastacembelidae		
64.	*Mastacembelus armatus* (Lacepede)	Bam	60 cm	Caught by rod and line; liked by natives
65.	*M. pancalus* (Ham.)	Bam	25 cm	Same as in case of *M. armatus*
66.	*Macrognathus aculeatum* (Bloch)	—	20 cm	—

* Reported for the first time

number of discrepencies from the avilable description from standard references, such as Day (1878) and Srivastava (1968), were noted and are given in the remarks column of Appendix II. These fishes are deposited in the Museum of the Zoology Department of the University of Rajasthan, Jaipur. Classification given in Appendix II is after Greenwood et al., (1966).

THE FISHERY OF THE DISTRICT

The fisheries of Swai-Madhopur district can broadly be divided into three different types, namely: (1) the riverine fishery constituted mainly by Chambal and Banas rivers and their tributaries, (2) the reservoir fisheries constituted by Morel, Kaliseel, Jagar, Mamchari, Needhar and Mansarover reservoirs. These reservoirs are fed by monsoon from the catchmant area and also by the perennial or seasonal rivers. The State Fisheries Department makes use of these reservoir by obtaining fish seed during breeding season and then stocking the seed so obtained in hundred and add smaller water areas (Ponds and smaller reservoirs). Each one of these smaller water areas is more or less, a source of revenue to the State. Induced breeding is being done wherever possible by the State Fisheries Department. It is rather unfortunate that it is not possible to make an accurate estimate of the total tonnage of fish produced as no such record is maintained either by the contractors or by the Fisheries Department, but it is fairly certain that a more scientific management of the reservoirs can contribute to increase the fish yield several times thus bringing revenue to the State and at the same time contributing the much needed cheap animal protein for our undernourished population. It is to be noted that even today most of the fish is sent outside the district, mostly to Calcutta and to lesser degree to Agra and Delhi. Greater production, accompanied by economic prosperity, should generate local consumption of the fish. In any case, it is an industry of high employment potential for the local population and a source of revenue to the State.

DISCUSSION

The present investigations have resulted in a number of interesting findings. Five species have been recorded for the first time. The most interesting is the finding of *Cirrhina chaudharyi* which has only been reported from Eastern Utter Pradesh (Srivastava, 1968). Equally interesting is the report of four specimens of *Labeo rajasthanicus*, a species which has so far been described only on the basis of one specimen collected from a very different part of Rajasthan (Datta and Majumdar, 1970). The most interesting perhaps are *Rhinomugil (Mugil) corsula*, *Ailia coila*, and *Rita rita* apart from a number of other silurids. This clearly shows that it is premature to reach any far-fetched zoogeographical conclusions until such time as exhaustive survey, based on intensive study, is made from other districts of Rajasthan.

It is noteworthy that out of the sixty-six species recorded, more than 50% species belong to a single family i. e., Cyprinidae, which contains commercially the most important species; and within the family Cyprinidae the maximum number is represented by the genus *Labeo* followed by the genus *Puntius*. Next in importance, both commercially and as regards the variety of species, are the silurids.

The fishery potential of the district is only a part of the general pattern prevailing in South-Western part of Rajasthan in atleast fifteen districts (Ganganager, Bharatpur, Jaipur, Swaimadhopur, Tonk, Kota, Jhalawar, Bhilaware, Chittor, Udaipur, Dungarpur, Banswara, Sirohi, and Alwar).

In conclusion, it may be emphasized that there is a need for an intensive survey of fish fauna and also a greater scientific effort at fishery management.

The present report is a part of a continuing investigation and it is proposed to publish the results as and when they take a more definite form.

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REVIEW OF CAPILLARIID NEMATODES (CAPILLARIINAE) PARASITIC IN AMPHIBIANS AND REPTILES. PART 1. GENERAL INTRODUCTION, GENERA CAPILLARIA, AONCHOTHECA AND PARATRICHOSOMA

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Abstract. A revision, based on studies of numerous type and other materials of nematodes of the subfamily Capillariinae from amphibians and reptiles, has shown that all the capillariid species parasitizing these groups of vertebrates can be assigned to the following six genera: *Capillaria* Zeder, 1800, *Aonchotheca* López-Neyra, 1947, *Paracapillaria* Mendonça, 1963, *Paratrichosoma* Ashford et Muller, 1978, *Amphibiocapillaria* Moravec, 1982, and *Pseudocapillaroides* Moravec et Cosgrove, 1982. *Paratrichosoma* is considered a valid genus within the Capillariinae. Three capillariid species described from amphibians, *Trichosoma bombinatoris* Linstow, 1892, *Capillaria fujianensis* Wang, 1982 and *C. ranae* Wang, 1982 are considered as *species inquirendae* and they cannot be assigned, for the time being, to any of the presently valid genera. All species of the genera *Capillaria, Aonchotheca* and *Paratrichosoma* from amphibians and reptiles are reviewed and redescriptions of *C. recondita* and *P. crocodylus*, based on type specimens, are provided; drawings of the two named species and those of *C. anatis*, a type species of *Capillaria*, are given too. The taxonomy, range of hosts and geographical distribution of the members of *Capillaria, Aonchotheca* and *Paratrichosoma* parasitizing amphibians and reptiles are discussed. The paper is supplemented by keys to genera and species of capillariids treated in the paper.

INTRODUCTION

Although capillariid nematodes are parasitic primarily in fishes, birds and mammals, numerous species of these parasites were described from amphibians and reptiles. In these hosts, capillariids attack mainly the digestive tube (stomach, intestine, rectum), penetrating there by their slender head ends deep into the mucosa; some parasites of snakes may sometimes migrate from the host's cloaca into connecting organs (e. g. posterior sections of oviducts, urinary bladder, penis). In addition to species parasitic in the digestive tube, tissue parasites are also found among the capillariids from amphibians and reptiles; these forms are parasitizing the liver, the mucosa and submucosa of the tongue or the buccal cavity and the skin. It is probable that, like capillariids from warm-blooded hosts and those from fishes, the capillariids from amphibians and reptiles may be also highly pathogenic for their hosts; so far there are little data in this respect, because these hosts do not usually represent a major economic interest. Pathogenic effects were found, e. g., in *Amphibiocapillaria tritoniscristati* parasitic in the liver of Eupropean newts (Arvy, 1951) or in *Pseudocapillaroides xenopi* from the skin of frogs, which was found to cause a serious disease in the laboratory breedings of the South African clawed frog *(X. laevis)* in the USA, resulting mostly in the death of these host animals (Cosgrove and Jared, 1977, Wade, 1982). Heavy capillariid infections are sometimes found in exotic snakes, e. g., in zoological gardens. The presence of serpentine tunnels in the belly skin of crocodilians produced by *Paratrichosoma* spp. is well recognized in the skin trade; by decreasing the value of the skin (see King and Brazaitis, 1971, Ashford and Muller, 1978) these nematodes may be an economic problem for crocodile farms.

According to present information, the capillariids parasitic in amphibians and reptiles are known from all main zoogeographical regions. While reptilian capillariids occur practically in tropical and subtropical regions only, in northern hemisphere for example reaching only the southernmost parts of the Holarctic, one comes across amphibian capillariids in cooler areas of the temperate zone too. Although some of these species were known to the helminthologists of the last century, it can be stated that the present knowledge of the species composition of these parasites in amphibians and reptiles is by far incomplete. Recent findings of some new interesting forms from these hosts suggest that subsequent studies may not only increase considerably the number of recognized species but may also result in discovering additional remarkable forms.

The taxonomy of nematodes of the subfamily Capillariinae has not been elaborated in detail so far, mainly due to insufficient and frequently erroneous species descriptions; it complicates considerably the species identifications of these parasites. For these reasons the present author has attempted during several recent years, to obtain and examine all available materials of capillariids from cold-blooded vertebrates to work out a revision of these parasites. This paper, based on the study of numerous own materials and those borrowed from various scientific institutions from abroad, presents results of a revision of the capillariids parasitizing amphibians and reptiles, being thus a continuation of the foregoing revision devoted to capillariids from fishes (Moravec, 1986).

The capillariids from amphibians and reptiles are dealt with in a single paper, because both these parasite groups comprise related forms, each of them being represented by a relatively small number of species.

Out of a total of 13 nominal species recently reported from amphibians, the author had 8 at his disposal, and of 17 reptilian species, 7 were available for study. It has been shown by the results of these studies that at present only 7 species of amphibian capillariids and 12 reptilian capillariids can be considered valid. In assigning the capillariid species to genera, the author starts from his earlier papers dealing with a new systematic classification of capillariids (Moravec, 1982, 1983, Moravec and Cosgrove, 1982) but a delimitation of some genera and subgenera has been made more precise on the basis of the study of new materials.

The names of the amphibian and reptilian species from which the nematodes studied by the present author originated have been designated by an asterisk (*) in the text. All measurements in species descriptions are in mm.

THE TAXONOMY OF CAPILLARIIDS PARASITIC IN AMPHIBIANS AND REPTILES AND THEIR SYSTEMATIC REVIEW

The same as in the foregoing paper dealing with capillariids from fishes (Moravec, 1986), in evaluating the systematic status of capillariid nematodes here I also follow the classification by Anderson and Bain (1982), who listed these parasites in the subfamily Capillariinae Railliet, 1915 within the family Trichuridae.

Owing to a chaotic situation in the taxonomy of capillariid nematodes mainly as to the delimitation of their genera, several years ago I proposed (Moravec, 1982) a new systematic classification of these parasites with newly diagnosed genera. This system was later supplemented by two additional newly established genera, *Pseudocapillaroides* Moravec et Cosgrove, 1982 from amphibians and *Tenoranema* Mas-Coma et Esteban, 1985 from mammals. Further modification of this system was carried out by Moravec (1986) in his revision of fish capillariids where, on the basis of studies of numerous materials, he added a new genus *Huffmanela*, and elevated the subgenus *Piscicapillaria* Moravec, 1982 to an independent genus. A justification of the division of cappillariids into several genera is also confirmed by the results of this revision dealing with capillariids from amphibians and reptiles.

Moravec (*1982, 1983*) and Moravec and Cosgrove (1982) reported cappillariids from amphibians and reptiles within the following 6 genera *Aonchotheca* López-Neyra, 1947, *Schulmanela* Ivashkin, 1964, *Pseudocapillaroides* Moravec et Cosgrove, 1982, *Capillaria* Zeder, 1800, *Paracapillaria* Mendonça, 1963 and *Pseudocapillaria* Freitas, 1959 of which the first three genera only from amphibians, whereas the last one only from reptiles. Campbell (1984) has recently recognized another genus, *Paratrichosoma* Ashford et Muller, 1978, within the Capillariinae which was previously transferred to this subfamily from the Trichosomoididae by Anderson and Bain (1982), the latter authors considered it, however, a synonym of *Capillaria*. The results of the present revision indicate that all species from amphibians and reptiles may be listed in 6 genera; species from amphibians belong to 4 genera, whereas those parasitizing reptiles to 3 genera. *Amphibiocapillaria* (formerly considered a subgenus of *Schulmanela*) is the only genus common for capillariids from amphibians and reptiles, while the remaining genera are present always in only one of these two host groups; only in amphibians the genera *Capillaria*, *Pseudocapillaroides* and *Aonchotheca* were recorded and only in reptiles the genera *Paracapillaria* and *Paratrichosoma*.

It has already been mentioned by Moravec (1986) in his revision of fish capillariids that, in view of the fact that the oldest valid genus in the Capillariinae is *Capillaria* with the type species *C. anatis*, it was necessary to carry out a detailed comparison of this species with congeneric species from cold-blooded hosts. For this purpose, a material of *C. anatis* from the caecum of ducks (*Anas platyrhynchos* and *A. platyrhynchos* f. *domestica*) from Czechoslovakia was obtained through the courtesy of Dr. J. Macko from Košice. The study of these specimens confirmed morphological similarly of *C. anatis* (see Fig. 1) to some species of the fish capillariids that were retained in *Capillaria*, for which, however, four distinct subgenera were established. As to capillariids from amphibians and reptiles, the only species listed provisionally in *Capillaria* by Moravec (1982) is *C. recondita* from South American frogs. A reexamination of the type specimens of *C. recondita* has shown that the general morphology of this species is typical of the genus *Capillaria* s. s. (in contrast to the original description, the presence of a spiny spicular sheath could not be confirmed, this being probably due to a poor condition of the type specimens) Taking into account insufficient knowledge of the morphology of this species I am retaining it, for the time being, in the genus *Capillaria* without assigning it to a certain subgenus; future studies may prove necessity to establish a new independent subgenus for this species.

Within the genus *Schulmanela*, the present author (Moravec, 1982) established a new subgenus *Amphibiocapillaria* Moravec, 1982 to accomodate some parasites of amphibians. In a recent revision of fish capillariids (Moravec, 1986), only the species *S. petruschewskii*, characteristic of its remarkable structure of the stichosome, has been retained in the genus *Schulmanela*, whereas the subgenus *Piscicapillaria* Moravec, 1982 has been raised to a genus; but it is necessary to raise also the subgenus *Amphibiocapillaria* Moravec, 1982 to the rank of an independent genus, because the species listed in it show not only marked morphological differences from the type species of *Schulmanela* but differ in the range of hosts too. The present revision has shown that it is necessary to assign to *Amphibiocapillaria* also two species from reptiles (*A. freitaslenti* and *A. serpentina*) in addition to members from amphibians. It is probable that because of the morphological and biological peculiarities of *A. tritoniscristati*, it will be necessary to list this species in an independent subgenus in future; however, a prerequisite for it is to obtain additional data on the morphology of this species.

The only member of *Aonchotheca* from cold-blooded vertebrates is *A. buccalis*, which has been assigned provisionally to this genus by Moravec (1982). Because of inavailability of the type species of *C. buccalis*, its belonging to this genus could not be verified. However, the fact that *C. buccalis* belongs to *Aonchotheca* is indicated not only by the species morphology but also by its localitization in the host, this being similar to that in some other congeneric species from warm-blooded hosts.

Pseudocapillaroides is retained here as an independent monotypic genus whose type species *P. xenopi* parasitizes the skin of African clawed frogs; this genus is principally based on the presence of larvated eggs in the female's uterus, marked differences in the body size of males and females and on the localization of nematodes in the host. These features show affinities with some members of the family Trichosomoididae, particularly of the genus *Anatrichosoma*.

It has been indicated by this revision that all hitherto known species of capillariids from snakes can be assigned, on the basis of their morphological features, to the genus *Paracapillaria* in the conception by Moravec (1982). Even though the general morphology of species of this genus from fishes and snakes is similar, the capillariids from snakes are noted for some differences, when compared with fish capillariids. The body of capillariids from snakes is usually several times longer, their spicule is mostly conspicuously long and there are also differences in the structure of eggs and some organs; marked differences are found in the structure of nuclei in stichocytes that are conspicuously large in capillariids from snakes, their nucleoli containing several well visible corpuscles. Since both these two morphological groups of species are also characterized by different host ranges, I consider it useful to divide the genus *Paracapillaria* into two subgenera; the subgenus *Paracapillaria* would include the species parasitic in fishes, while *Ophidiocapillaria* subgen. n. would contain species from snakes. Moravec (1982) assigned provisionally also *C. bufonis* from amphibians to the genus *Paracapillaria*, but now it is transferred, on the basis of its morphological features, to the genus *Amphibio-*

capillaria. The morphology of *Paracapillaria* members indicates certain affinities with some forms parasitizing birds, these being, however, housed in other genera.

A special problem was the genus *Paratrichosoma* Ashford et Muller, 1978 including two species parasitizing the skin of crocodiles. Originally Ashford and Muller (1978) placed it in the family Trichosomoididae because of the supposed lack of a spicule and a spicular sheath; for this reason this genus was not included in the newly proposed system of the Capillariidae by Moravec (1982). Anderson and Bain (1982) considered only one valid genus, *Capillaria*, in the subfamily Capillariinae, family Trichuridae, and it was the opinion of these authors that *Paratrichosoma* was a synonym of *Capillaria*, based on unpublished information provided by Dr. D. M. Spratt, Australia. Dr. B. G. Campbell from Louisiana, USA, in his recent excellent review of the taxonomy of the family Capillariidae and selected species (Campbell, 1984), has listed *Paratrichosoma* as a distinct genus in this family. Dr. Spratt was kind enough to provide me his, at that time unpublished results of his reexamination of the type specimens of the type species of *Paratrichosoma*, *P. crocodylus*. According to his observations these nematodes were characterized by the presence of a nonsclerotized spicule and a spiny spicular sheath. He concluded that *P. crocodylus* was more comfortably located in *Capillaria* s. l. but that it possessed a number of exceptional characters: a) thickness of cuticle and consequent form of hypodermal glands, b) termination of stichosome well anterior to oesophago-intestinal junction, c) site of insertion of spicule retractor muscle anterior to distal end of ejaculary duct. Dr. Spratt's data have recently been published (Spratt, 1985).

My own reexamination of the type specimens of *P. crocodylus* practically confirmed Dr. Spratt's observations. The presence of the well developed spicule and the spiny spicular sheath indicates clearly that *Paratrichosoma* belongs to the Capillariinae. Since it markedly differs in many important morphological features from other capillariid genera, I consider it necessary to take it for an independent genus; in addition to the differentiating features already mentioned by Spratt, also the structure of the male tail and the specific localization of *Paratrichosoma* in the host should be considered.

Systematic survey of capillariids from amphibians and reptiles:

Subfamily Capillariinae Railliet, 1915

I. Genus *Capillaria* Zeder, 1800
    - *C. recondita* Freitas et Lent, 1942

II. Genus *Amphibiocapillaria* Moravec, 1982
    - *A. bufonis* (Morishita, 1926)
    - *A. costacruzi* (Travassos, 1932)
    - *A. freitaslenti* (Araujo et Gandra, 1941)
    - *A. serpentina* (Harwood, 1932)
    - *A. tritoniscristati* (Diesing, 1861)
    - *A. tritonispunctati* (Diesing, 1851)

III. Genus *Paratrichosoma* Ashford et Muller, 1978
    - *P. crocodylus* Ashford et Muller, 1978
    - *P. recurvum* (Solger, 1877)

IV. Genus *Pseudocapillaroides* Moravec et Cosgrove, 1982
   P. xenopi Moravec et Cosgrove, 1982

V. Genus *Aonchotheca* López-Neyra, 1947
   A. buccalis (Yamaguti, 1943)

VI. Genus *Paracapillaria* Mendonça, 1963
   1. Subgenus *Ophidiocapillaria* subgen. n.
      P. (O.) cesarpintoi (Freitas et Lent, 1934)
      P. (O.) congolensis sp. n.
      P. (O.) kuntzi Moravec et Gibson, 1986
      P. (O.) longispicula (Sonsino, 1889)
      P. (O.) madagascariensis (Ghadirian, 1968)
      P. (O.) modiglianii (Parona, 1897)
      P. (O.) murinae (Travassos, 1914)
      P. (O.) sonsinoi (Parona, 1897)

VII. Species considered as *species inquirendae:*
   "*Trichosoma*" *bombinatoris* Linstow, 1892
   "*Capillaria*" *fujianensis* Wang, 1982
   "*Capillaria*" *ranae* Wang, 1982

KEY TO THE GENERA OF NEMATODES OF THE CAPILLARIINAE FROM AMPHIBIANS AND REPTILES

1 Spicular sheath in male spiny 2
— Spicular sheath in male nonspiny 4
2 Cuticle *not conspicuously* thick; stichosome terminating at junction of oesophagus and intestine; male tail provided with membraneous bursa or large lateral lobes; intestinal and liver parasites of amphibians and reptiles (not in crocodiles) 3
— Cuticle conspicuously thick; termination of stichosome well anterior to oesophago-intestinal junction; caudal end of male without membraneous bursa, lobes or distinct genital papillae; parasites of skin of crocodiles *Paratrichosoma*
3 Membraneous bursa on male tail absent, tail provided with two large lateral lobes with cuticular margin; intestinal parasites of frogs . . . . *Capillaria*
— Membraneous bursa on male tail present, being supported by two rib-like dorsolateral projections bent along posterior border of bursa; one pair of large papillae present at base of caudal projections; parasites of intestine and liver of amphibians, turtles and lizards . . . . . . *Amphibiocapillaria*
4 Membraneous bursa on male tail absent, tail provided only with pair of small dorsolateral papillae; eggs in uterus containing larva; parasites of skin of frogs . . . . *Pseudocapillaroides*
— Membraneous bursa on male tail present, well developed, being supported by two narrow, dorsolateral projections; one pair of large papillae usually present at base of caudal projections; eggs in female uterus uncleaved; parasites of digestive tract 5
5 Lateral caudal alae in male present; parasites of mucosa of tongue, buccal cavity and oesophagus of frogs . . . . *Aonchotheca*
— Lateral caudal alae in male absent; parasites of digestive tract (stomach, intestine, cloaca), being exceptionally found also in urinary bladder, oviducts or penis, of snakes . . . . *Paracapillaria*

REVIEW OF THE GENERA AND SPECIES OF CAPILLARIIDS

Genus *Capillaria* Zeder, 1800

Syn.: *Trichosoma* Rudolphi, 1819, partim; *Trichosomum* Creplin, 1829; *Thominx* Dujardin, 1845, *Orthothominx* Freitas et Silva, 1960.

Diagnosis: Stichosome composed of single row of stichocytes; lateral caudal alae in male absent; posterior end of male rounded, usually provided with two lateral, ventrolateral or dorsolateral lobes; membraneous bursa absent; one pair of small sessile papillae usually present near cloacal opening; spicule with numerous rough transverse grooves on surface; spicular sheath spiny; vulvar appengage present or absent; parasites of intestine and liver.
Type species: *C. anatis* (Schrank, 1790) (see Fig. 1)
The only member from amphibians is *C. recondita.*

1. *Capillaria recondita* Freitas et Lent, 1942 (Fig. 2)

Following description based on type specimens from *Crossodactylus gaudichaudii* from Brazil.
Description: Small-sized nematodes. Head end rounded; bacillary bands indistinct. Stichocytes arranged in single row; stichocytes elongated, subdivided into several transverse annuli and provided with large nuclei; number of stichocytes could not be established.
Male (1 specimen): Length of body 4.99, maximum width 0.057. Length of entire oesophagus 2.64 (53 % of body length), of muscular oesophagus 0.258, of stichosome 2.38; distance of nerve ring from anterior extremity 0.069. Spicule sclerotized, thin-walled, its surface appearing to be smooth; proximal end of spicule somewhat expanded, funnel-shaped ,distal end broadly rounded. Length of spicule 0.168, its width 0.006. Evaginated spicular sheath 0.018 long and 0.012 wide, appearing to be without spines (it is spiny according to original description and drawings; spines may be indistinct in this specimen as a result of strong clearing of preparation). Tail rounded, in ventral view with two large, round lateral lobes provided with narrow cuticular margin; caudal papillae not observed. Width of body just anterior to caudal lobes 0.024, at their level 0.030. Length of tail 0.009.
Female (3 specimens): Body length of females without eggs in uterus 6.03 —7.43, maximum width 0.068—0.081. Length of entire oesophagus 2.68—3.11 (39—50 % of body length), that of muscular oesophagus 0.195—0.252, of stichosome 2.48—2.86; distance of nerve ring from anterior end 0.060—0.081. Vulva situated at level of junction of oesophagus and intestine , i. e. 2.68—3.13 from anterior extremity. Anterior lip of vulva markedly elevating. Eggs in uterus lacking. Posterior end of body rounded, anus subterminal, length of tail 0.006. Posterior end of ovary exceeding mid-length of rectum; length of rectum 0.450.
Localization: small intestine.
Host: Type- and the only host is the frog **Crossodactylus gaudichaudii* of the family Leptodactylidae.
Distribution: Hitherto recorded once in Brazil (Grajaú, Rio de Janeiro, D. F.) (Freitas and Lent, 1942).
Specimens: Fundaçao Oswaldo Cruz, Rio de Janeiro — syntypes (Cat. Nos. 15425a, b and 15426a, b).
Comments: The present knowledge of the morphology of *C. recondita* (allegedly a spiny spicular sheath, structure of stichosome and that of male tail, subterminal anus in female) makes it possible to assign this species provisionally to the genus *Capillaria;* its subgeneric status is problematic for the time being and it will recquire additional data on the morphology of *C. recondita* until it is elucidated.

Genus *Aochotheca* López-Neyra, 1947

Diagnosis: Stichosome composed of single row of stichocytes; lateral caudal alae in male present, well developed; posterior end of male provided with membraneous bursa supported by one or more pairs of narrow, elongate, often ventrally bent lateral projections; spicule present, sometimes indictinct due to insufficient sclerotization; spicular sheath nonspiny; vulvar appendage absent or present; parasites of digestive tract of mammals, less frequently birds and amphibians.

Type species: *A. putorii* (Rudolphi, 1819)

The only species parasitizing amphibians is *A. buccalis.*

1. *Aonchotheca buccalis* (Yamaguti, 1943) Freitas et Mendonça, 1961
   Syn.: *Capillaria buccalis* Yamaguti, 1943.

Description (adapted from Yamaguti 1943): Medium sized nematodes. Cuticle almost smooth. Bacillary bands present, starting at level or nerve ring and extending posteriorly to body end. Stichosome formed by 28–42 stichocytes provided with large nuslei.

Male: Length of body 6.8–8.8, maximum width 0.08–0.09. Length of entire oesophagus 2.7–3.9, number of stichocytes 36–42. Length ratio of oesophagus and posterior part of body 1 : 1.25–1.5. Distance of nerve ring from anterior extremity 0.065–0.100. Spicule 0.57–0.61 long and 0.018–0.027 wide at its expanded end, tapering posteriorly to blunt point. Spicular sheath nonspiny, with fine transverse wrinkles. Pair of small lateral caudal alae 0.045–0.070 long present in front of cloacal opening level; each of them containing one minute papilla. Genital bursa itself short, length 0.015, on either side being supported by two dissimilar, ventrally directed rays with common base; anterior ray slender, finger-shaped, 0.015 long, with doubled end; posterior ray a little thicker and shorter, slightly anteriorly bent, almost parallel with anterior ray. Cloacal opening ventrolateral.

Female: Length of body 8.1–12, maximum width 0.011–0.015. Width of bacillary band 0.090. Length of entire oesophagus 2.9–4.1, number of stichocytes 28–38. Length ratio of oesophagus and posterior part of body 1 : 15–2.2. Vulva usually narrowed, situated at level of posterior end of oesophagus (2.9–4.1 from head end). Eggs lemon-shaped, 0.066–0.078 long including polar plugs, width 0.024–0.036, without sculpture. Anus terminal.

Localization: mucosa and submucosa of tongue, mainly its underside, palate and pharynx.

Host: The toad *Bufo bufo japonicus* (fam. Bufonidae).

Distribution: So far it has been found once in Japan (Kyoto) (Yamaguti, 1943).

Specimens: Neither the type- or other specimens of *A. buccalis* were obtained for study.

Comments: This species can be easily distinguished from all the capillariids parasitizing amphibians by the presence of lateral caudal alae and by their localization in the host's body. *A. buccalis* is the only member of *Aonchotheca* parasitic in cold-blooded vertebrates.

Genus *Paratrichosoma* Ashford et Muller, 1978

Diagnosis: Cuticle conspicuously thick, with numerous external pore openings of papilla-like hypodermal gland cells; stichosome consisting of single row of very elongate stichocytes, termination of stichosome well anterior to oesophago-intestinal junction; lateral caudal alae in male absent; posterior end of male simple, without membraneous bursa, lobes or distinct genital papillae, cloacal opening terminal; spicule with numerous rough transverse grooves on its surface; spicular sheath spinose; vulvar appendage absent; parasites of skin of crocodiles.

Type species: P. *crocodylus* Ashford et Muller, 1978

At present two nominal species of *Paratrichosoma* are known, *P. crocodylus* and *P. recurvum;* the latter was inadequately described from available females only and, consequently, it is impossible to compare the morphology of both these species. They can be separated on the basis of their geographical distribution only, although their conspecificity cannot be excluded. King and Brazaitis (1971) have reported undulating "worm trails" on the ventral scales of an Orinoco crocodile, *Crocodylus intermedius,* which were apparently produced by *Paratrichosoma* sp.; the authors also mention that similar trails have been seen on additional four crocodile species — *C. johnsoni, C. moreletii, C. niloticus* and *C. porosus.* According to information by Dr. D. I. Gibson from the British Museum, they recently had some crocodile skin, from a crocodile farm in Zimbabwe, which had patterns on it similar to those produced by *Paratrichosoma* spp. These data indicate that *Paratrichosoma* members are distributed in South America and Africa too.

Key to species of *Paratrichosoma:*

1 Parasites of abdominal skin of crocodiles in Central America (Yucatan, Mexico) . . . . *P. recurvum*
— Parasites of abdominal skin of crocodiles in Australia and New Guinea . . . . P. *crocodylus*

1. *Paratrichosoma crocodylus* Ashford et Muller, 1978 (Fig. 3)

Following description based on type specimens from *Crocodylus novaeguineae* from Papua New Guinea.

Description: Comparatively big nematodes. Cuticle conspicuously thick Two broad lateral bacillary bands present, occupying almost entire circumference of nematode throughout mid-body region; one narrow ventral bacillary band also present. Stichosome formed by single row of very elongated stichocytes, their subdivision into transverse annuli indistinct; nuclei of stichocytes comparatively small-sized. Stichosome terminating well anterior to oesophago-intestinal junction; two mesenchymal cells not visible at junction of oesophagus and intestine.

Male (1 specimen) (paratype): Length of body 25.19, maximum width 0.054 mm; maximum width of cuticle 0.006—0.009. Length of entire oesophagus 10.74 (43 % of body length), of muscular oesophagus 0.123, of stichosome 10.56; number of stichocytes could not be established. All stichocytes light in colour, being mostly 0.210—0.270 long and 0.030 wide in posterior part of stichosome. Distance between posterior border of stichosome and intestine being 0.060 Distance of nerve ring from anterior extremity 0.051. Spicule 0.369 long, its width at anterior end, mid-length and distal end 0.018, 0.012 and 0.009, respectively. Middle part of spicule with many rough transverse grooves on surface; distal end of spicule weakly sclerotized, smooth. Spicular sheath densely spinose, length of robust, blunt spines being 0.003—0.005. Posterior end of body simple, without any distinct lobes or genital papillae. Only papilla-like hypodermal gland cells as a consequence of necessity to pass through thick cuticle to external pores seem to be present at posterior body end of male; they belong to two lateral and one ventral bacillary bands. Cloacal opening terminal, length of inflated cuticle on posterior extremity 0.009.

Female (3 specimens) (holotype and 2 paratypes): Body length of gravid females 60.07—60.15, maximum width 0.122—0.136; maximum width of cuticle 0.006. Length of entire oesophagus 17.41—19.25 (32—35 % of body length), of muscular oesophagus 0.225—0.270, of stichosome 17.19—18.93; number of stichocytes about 40. Distance between posterior end of stichosome and anterior end of intestine being 0.051—0.096. Distance of nerve ring from anterior extremity 0.084. Vulva situated slightly below (up to 0.150) or in front (0.075) of oesophago-intestinal junction, its lips nonelevating. Eggs in uterus arranged in one row. Eggs oval, thin-walled, with smooth surface; their polar plugs not protruding. Mature eggs in uterus nonembryonated. Size of eggs 0.075—0.078 × 0.027—0.033, thickness of their wall being 0.0015; length of polar plug 0.0045, its width 0.006. Posterior end of body rounded, anus terminal. Length of rectum 0.240. Posterior end of ovary reaching to rectum level.

Localization: *in tunnels in epidermis of skin of abdomen.*

Hosts: Crocodiles, **Crocodylus novaeguineae* (type host), *C. porosus* and *C. johnsoni* (fam. Crocodylidae).

Distribution: Papua New Guinea (crocodile farm at Moitaka, Port Moresby) (type locality) and Northern Australia (Ashford and Muller 1978, Burgins 1981, Webb and Manolis 1983).

Specimens: British Museum (Nat. Hist.), London — types (Cat. Nos. 1978.915—920).

Comments: This species was described by Ashford and Muller (1978) from the New Guinea crocodile, *Crocodylus novaeguineae*, from the crocodile farm at Moitaka, Port Moresby, from Papua New Guinea. The authors also mention its occurrence in saltwater crocodiles (*C. porosus*); according to them, preliminary results of the prevalence of infection in wild and captive populations in Papua New Guinea and Northern Australia indicate that the parasite is rare or absent in crocodiles from areas of saline water, and that transmission does not occur in some rearing conditions. Later records from Australia by Burgins (1981) and Webb and Manolis (1983) from *C. porosus* and *C. johnsoni*, respectively, concerned evidently this species.

Ashford and Muller (1978) provided a very short description of this species that was named *P. crocodilus*; since the parasite's specific name is derived from the generic name of the host, this being spelled *Crocodylus*, accordingly the correct name of this parasite is *P. crocodylus*.

The above mentioned authors did not find a spicule or a spicular sheath in the male of this species and, therefore, they considered it a member of the family Trichosomoididae, for which they erected a new genus *Paratrichosoma*. However, a recent reexamination of the type specimens of *P. crocodylus* carried out by Spratt (1985) has indicated the presence of the spicule and the spicular sheath with robust, blunt spines in this species, confirming thus its belonging to the Capillariinae. Own study of the type specimens of *P. crocodylus* has confirmed his observations.

2. *Paratrichosoma recurvum* (Solger, 1877) Ashford et Muller, 1978

Syn.: *Trichosoma recurvum* Solger, 1877.

Description: (after Freitas and Lent, 1935):

Male: unknown.

Female: Length of body 70—75, width 0.09—0.10. Body considerably narrowed anteriorly. Vulva situated 25 from head end, approximately at border of anterior and middle thirds of body length. Anus terminal, with two lateral papillae. Eggs in uterus measuring 0.063 × 0.030, not embryonated.

Localization: abdominal skin.

Host: Crocodiles, *Crocodylus acutus* (fam. Crocodylidae).

Distribution: Mexico (Yucatan) (Solger, 1877, 1933, Skryabin et al., 1957, Campbell — pers. comm.).

Specimens: The type specimens of this species were not obtained for study and it is probable that they have been lost.

Comments: The only existing description of P. *recurvum* is that provided by Solger (1877) who inadequately described female specimens found in the abdominal skin of crocodiles from the Yucatan Peninsula, Mexico. According to personal communication of Dr. B. G. Campbell, this species has recently been found to be a frequent parasite of crocodiles in the Yucatan. A redescription of this species is needed in order that its morphology might be compared with that of *P. crocodylus.*

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The figures 1—3 will be found at the end of this issue.

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KUDOA ATROPI SP. N. (MYXOSPOREA: MULTIVALVULIDA) A MYXOSPORIDIAN PARASITE FROM THE GILLS OF ATROPUS ATROPUS

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Abstract. A new species of *Kudoa*, *K. atropi* sp. n. is described from the gills of the marine fish, ***Atropus atropus*** (Bloch et Schneider) (Fam. Carangidae). The host fish is collected from the Offshore Fishing Station at Visakhapatnam (Andhra Pradesh, India) during Sept. 1980 — Jan. 1981. The cyst-like bodies are opaque with measuring 0.5—1.0 mm in diameter and are attached to the gill filaments. Quadrate spores measuring 9.0—11 × 9.0—11.0 × 8.0—9.0 μm are observed. The systematic position of the parasite is discussed

Myxosporean parasites are reported from a variety of piscine hosts from different parts of the world. A perusal of the literature shows that most of the significant epizootics are recorded from culture fish, while the potential hosts of the marine environment are less explored. In India several myxosporeans belonging to different genera and species are reported from fresh water and estuarine fishes while only a few have been reported from marine hosts

During the course of a routine survey of the myxosporean and microsporidan parasites of the food fishes of the coast of Visakhapatnam (Andhra Pradesh, India) a myxosporean parasite belonging to the genus *Kudoa* is encountered on the gills of the carangid fish *Atropus atropus*. For reasons discussed elsewhere in the text of the paper it is considered new to science for which the name *Kudoa atropi* sp. n. is suggested.

The host fish, *Atropus atropus* (Fam. Carangidae) ranging in size from 20—30 cms were collected from the routine fish catches. They were mostly collected during the colder months of the year (September—January). They were brought to the laboratory immediately after collection and the different organs were examined for the infection. The examination of the gills revealed the presence of opaque white cyst-like bodies attached to the gill filaments. Smears of the cyst-like bodies showing the spores and other developmental stages of the parasite were either air-dried, fixed in acetone free methyl alcohol and stained with Giemsa in the usual manner or fixed in hot Schaudinn's fluid and stained with Heidenhain's iron haematoxylin Spores were also stained with Feulgen's after fixing in Carnoy's fluid. For examining the spores at the same level Lom's (1969) agar layer method was followed To detect the presence of iodinophilous vacuole Lugol's iodine was used. India ink was use to observe the presence of any mucous envelopes. All the drawings were made with the aid of a Camera lucida

Kudoa atropi sp. n.

Host: *Atropus atropus* (Fam. Carangidae)
Locality: Visakhapatnam coast, Bay of Bengal
Site of infection: Gills

Type slides: Department of Zoology, Andhra University Waltair and Author's collection.

A total number of 150 *Atropus atropus* ranging in size from 20—30 cms and belonging to both the sexes were examined during September 1980 and January 1981. The prevalence of infection was low and only 10 of the fish examined were infected. The intensity of infection was also low and each infected fish yielded 3—4 cystlike bodies. There are no apparent changes in the host tissue on acount of the infection. Opaque white cyst-like bodies measuring 0.5—1.0 mm in diameter were found attached to the gills or are sometimes embedded in the tissue below the gills. Smears prepared by rupturing the cyst-like bodies revealed a number of disporic pansporoblasts and developmental stages of the spores.

Spores are quadrate in polar view with deep notches extending about 1/4 the length of the sutural line and have rounded ends with a delicate mucous membrane around, which is seen only in spores stained with India ink. They measured 9.0—11.0 × 9.0—11.0 × 8.0—9.0 µm (average 10.0 × 10.0 × 9.0 µm, n = 50) (Fig. 1). The surface of the spore is smooth. In a lateral view the posterior end appeared broadly oval while the anterior end tapered to a blunt point (Fig. 2). The sutural lines when stained with Giemsa after an initial hydrolysis in 1N H Cl for 10 min showed characteristic thickening of the sutural ridge (Fig. 3). This thickening is probably seen during the process of maturation. The polar capsules were pyriform and measured 3.0—3.6 µm × 1.6—1.8 µm (average 3.3 × 1.7 µm; n = 50). They were equal in size and open at the anterior end of the spore. 6—7 coils of the polar filament could be clearly seen in well differentiated specimens. The sporoplasm was oval and contained two nuclei each with an incipient nuclear membrane and a single deeply stained endosome (Fig. 4). There are no inclusions and there was an iodinophilous vacuole in the posterior half of the spores which stained mahogany brown with Lugol's iodine (Fig. 5). The addition of a drop of 1N K OH or H_2O_2released the polar filaments in 30 $^0/_0$ of the spores. Generally only 2—3 filaments were extruded out simultaneously while the fourth was rarely released. The filaments were uniformly thin measuring 8—12 µm (average 10 µm; n = 50) (Fig. 6). Spores with five spore valves and five polar capsules were occasionally observed in smears but since their number was insignificant it was considered an abnormality (Fig. 7). A few early sporogonic and plasmodial stages were observed in smears prepared from the small cyst-like bodies. The contents of these cyst-like bodies showed the trophozoites as well as developing sporoblast. The earliest stage observed was an oval trophozoite measuring 3.2 × 2.4 µm with two deeply stained vesicular nuclei (Fig. 8). The nuclear membrane was delicate and there was a clear halo around a deeply stained centrally placed endosome. Trophozoites with 16 nuclei measuring 8.6 × 7.8 µm showed a difference in the size of the nuclei, four of them which were medially placed were large while the rest of the eight which were peripherally placed were small. The staining reaction in both was however the same (Fig. 9). They probably represent the generative and vegetative nuclei respectively. The fully developed pansporoblasts were dumbbell shaped and measured 14.0 × 6.4 µm and had a total number of 20 nuclei, 10 in each half. In each half two of the nuclei were bigger and were probably the generative nuclei and the rest of the eight which were smaller were the somatic nuclei (Fig. 10). There is a single enveloping cell. Pansporoblasts were disporic. The two spores in the pansporoblast were seen attached at their anterior ends, each spore showing 4 capsulogenous nuclei below the capsule, 4 valogenous nuclei near the periphery and 2 sporoplasmic nuclei which were large and were adherent to each other and were placed in the centre. Numerous such pansporoblasts were seen in a single cyst.

Discussion and systematic position: The genus *Kudoa* is characterised by the presence of quadrate or stellate spores and having histozoic or coelozoic development and typically parasites of skeletal muscles. Meglitsch (1947) after separating the genus from *Chloromyxum* transferred 8 species of *Chloromyxum* to the new genus *Kudoa*. Several species have been reported from fishes from different parts of the world and among them 5 species, *K. chilakensis* Tripathi, 1952, *K. tetraspora* and *K. sphyraeni* Kalavati and Narasimhamurti, 1979a, b, *K. bengalensis* and *K. tachysurae* Sarcar and Mazumdar, 1983 are from fishes collected from Indian waters.

The present form resembles *K. crumena* Iversen and Van Meter, 1967 from the muscles of the spanish mackerel, *Scomberomerus maculatus* collected in south Florida in the measurements of the spore but is tetrasporoblastic while the present form is disporoblastic. The present form also resembles *K. musculoliquifaciens* Matsamoto, 1954 from the muscles of *Xiphias gladius* from Japan and *K. funduli* (Hahn) Meglitsch, 1947 from the median fins of *Fundulus heteroclittus* in the general appearance of the spore but the size of the spores in the present form is consistently larger than the above mentioned species. Among the species reported from India the present form resembles *K. tetraspora* and *K. sphyraeni* in the measurements of the spore but the former is reported from the optical lobes of the estuarine fish *Mugil cephalus* and the latter is reported from the gut of the marine fish *Sphyraena jello*. Both the species are tetrasporic while the present form from the marine fish, *Atropus atropus* is disporic. Disporic pansporoblasts are seen in *K. cerebralis* Paperna and Zwerner, 1974 but the site of infection is the brain tissue while in the present form it is from the gill filaments. The spore measurements in the present form resemble those of *K. paniformis* but the spore in the later species are sub quadrangular in shape, sometimes with uneven sutures and sub equal polar capsules which is not the case in the present form. In view of what is stated above and since the gills are a new site of infection for the genus *Kudoa* the present form is considered new to science and the name *Kudoa atropi* sp. n. is proposed for the same.

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

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SENSITIVITY OF THE OLFACTORY ORGAN OF THE COMMON SHREW (SOREX ARANEUS) TO SOME FATTY ACIDS*

František SEDLÁČEK

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Abstract. An olfactometer and experimental apparatus were constructed according to data in literature, and the sensitivity of the olfactory organ of the common shrew (*Sorex araneus*) to three fatty acids was tested. Five shrews (4 males and 1 female) were trained by operant conditioning to prefer a trapdoor in front of which air enriched with vapours of fatty acid was coming out of a tube. The following threshold values were obtained by a gradual reduction of concentration: a) 1.0×10^{13} molecules of acetic acid per cm^3 of air, b) 2.0×10^{11} molecules of propionic acid per cm^3 of air, c) 8.0×10^{10} molecules of butyric acid per cm^3 of air.
In comparison with other mammals, these values are in keeping with some quantitative parameters of the olfactory epithelium, but they do not correlate with neuroanatomical findings on the size of olfactory centres in the telencephalon.

INTRODUCTION

The common shrew *(Sorex araneus)* is one of the mammals possessing a relatively small brain. Phylogenetically old structures, palaeocortical and archicortical ones, take up more of the telencephalon than those formed later in evolution, which are concentrated in the neocortex (Stephan 1960, 1967a, Bauchot and Stephan 1968). Since olfactory information is processed not only by the olfactory bulbus but also by other structures of the olfactory allocortex (Stephan 1960), it is presumed that the sence of smell is of primary importance in the lives of mammals having a large olfactory allocortex.

Although the large size and microscopic structure of the olfactory organ of soricids have been confirmed by Wöhrmann — Repenning (1975) and Zima (1976), echolocation experiments (Gould et al. 1964, Buchler 1976) and morphological studies on their auditory organ (Fleischer 1973, Burda 1978, 1979a, b, c) indicate that the hearing of soricids is very good. Also touch seems to have an important role in their lives, as has been shown e. g. by Grünwald (1969). Vogel (1972, 1973) and Vlasák (1970, 1973) have also contributed by their ontogenetical studies to our knowledge of the effectiveness of the senses of soricids. However, Vlasák (l. c.) noted that their sense of smell, similarly as sight (Braniš 1981) are not of primary importance in their communication with environment.

Only in 1972 Bretting published an experimental study on the sensiti-

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* The subject was chosen and work on the thesis supervised by RNDr. L. Sigmund CSc.

vity of the olfactory organ of the hedgehog *Erinaceus concolor* whose brain resembles that of the common shrew in its neuroanatomic arrangement. Surprisingly, Bretting (1972) found that the olfactory organ of the hedgehog is approximately as sensitive to certain fatty acids as that of man whose olfactory centres are much smaller than the hedgehog's (Stephan 1960). These findings are consistent with the results of Adrian's (1942) electrophysiological experiments on the olfactory cortex and bulbus of the hedgehog. For the time being, the results of the neuroanatomical studies then do not seem to coincide in this respect with the results of the electrophysiological and neuroethological experiments.

The object of the present study is to verify Bretting's experiments in another insectivore and thus learn more about the little known life of the common shrew, as well as to obtain more information on the function of the mammalian olfactory organ.

MATERIAL AND METHODS

Experimental animals (subadult males A, B, D, E and subadult female C) were trapped in the eastern suburb of Karlovy Vary (Carlsbad) in the autumn of 1978 and 1979.

The individual shrews were kept in glass terraria sized 60 × 30 × 30 cm. The bottom of each terrarium was covered with 3–5 cm of damp soil, and about one third of the surface with dry grass. There was a transportation box (12 × 7 × 7 cm) in each terrarium. The shrews were fed beef, earthworms, and sometimes the viscera of venison every night when experiments had been finished. The room temperature was about 10 °C in winter and about 20 °C in summer. For more details on rearing see Vlasák (1970, 1973).

Three fatty acids of biological importance were used for the experiments, acetic, n-propionic and n-butyric of P. A. purity, which had also been used by Neuhaus (1953), Bretting (1972) and others. The sensitivity of the olfactory organ was established by determining the values of threshold concentrations by the method of operant conditioning (Neuhaus 1953): the animals were trained to show preference for one of three trapdoors in front of which air enriched with vapours of fatty acid was coming out of a tube. The shrews could freely go through this door, whereas the other two, in front of which the same amount of clean air was blowing from a tube, remained closed. When the shrew had accidentally gone through the door which could be opened, it was rewarded with food. When the animals had learned this, they mostly chose the door associated with the odour of fatty acid and ignored the others. Correct choices were much more frequent than errors.

When the threshold concentration was being determined, all doors could be passed through and the concentration of vapours of the fatty acid was gradually reduced until the proportion of correct choices decreased so much that preference for a certain door could not be proved any longer. The X^2-test was then used for determining the lowest, i. e. threshold concentration at which the shrews still chose the door associated with the smell (cf. Bretting 1972).

An olfactometer (Fig. 1 A) producing required concentrations of odour was constructed after Gruch (1957). The exhaust of a vacuum cleaner was used as a source of air current which was guided through a long hose to a distributor where the air was filtered through silon wool and filter charcoal. Three PVC hoses of 3 mm inner diameter guided the air from the distributor to individual flow meters consisting of a U-manometer filled with water, and a Venturi tube. The air was guided from each flow meter through PVC hoses to three filters of silon wool and charcoal. Glass T-tubes of 6 mm ID stoppered with polystyrene plugs with capillaries were inserted into the other end of the filters. Only one of the capillaries was filled with fatty acid. The glass T-tubes were attached to the distribution tubes of the apparatus by short rubber sleeves. Thus a T-tube with the capillary filled with fatty acid easily be replaced with another T-tube with an empty capillary, and vice versa. The passage of air was 20 cm^3/S in all experiments. Another current of air

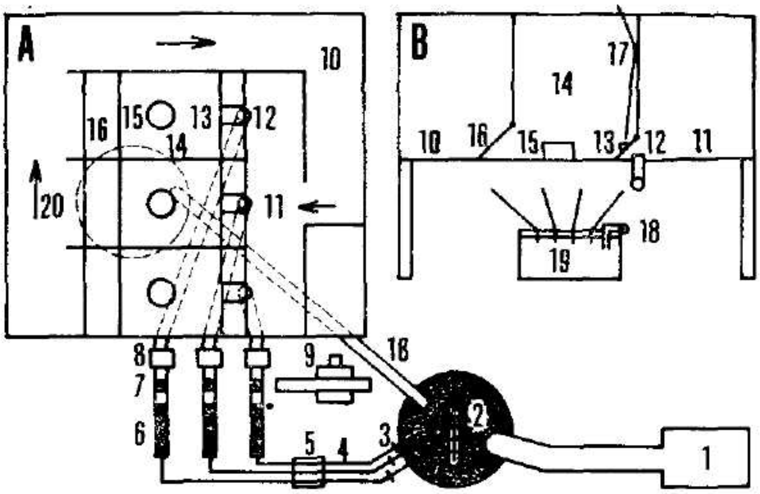

Fig. 1 Scheme of the apparatus (A) and its cross section (B) 1 — source of air current, 2 — distributor of air current, with filter and thermometer, 3 — regulators of passage, 4 — PVC hoses, 5 — flow meters, 6 — T-tubes with filters, 7 — capillaries, 8 — rubber sleeves, 9 — microscope, 10 — corridor, 11 — room of choice, 12 — opening of distribution tube, 13 — small door, 14 — compartment for rewards, 15 — dish, 16 — large door, 17 — lever, 18 — ventilation tube, 19 — clean air duct, 20 — direction of the shrew's movements.

from the distributor was conducted under the apparatus to improve its ventilation Different concentrations of vapours of the fatty acids were obtained by using capillaries of different inner diameters, from 0.75 to 0.05 mm, and by different shapes of their openings into the air current. The concentration of vapours of the fatty acids was calculated from the volume of air that had passed and from changes in the volume of the compound in *the capillary during a certain time. The decrease* in the amount of the compound in the capillary was observed under a microscope at 30$\times$ magnification. The concentrations were calculated according to the formula

$$C = \frac{L \times \rho \times N}{V \times M}$$

C = number of molecules of compound per cm^3 of air
L = volume of evaporated compound in mm^3
ρ = density of compound in g/mm^3
N = Avogadro constant 6.023×10^{23}/mol
V = volume of air passage in cm^3
M = molar weight of compound

For a detailed analysis of the calculation see e. g. Neuhaus (1953). The values of two concentrations calculated by this formula were verified using a Hewlett-Packard 5700 A gas chromatograph. The calculated values were lower by approx 25 per cent. In view of the differences in the values of threshold concentrations already determined for some species (Fig. 2) our calculations can be considered accurate enough.

The experimental apparatus (Fig. 1) in which the shrews learned and were tested had been constructed after Bretting (1972). A table consisting of a wooden frame (50 $\times$ 40 cm) with a silon net (mesh size 1 mm) and a fixed system of glass tubes (ID 6 mm) supported walls 20 cm high. These were arranged to form a corridor, *room of choice, and three compartments where rewards would* be received. Small trapdoors which opened only one way led from the room of choice into the individual compartments. A glass tube opened 5 mm above the net in front of each trapdoor.

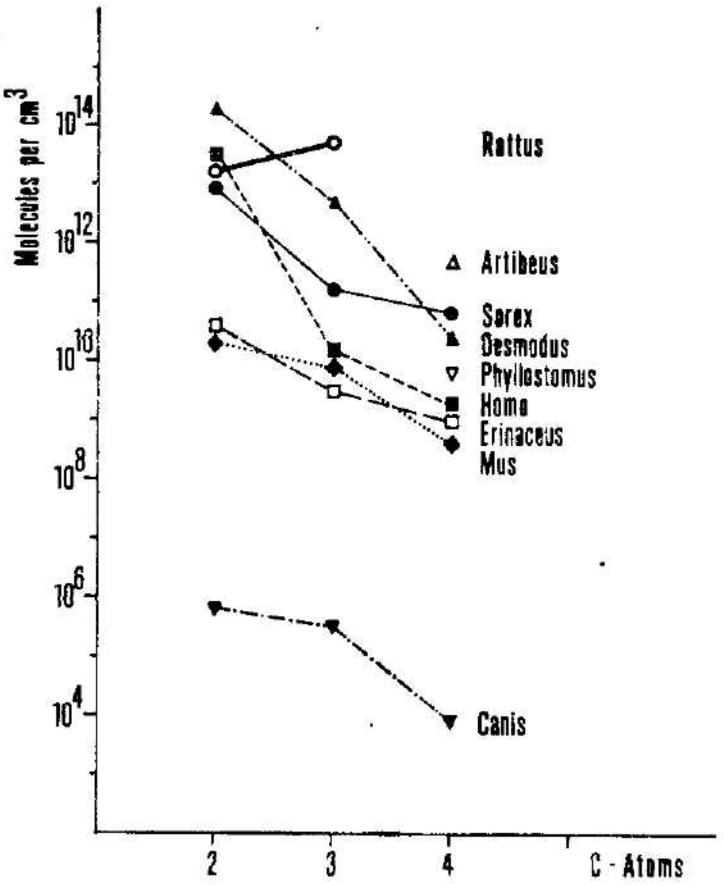

Fig. 2. Comparison of the values of threshold concentrations of acetic acid (C 2), n-propionic acid (C 3) and n-butyric acid (C 4) determined for some mammals. *Homo* (Passy 1892 ex Neuhaus 1953, Goldenberg 1967), *Canis* (Neuhaus 1953), *Rattus* (Gruch 1957), *Erinaceus* (Bretting 1972), *Desmodus, Phyllostomus, Artibeus* (Schmidt 1975), *Mus* (Schmitd 1978).

The doors could be closed by levers fastened inside the compartments. When the trapdoor was shut, the other arm of the lever did not quite bear on a tooth on the trapdoor, which allowed it to be moved slightly. When the shrew pushed against the closed door, the tooth gave a click, which announced an error during the period of learning (Fig. 1 B). In each compartment there was a dish into which pieces of *Tenebrio molitor* larvae were thrown. A large trapdoor led from each compartment into the corridor. It also enabled only one-way passage, so that the shrews could run throughout the apparatus in one direction only. All walls and doors were made of wood-paper cardboard and covered with a thick layer of a two-component resin varnish.

The experiments were conducted as follows. The source of air, the vacuum cleaner was switched on. The polystyrene stoppers with capillaries, one of which contained the fatty acid, were inserted into the vertical openings of the T-tubes. The amount of the compound in the capillary was measured, and a stop watch was switched on at the moment when the value was being read. The T-tube plugged with the capillary containing the fatty acid was inserted into a randomly selected distribution tube, and the lever was positioned to allow passage through the small door.

The dry grass in the terrarium was gently rustled with a stick to make the shrew enter the transportation box. If any of the shrews avoided the box it was left alone till the next expt. The shrew was then released from the box into the corridor through which it came into the room of choice, and could choose any of the three doors. If it had gone through the door smelling of the fatty acid it was rewarded in the small compartment. The cut pieces of larvae were big enough to give us time to exchange the T-tubes and let at least ten times as much air as was the volume of the distribution tubes pass through them while the shrew was eating its reward. This ensured that the next choice the shrew would make would again be between clean air and the calculated concentration of vapours of the fatty acid. When the experiment was over the transportation box was again placed inside the apparatus and the shrew was returned to its terrarium. The decrease in the amount of the compound in the capillary and the duration of evaporation were then measured. The apparatus was washed with detergent and hot water after each experiment. They began at 9, 12 a. m., 3 and 6 p. m. o'clock and took about 15 minutes each.

RESULTS

The initial part of training was done without switching on the olfactometer. The shrews released from the transportation boxes into the apparatus remained motionless for a few seconds. After an average of 20 s they reached the room of choice (Fig. 1). All the small doors were kept half ajar by polystyrene blocks in such a way that when the tested shrew was going through the door the block was pushed aside and the door was closed. The shrews would run about the room of choice and in the corridor for an average of 30 s, then they entered the compartment and ate their rewards. All the shrews easily crawled under the large trapdoor although it was not ajar. The shrews thus ran through the apparatus 5—7 times. During the initial expt. they chose the door through which they had passed the first time. If any of the tested shrews stopped returning through the corridor, or when it began to run round very quickly without eating the reward, the experiment was discontinued and the shrew was returned to its transportation box. In the following trials the small trapdoors were gradually closed until the shrews learned to push them up.

Only one randomly chosen door remained passable in subsequent experiments. In the new situation some of the shrews, having hit a firmly closed door, tried again to push up another one after a few seconds. Others returned into the corridor, but then went back to the room of choice and tried again to pass through one of the trapdoors. After several attempts no shrew returned or remained on one spot, but all tried to pass through one of the three doors. In total, the five shrews made 287 choices in 40 expts. during the initial phase of training.

In the second phase the shrews were taught to discriminate the doors and to choose the one that would open by the odour emanating from the tube placed in front of it. During these experiments the olfactometer produced a high concentration of acetic acid (3.2×10^{14} molecules per cm^3 of air) to which the animals would presumably respond.

The shrews followed several stereotyped routes in the room of choice (Tab. 1). In approximately 80 $^0/_0$ of the attempts the shrews first tried the middle door and when they failed to open in they ran directly either to the left or right one. In case of another failure they ran to the opposite door, ignoring the middle one in about 85 $^0/_0$.

Table 1. An example of two recorded experiments and their evaluation

shrew B	**XI 2, 1979**	**5.0×10^{13}**	**molecules of acetic acid/cm^3**		
beginning	scheme of individual choices	evaluation	number of choices	number of correct choices	%
9.00 a. m.	x O– o	0			
	–o——o——X	1			
	X——o– o	1			
	o –X o	1			
	x –O o	0			
	–o——o——X	1			
	o –o——X	1			
	X——o——o–	1			
	X——o– o	1			
	o O– x	0			
	O—— x o	0	11	7	63.6
12.00 a. m.	o O– x	0			
	x O– o	0			
	x O– o	0	3	0	0
	only runs round without seeking reward, the experiment is not counted				

x — door with odour, X — correct choice of door with odour (1), o — door without odour, O — wrong choice of door without odour (0).

It was quite apparent that at first the shrews would hit the firmly closed doors, but later they only touched them. Also the speed with which they moved about the room of choice was slightly decreasing. At times the shrews ran very quickly and ignored the food; when this happened the animal was immediately caught and returned to the terrarium.

The percentage of correct choices was calculated from the total number of choices, mostly made during 10 experiments. The training was considered complete when correct choices reached 70 % (Bretting 1972). The number of expts, choices, and the percentage of correct choices during the second phase of training are given in Tab. 2.

Threshold concentrations were determined as follows: The value of threshold concentration of acetic acid was determined first. The concentration was

Table 2. Number of experiments and choices, and the percentage of correct choices in the second phase of training

shrew	number of experiments	number of choices	percentage of correct choices
A	128	1374	72.3
B	61	687	72.4
C	74	831	76.0
D	65	790	74.3
E	63	676	70.6

Table 3. Determination of the threshold concentration of acetic acid for shrew A

	concentration (mol./cm^3)	number of experiments	number of choices	number of correct choices	%
series I					
	1.0×10^{14}	37	410	291	71.0
	7.5×10^{13}	34	342	219	64.0
	5.0×10^{13}	36	377	261	69.2
	2.0×10^{13}	44	482	298	61.8
	1.0×10^{13}*	12	149	68	45.6
	6.3×10^{12}	13	132	43	32.6
series II					
	7.5×10^{13}	15	180	103	57.2
	5.0×10^{13}	10	101	56	55.4
	2.0×10^{13}	9	115	70	60.9
	1.0×10^{13}*	8	85	40	47.1
	6.3×10^{12}	8	88	30	34.1
	1.0×10^{14}	10	105	65	61.9

* threshold concentration

gradually reduced, and each concentration was tested over 30 times on shrew A, about 6 times on the others. The percentage of correct choices calculated from all choices made at the same concentration decreased along with the decreasing concentration to the value which could no longer be distinguished from 33.3 % by the X^2-test. Theoretically, given three alternatives, this proportion of correct choices is in keeping with random choice without any sign of preference for the door associated with odour. This first series of experiments was informative, revealing the olfactory ability of the tested animals.

In the second series of experiments, most of the new concentrations were prepared in such a way that the difference between the threshold concentration and the next subthreshold one would be as little as possible. When the second series had been completed a higher concentration was used again for control. Similarly as at the beginning of the second series, the percentage of correct choices increased after one or two experiments. The course of the tests on shrew A is given as an example (Tab. 3).

Table 4. Number of experiments and choices made for individual determinations

shrew	acetic acid		propionic acid		butyric acid	
	experiments	choices	experiments	choices	experiments	choices
A	236	2566	44	476	58	625
B	78	788	54	559	41	446
C	72	789	20	229	+	
D	78	912	55	644	63	717
E	24	264	+		+	

+ unfinished because the shrew died

Table 5. Determined values

shrew	acid	total number of choices	correct choices	%	at threshold concentration (mol./cm^3)	total number of choices	correct choices	%	at the next subthreshold concentration (mol./cm^3)
A	acet.	234	108	46.2*	1.0×10^{13}	220	73	33.2**	6.3×10^{12}
A	prop.	96	46	47.9*	2.0×10^{11}	39	14	35.9**	1.2×10^{11}
A	butyr.	132	74	56.1*	8.0×10^{10}	70	23	32.9**	5.3×10^{10}
B	acet.	126	71	56.3*	1.0×10^{13}	109	35	32.1**	6.3×10^{12}
B	prop.	140	93	66.4*	8.0×10^{11}	61	21	34.4**	6.2×10^{11}
B	butyr.	67	35	52.2*	1.3×10^{11}	120	40	33.3**	8.0×10^{10}
C	acet.	150	74	49.3*	1.0×10^{13}	132	46	34.8**	6.3×10^{12}
C	prop.	73	37	50.7*	2.6×10^{12}	58	18	31.0**	8.0×10^{11}
D	acet.	77	40	51.9*	1.6×10^{13}	196	71	36.2***	1.0×10^{13}
D	prop.	66	33	50.0*	9.2×10^{11}	125	41	32.8**	6.0×10^{11}
D	butyr.	100	49	49.0*	1.2×10^{11}	74	25	33.8**	9.4×10^{10}
E	acet.	63	32	50.8*	5.0×10^{13}	69	28	40.6***	2.0×10^{13}

* significant difference in the frequency of deliborate and random choices ($p = 0.005$)
** concurrence of the frequencies of deliberate and random choices ($p = 0.70$),
*** ($p = 0.20$)

The shrews were trained again prior to determination of the values of threshold concentrations of the propionic and butyric acids. After mere 8 – 10 expts. the shrews again made 70 % of correct choices. The values of threshold concentrations were then determined in the same way as with acetic acid. The number of expts. and choices is given in Table 4.

At high concentrations the shrews ran about the room of choice without stopping. Only at low concentrations they sometimes paused at the door associated with the odour. The shrews ran past the door associated with the smell without trying to get into the compartment containing reward on the average in 3 % of choices till the threshold concentration. Wrong choices occurred mostly because the shrews either ran directly through the middle door without any smell, or, having made a correct decision at the middle door (no smell) they went through the door without any smell either on the left or right side. At subthreshold concentrations the percentage of correct choices dropped mainly because the shrews ran past the door where the odour emanated. Expts during which the shrews ran very quickly exclusively through the middle door without eating the reward, if there was any, have not been included in the calculations (Tab. 1).

The lowest values of threshold concentrations to which the common shrew responded (cf. Tab. 5) have been selected for comparison with data in literature (e. g. Bretting 1972):

a) 1.0×10^{13} molecules of acetic acid per cm^3 of air

b) 2.0×10^{11} molecules of propionic acid per cm^3 of air

c) 8.0×10^{10} molecules of butyric acid per cm^3 of air

DISCUSSION

Although the common shrew is one of the commonly occurring European mammals, only Shibkov (1979) has used it so far for neuroethological experiments. The reasons may be its difficult rearing and high mobility which complicates experimental work. Also the many repetitions necessary for teaching a shrew to perform an operation (Tab. 2) show how difficult is work with this species. For instance, a house mouse caught in the field learned to perform the same operation in the same apparatus after only 1/3 of lessons needed by the shrew (the author's unpublished observation). Moreover, the shrews occasional (this happened on the average once in nine trials) rapid running about without seeking the reward (Tab. 1) suggests that the experimental conditions may not have always been best for them. It is quite possible that the sensitivity of the soricid olfactory organ could be much better utilized in differently organized experiments. Nevertheless, the obtained values suggest much about the olfactory capacity of the common shrew. The values in Tab. 1 show that there always was a sufficient difference between the threshold and subthreshold concentrations in the percentage of correct choices. Also the small differences among the individual shrews (Tab. 5) coming from one locality might reflect the changes achieved in their perception. Besides, the lowest values of threshold concentrations are quite in keeping with data in literature (Fig. 2).

The values given in Fig. 2 show that e. g. the threshold concentration of butyric acid is 80 times higher for the common shrew than for the hedgehog

(Bretting 1972) and 30 times higher than for man (Goldenberg 1967), which might indicate a lower sensitivity of the common shrew's olfactory organ. However, according to Herter's (1957) observations and Shibkov's (1979) experiments, smell is a very important sense for the common shrew in its search for food, although the shrew seems to respond to it only at the distance of a few centimeters. The situation in the other members of the family Soricidae is not quite clear either. Various observations have led to the conclusion that *Sorex cinereus* (Blossom 1932 ex Buchler 1976), *Sorex fumeus, Cryptotis parva* (Hamilton 1940, 1944), *Blarina brevicauda* (Rood 1958), *Notiosorex crawfordi* (Hoffmeister and Goodpaster 1962) and *Crocidura suaveolens* (Vlasák 1970) respond to motionless food or other stationary objects only at short distances of up to 10 cm, which might indicate a weak sense of smell. In contrast, experiments in *Sorex cinereus, Blarina brevicauda* (Holling 1958), *Crocidura olivieri* (Grünwald 1969), *Sorex araneus, Neomys fodiens* (Shibkov 1979) and *Crocidura russula* (Schmidt 1979) seem to prove a well-developed sense of smell. However, all these experiments had one drawback: the odours were not expressed in concentrations of chemically pure compounds, which would have enabled accurate comparisons and conclusions. Therefore it is impossible to say whether the results of the present study are consistent with the findings mentioned above.

The olfactory epithelium of the common shrew is very well developed (Ganeshina et al. 1957, Wöhrmann-Repenning 1975, Zima 1976, Sigmund and Sedláček 1985). According to these studies the regio olfactoria takes up much of the nasal cavity on richly coiled turbinalia. Also the great density of well-developed receptors suggests that it is an important sense organ. However, there are only 14.3 × 10^6 receptors in the entire olfactory epithelium (Sigmund and Sedláček 1985). In this respect the determined values of threshold concentrations could correlate with the number of receptors, as man, whose sensitivity is almost the same (Fig. 2), has 10—20 × 10^6 of these cells (Hensel 1966). The more sensitive hedgehog *(Erinaceus concolor)* has been found to possess 82.1 × 10^6 (Zima 1976), and according to Müller (1955), a much more sensitive dog (foxterrier) has 147.2 × 10^6 receptors in its olfactory epithelium. The results obtained in the shrew may then be in keeping with Neuhaus's (1957) conclusion that sensitivity is determined by the number of receptors and, consequently, the olfactory organ of tiny mammals possessing few receptors would then be less sensitive than that of larger ones.

The sensitivity of the olfactory organ of the common shrew might also correspond with the density of smell receptors in the olfactory epithelium. If the densities of these receptors in the three mammalian species are ordered according to their increasing sensitivity to fatty acids (Fig. 2), it ensues that the highest density of olfactory cells (63 740 per mm^2) occurs in the common shrew which has proved to be the least sensitive to the three fatty acids (Sigmund and Sedláček 1985); the lowest density of olfactory cells (17 630 per mm^2) has been found in the highly sensitive dog (foxterrier) (Müller 1955), and the hedgehog *E. concolor* is halfway between these two species (42 000 per mm^2) (Zima 1976). Consequently, it seems that a lower density of receptors promotes sensitivity. The olfactory cilia of each receptor probably can better spread out in the thin surface film of mucus on the epithelium, and thus have more contact with the odorant molecules (Sigmund and Sedláček 1985).

However, a comparison of the sensitivity of the olfactory organ to fatty acids with the size of the olfactory centres in the brain has quite a different outcome. These phylogenetically old parts take up of the telencephalon of the common shrew. Its sensitivity to odours is very low from this point of view, because man with his greatly reduced olfactory centres displays approximately the same sensitivity of his olfactory organ (Stephan 1960, 1967b). A similar contradiction was first pointed out by Bretting (1972) who had found that the olfactory organ of the hedgehog is only twice as sensitive to butyric acid as that of man. He deduced that the well-developed bulbus *olfactorius* of the hedgehog is a manifestation of the ability to distinguish among many different smells rather than to register their low concentrations. Apparently, a large volume of olfactory centres in the telencephalon does not reflect a generally high sensitivity of the olfactory organ. Of course, the comparisons given above are only superficial, as neither the size of receptors, which e. g. Kolb (1971) considers important, nor their specificity which is presumed by all theories of olfaction (e. g. Wright 1964, Davies 1971) have been taken into account. It is then possible that on the small surface of the olfactory epithelium of the common shrew there are large numbers of only certain kinds of receptors to the exclusion of others, which may be manifested in different degrees of sensitivity to different compounds (Schmidt 1975).

Therefore it would be premature to base a formulation of generally valid conclusions about the sensitivity of the olfactory organ of the common shrew on the present experiments. Similar ones should be made with other mammalian species and natural odours at known concentrations in order to arrive at more accurate conclusions.

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DIE BEDEUTUNG VERLASSENER BRÜCHE ALS REFUGIALGEBIETE DER AMPHIBIEN

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Abstract. In average 2.4 species of amphibians were found in 48 reservoirs located in 11 abandoned pits. Most species inhabited reservoirs surrounded by mixed forest (3.5), the least number of species were found in reservoirs surrounded by coniferous forest (1.4). The number of species in particular pits increases with increasing number of reservoirs here and also with increasing of their total surface area. Both these factors contributed to the enlargement of the number of species by 70.5 % (35.8 and 34.7 %, respectively). Changes of pH between 5.5 and 7.5 in a combination with the reservoir area contributed only by 63 % (13 and 50 %, respectively). The most numerous population (per 100 m^2) of the species, living in the water nearly the whole vegetation period, were determined in *Triturus vulgaris* (294 specimens) and *Bombina variegata* (101 specimens).

EINLEITUNG

Laut Schätzungen des Red Data Book (1979) sind gegenwärtig 34 Arten und 7 Unterarten von Amphibien, d. i. im ganzen 41 Formen, (alle aus der Kategorie A) vom Aussterben bedroht. Das Krasnaja kniga RSFSR (1983) führt in der gleichen Kategorie 4 Arten an. Bei uns sind einstweilen von 18 Arten Amphibien 11 als bedroht bezeichnet, in der Kategorie kritisch bedrohter sind es drei Arten (Baruš, 1981). Die sog. Washington-Konvention vom internationalen Markt mit bedrohten Tierarten, die von 1. 7. 1975 in Gültigkeit ist, registriert im ganzen 10 Arten von Amphibien, bei denen der Markt die Regeln und Bestimmungen der Konvention beachten muss. Als Hauptursache für das Sinken der Populationsdichte der Amphibien erachtet man die Degradation der entsprechenden Biotope, das Sammeln und die Jagd, sowie auch die Akklimatisation ungelegener Wirbeltierarten Jablokov, Ostrounov (1983).

Verlassene Steinbrüche können, nachdem sie ihre Funktion verloren haben, als bedeutsame Ersatzbiotope einer Reihe Amphibienarten dienen. So entstehen hier oft Bassins, die einer natürlichen Entwicklung überlassen werden. An ihnen kann man dann gut die Abhängigkeit zwischen dem Charakter des Bassins und der Anzahl der darin lebenden Amphibienarten verfolgen.

In der vorliegenden Arbeit wurde die Anzahl der Amphibienarten in ihrer Abhängigkeit von der Anzahl der Bassins in den einzelnen Brüchen, von deren Durchschnitts- und Gesamtfläche, von der Azidität, der Maximaltiefe, dem Alter des Bruches und vom vorherrschenden Biotop der Umgebung bewertet. In einigen Fällen wurden auch Schätzungen vorgenommen, welche die Anzahl der Amphibien und deren Wanderung zwischen den Bassins betrafen.

Diese Arbeit stellt einen Teil der Diplomarbeit dar, die am Lehrstuhl für systematische Zoologie verfasst, und am Lehrstuhl für Umweltschutz und Landschaftsökologie ergänzt wurde.

Für kritische Bemerkungen zur Handschrift danken die Autoren dem Dozenten Dr. O. Oliva, CSc.

MATERIAL UND METHODIK

Im ganzen wurden 48 Bassins untersucht, die sich *in einem* Gebiet *von* 11 verlassenen Brüchen befanden. Hier wurden früher Lehm, Ton oder Kaolinarkose gewonnen. Die gesamte Wasserfläche aller Bassins betrug 26 580 m^2 (2,66 ha), die durchschnittliche Fläche der Bassins in einem Bruch betrug 2 416 m^2. Das kleinste Bassin hatte eine Fläche von 7 m^2, das grösste von 4 100 m^2, die Durchschnittsfläche war 454 m^2. Alle untersuchten Brüche befinden sich im zentralen Teil des Pilsner Hügellandes in Westböhmen. Die durchschnittliche Temperatur hier ist 8 °C, die durchschnittliche Niederschlagsmenge beträgt 600 mm, die Höhe über dem Meeresspiegel bewegt *sich um 370 — 510 m.*

In den Frühlingsmonaten 1980—81 wurden sämtliche Entwicklungsstellen der Amphibien in den einzelnen Bassins vermekt. Der vorherrschende Typus der Pflanzengesellschaften der unmittelbaren Umgebung aller Bassins wurde als Nadelwald, Mischwald oder landwirtschaftlicher Boden bezeichnet. Die Azidität des Wassers wurde mit Hilfe eines übertragbaren pH Meters bemessen. Die Fläche der Bassins wurde bei gefrorenem Wasser festgestellt (Schwankugen des Wasserspiegels beeinflussten das Ausmass der Wasserfläche geringfügig). Das Alter der Bassins wurde nach literarischen Angaben von der Beendigung der Arbeiten in den Brüchen (Wild, 1977), nach den Angaben der Unternehmen, welche dort gefördert hatten, sowie auch nach Angaben örtlicher Bewohner, abgeschäzt. Die Amphibien wurden durch Amputation eines Fingers gekennzeichnet. Die Schätzungen wurden nach der Methode von Schnabel (1938) durchgeführt. Ähnlich verfuhren auch die Autoren Hodrová (1981), Lukáš (1968), Kristián (1982). In den Bassins wurden folgende Arten festgestellt: der Bergmolch — *Triturus alpestris* (Laurentus, 1768), der Kammolch-*Triturus cristatus* (Laurentus, 1768). *der* Teichmolch — *Triturus vulgaris* (Linnaeus, 1758), die Knoblauchkröte-*Pelobates fuscus* (Laurentus, 1768), die Gelbbauchunke-*Bombina variegata* (Linnaeus, 1758), die Erdkröte-*Bufo bufo* (Linnaeus, 1758), die Wechselkröte — *Bufo viridis* (Laurentus, 1786), der Wasserfrosch — *Rana esculenta* (Linnaeus, 1758).

ERGEBNISSE

Die Anzahl der Amphibienarten in Abhängigkeit von dem Bassintyp

Die grösste Anzahl der Amphibienarten im Durchschnitt wurde in Wasserbassins, welche sich in Mischwäldern befanden, festgestellt (3,5 Arten). Erheblich geringer war die Durchschnittszahl der Arten in Bassins, die sich in landwirtschaftlich bebauter Umgebung befanden (1,8 Arten). Das häufige Aufkommen der Gelbbauchunke in diesen Bassinstypen (mehr als 90 % aller Bassins) sowie auch die ihr häufiges Vorkommen in stark verunreinigtem Wasser beweist, dass diese Art gegen die Chemisation der Landschaft in hohem Masse resistent ist. Die wenigsten Arten fanden wir in Bassins, die in einem Nadelwald situiert waren. Es kamen hier oft nur Molche vor. Im Durchschnitt wurden hier 1,4 Arten festgestellt. Das Vorkommen von Molchen in diesen Bassins hängt damit zusammen, dass sie gegen niedrige pH Werte tolerant sind. Auch für Arten, welche in der Zeit ihrer Vermehrung nur für einige Tage im Wasser verweilen. (die Knoblauchkröte, der Springfrosch, die Erdkröte und die Wechselkröte) ist der Nadelwand wegen der kärglichen Pflanzenschicht und des Nahrungsmangels, kein geeigneter Biotop für ein Leben auf festem Land.

Tab. 1. Die Relativzahl des Aufkommens der Amphibien in Bassins (die Anzahl der besiedelten Bassins dividiert durch die Anzahl aller Bassins) abhängig von pH, der *Wasserfläche (m²) und dem Alter der Bassins. Der vorwiegende Biotop 1. Nadelwald;* 2. Mischwald; 3. landwirtschaftlicher Boden; 4. im ganzen

Art	1.	2.	3.	4.	pH	Wasserflache	Alter
Triturus alpestris	0,29	0,32	0,0	0,23	5,5—7,5	70—1350	43—84
Triturus cristatus	0,29	0,55	0,08	0,35	5,5—7,5	40—1350	15—84
Triturus vulgaris	0,43	0,77	0,25	0,54	5,4—7,5	7—1390	10—84
Pelobates fuscus	0,14	0,32	0,25	0,25	5,4—7,5	250—1350	15—73
Bombina variegata	0,07	0,59	0,92	0,48	6,1—7,5	70—4100	10—50
Bufo bufo	0,07	0,0	0,08	0,04	6,0—6,5	1450—3290	13—43
Bufo viridis	0,0	0,14	0,08	0,08	6,5—7,5	320—3290	13—43
Rana dalmatina	0,0	0,36	0,09	0,19	5,5—7,5	7—1350	27—50
Rana esculenta	0,07	0,45	0,08	0,25	6,1—7,5	210—3290	13—43
im ganzen	1,36	3,50	1,82	2,41			

Für die Knoblauchkröte und den Springfrosch kommt noch die geringe Luftfeuchtigkeit hinzu und die Möglichkeit einer Verletzung an den heruntergefallenen Nadeln.

Von den insgesamt 48 beobachteten Bassins waren es 37, welche von wenigstens einer Art besiedelt waren. Durchschnittlich kamen auf ein Bassin 2,4 Amphibiearten. Die Anzahl der Amphibien in den einzelnen Bassins nach deren Charakter enthält die Tab. 1.

In den kleinsten, unbeständigen Tümpeln, die in der Nähe der ständigen lokalisiert waren, kamen öfters nur der Teichmolch und die Gelbbauchunke vor, die kleinsten der ständigen Bassins bewohnten der Springfrosch und der Teichmolch. In ständigen Bassins mit einer Fläche bis zu 100 m² wurden ausser den erwähnten Arten noch der Bergmolch, der Kammolch und die Gelbbauchunke vorgefunden. Alle Arten wurden in ständigen Bassins festgestellt, deren Fläche über 200 m² betrug. In Bassins über 1350 m², fehlten dagegen der Kammolch, der Bergmolch, die Knoblauchkröte und der Springfrosch. In den grössten Bassins, mit einer Fläche über 1500 m² konnte man ein weiteres Sinken der Amphibienarten bemerken. Das Schwinden der Amphibien ist auf die grössere Tiefe des Wassers zurückzuführen (über 3m), da das Bassin für Fischzucht und zur Rekreation benützt wird. Auch die steigende Azidität des Wassers in den einzelnen Bassins verursachte ein Sinken der Artenzahl. So halten sich in Bassins mit einem pH niedriger als 6 (5.2—5,9) nur die drei Molcharten auf, in zwei Fällen die Knoblauchkröte und in 4 Fällen der Springfrosch. Alle anderen Arten, die erwähnten inbegriffen, kamen in Bassins mit pH 6 und darüber, d. i. von pH 6—7, vor. Die Azidität des Wassers ist nicht nur von der Lokalisierung des Bassins, sondern auch von dessen Grösse abhängig.

Die ursprüngliche Vermutung, dass mit dem Alter des Bassins auch die Zahl der vorhandenen Amphibienarten wächst, hat sich nicht bestätigt. Ein gewisses Vermehren der Amphibienarten im Zusammenhang mit dem Alter des Bassins gilt nur für die Bassins, die jünger als 50 Jahre sind. Brüche, die älter als 50 Jahre sind, waren höchstens mit drei Molcharten und der Kno-

Tab. 2. Schätzungsergebnisse für *Triturus alpestris* (*Ta*), *Triturus cristatus* (*Tc*), *Triturus vulgaris* (*Tv*), *Bombina variegata* (*Bg*) und *Rana esculenta* (*Re*) in drei beständigen Bassins und im einem Komplex von 29 Tümpeln (auf 100 m^2 berechnet)

Bassin	pH	Fläche m^2	Zahl der Arten	Tiefe (m)	Ta	Tc	Tv	Bg	Re	Σ
1.	7,0	460	6	2,2	12	24	249	—	—	284
2.	6,1	1250	6	0,4	—	—	2	12	7	22
3. (1980)	7,0	970	6	1,6	—	—	—	—	21	21
3. (1981)	7,0	590	6	1,0	—	—	—	3	8	11
Lachen	—	Σ 200	6	0,1—0,4	—	—	26	101	—	127

blauchkröte besiedelt. Das hängt damit zusammen, dass die Umgebung der ältesten Brüche in drei von vier Fällen ein kultivierter Nadelwald bildet, welcher pH des Wassers herabsetzt.

Anzahl- und Migrationsschätzungen

Auf dem Gebiete eines erwählten Bruches wurden in den Jahren 1980—81 Schätzungen einiger Amphibienarten (Tab. 2) durchgeführt, und zwar an drei ständigen und einem Komplex von unbeständigen Bassins. Die Entfernung zwischen den beständigen Bassins war bis zu 350 m, sie unterschieden sich voneinander nur durch die Fläche. An einem dieser Bassins wurde die Schätzung nach zwei Jahren wiederholt, da es hier zu einer erheblichen Senkung des Wasserspiegels und zu einer Verkleinerung der Wasseroberfläche kam, da das Wasser zum Teil in einem unterirdischen Raum abfloss. In den unbeständigen Bassins (im ganzen 28 Tümpel) wurden die Schätzungen an der ganzen Gruppe der Tümpel durchgeführt. Die durchschnittliche Entfernung zwischen ihnen war 24 m.

Die Zahlschätzungen wurden an allen drei Molcharten, an der Gelbbauchunke und am Wasserfrosch durchgeführt. Die auf 100 m^2 berechnete Anzahl der einzelnen Arten zeigt die Tab. 2. Das Sinken der Fläche im Bassin Nr. 3 von 980 m^2 auf 590 m^2 und das Abnehmen der Tiefe von 1,6 m auf 1,0 m führte zu einer Verminderung der Anzahl der Wasserfrösche von 21 Individuen. 100 m^{-2} auf 8 Individuen . 100 m^{-2}.

Da die Schätzung wiederholt wurde, und die Wasserfrösche unterschiedlich bezeichnet wurden, konnte man auch die erfassen, welche sich in beiden Jahren hier vorfanden. Im Jahre 1980 wurden in diesem Bassin im ganzen 129 Frösche (Spring- und Wasserfrösche) bezeichnet. Die Schätzung war 204, (164—267), wovon ein Jahr später (1981) nur 11 wiederholt gefangen wurden. Im Jahre 1981 wurden bloss 45 Stücke gefangen (nach Schätzung 48, 39—63). Der niedrige Wert des Überlebens (48/204 = 0,24) wurde hauptsächlich durch die Emigration der Frösche nach der Verkleinerung der Fläche und der Tiefe des Bassins herbeigeführt. Von der gesamte Anzahl von 18 wandernden Fröschen waren 13 (72 %) Frösche eben aus diesem Bassin. Soweit wir diese hohe Zahl der Emigration an der ursprünglichen Anzahl der gekennzeichneten Frösche im Jahre 1980 geltend machen, dann müssten von 129 gekennzeichneten Fröschen 93 auswandern. Vom ursprünglich abgeschätzten Stand (204) müssten es 146 Frösche sein. Dadurch würde die Zahl der Frösche im Bassin 1981 auf

Tab. 3. Migrationsentferunungen der *Gelbbauchunke* (a) und des Wasserfrosches (b)

a		b	
Zahl der Migranten	Entfernung in m	Zahl der Migranten	Entfernung in m
11	bis zu 10	8	100
9	11— 20	3	150
9	21— 50	1	250
9	51—100	1	300
1	140	5	350
2	180		
3	250		
1	260		

59 sinken. In Wirklichkeit wurde nach Schätzung die Zahl der Frösche mit 48 ermittelt. Das Überleben, welches die Migration ausschliesst, erreicht den Wert 48 58 = 0,83.

Im Laufe der Schätzung wurde auch die Migration zwischen den einzelnen Bassins ermittelt. Am häufigsten migrierten die Gelbbauchunken (in 45 Fällen). Dabei ging es in 29 Fällen (65 %) um die Wanderung zwischen unbeständigen *Bassins, in 9 Fällen (20 %) um Migration aus unbeständigen Bassins in beständige*. Bei den restlichen Fällen (7; 15 %) handelt es sich um seine Migration von unbeständigen in fixe Bassins.

Die Zahl der migrierenden Gelbbauchunken ist bis zu einer Entfernung von 100 m fast die gleiche. Die grösste Entfernung bei der Migration der Unke war 260 m. Beim Wasserfrosch wurden nur wenige wandernde Individuen gefangen. Die grösste Anzahl von Migranten wurde bei einer Entfernung bis zu *100 m* festgestellt. In Gesensatz zur Unke war die grösste Enfernung der Migraton 350 m, auch war die Anzahl der Migrationen in diese Entfernung hinsichtlich der Gesamtzahl der Migrationen bedeutend hoch (Tab. 3).

DISKUSSION

Bei der Bewertung der erlangten Daten wurde eine positive Korrelation zwischen dem Logarithmus der Anzahl der Bassins in den einzelnen Brüchen und der Anzahl der in ihnen vorkommenden Amphibienarten (r = 0,696) festgestellt. gleichzeitig auch eine positive Korrelation zwischen dem Logarithmus der Gesamtfläche der Bassins in den einzelnen Brüchen und dem Logarithmus der Anzahl der dort lebenden Amphibienarten (r = 0,710). Da man infolgedessen auch eine positive Korrelation zwischen der Anzahl der Bassins und deren Fläche (wurde mit r = 0,4 festgestellt) erwarten kann, ergibt sich die Frage, wie diese beiden Faktoren das Wachsen der Anzahl der Amphibienarten beeinflussen. Der gemeinsame Korrelationskoeffizient der Abhängigkeiten der Artenzahl der Amphibien von der Zahl der Bassins und ihrer Fläche ist wirklich höher (r = 0,840) und signalisiert, dass beide Faktoren die Zahl der Arten in den einzelnen Brüchen positiv beeinflussen. Durch weitere Berechnungen kann ermittelt werden, dass die Zahl der Bassins in den einzelnen Brüchen sich mit 35,8 %, ihre Gesamtfläche mit 34,7 % am Wachstum der Arten beteiligt. Die restlichen etwa 29 % entfallen auf unbestimmte Faktoren (z. B. die Tiefe des Bassins, der Charakter des Biotops usw). Festgestellte Fakten müssen

Tab. 4. Der Regressionskoeffizient „a“ und „b“ und der Korrelationskoeffizient „r“ der Gleichung $y = yx^b$ für verschiedene Formen der Abhängigkeit zwischen Bassinsfläche, der Zahl der Bassins, pH und der Artenzahl der Amphibien

a	b	r	Anmerkung
0,155	0,106	0,232	Fläche gegen Artenzahl, Bassins mit wenigstens einer Art (im ganzen 37 Bassins)
—1,059	0,497	0,522	dgl. für alle Bassins (im ganzen 48)
—0,673	0,356	0,710	dgl. für einzelne Brüche (im ganzen 10)
0,206	0,488	0,696	Zahl der Bassins in den einzelnen Brüchen gegen Artenzahl
2,865	0,560	0,400	Zahl der Bassins in den einzelnen Brüchen gegen ihre Fläche
0,070	0,218	0,783	Fläche eines Bassins im Mischwald gegen Artenzahl (im ganzen 18)
—1,332	2,375	0,654	pH eines Bassins im Mischwald gegen Artenzahl
0,680	0,054	0,705	pH von Bassins im Mischwald gegen Fläche dieser Bassins

bei Verfügungen des Naturschutzes respektiert werden, damit eine maximale Mannigfaltigkeit der Arten erhalten bleibt. Es ist nötig, nicht nur die Fläche des Bassins, sondern auch ihre Anzahl zu erhöhen. Bei gleicher Fläche ist eine grössere Anzahl der Bassins vorteilhafter.

Es ist nicht uninteressant, dass die Steile der erwähnten Beziehungen zwischen Bassinfläche und der Anzahl der Amphibienarten (0,355) der Intervallsteile, welche bei verschiedenen Gruppen von Lebewesen und auch Pflanzen, die auf Inseln leben (0,24—0,33), angeführt wird, sehr nahe ist (Pianka, 1981). Die Steile der Abhängigkeit zwischen der Zahl der Bassins und der Artenzahl ist noch etwas höher (0,488), sodass sich vorläufig daraus schliessen lässt, dass die Anzahl der Bassins das Wachsen der Zahl der Arten in den einzelnen Brüchen mehr beschleunigt, als ihre Fläche.

Bassins mit der grössten Durchschnittszahl von Amphibien, d. i. solche, die

Tab. 5. Die Anzahl verschiedener Amphibienarten auf 100 m^{-2} (N)

Art	Autor	N	Art	Autor	N
Bufo bufo	Hodrová 1981	158 (80—261)	*Rana esculenta*	Růžička 1974	5
Triturus alpestris	Kristián (1982)	32— 45	dtto	eigene Ergebnisse	7— 21
dtto	Lukáš (1968)	54	*Bombina variegata*	eigene Ergebnisse	12—101
dtto	eigene Ergebnisse	12	*Triturus vulgaris*	Lukáš (1968)	167
			dtto	eigene Ergebnisse	26—249

in einem Mischwald lokalisiert waren (im ganzen 18 Bassins mit einer Durchschnittsfläche von 512 m^2 mit Abständen von 7–20 000 m^2) wurden hinsichtlich des beiderseitigen Einflusses ihrer individuellen Fläche und Azidität, auf die Anzahl der in ihnen lebenden Arten bewertet. (Tab. 4) Der gemeinsame Korrelationskoeffizient war in diesem Fall nur unbedeutend höher ($r = 0{,}819$), als der Koeffizient zwischen der Fläche des Bassins und der Zahl der darin lebenden Arten ($r = 0{,}783$). Das deutet auf einen gewissen kleinen Einfluss von pH in den Grenzen der beobachteten Werte, d. i. 5,5–7,5 auf die Zahl der Amphibienarten. Die individuelle Fläche des Bassins beteiligt sich an der Vermehrung der Amphibienarten mit 50 %, die Verminderung der Azidität mit 13 %. Den Rest bilden unbekannte Faktoren. Tab. 5.

In Bassins, deren pH niedriger ist als 6 (mit Schwankungen 5,2–5,9), die sich in Nadelwäldern befanden, wurde hinsichtlich der wenigen Messungen und der kleinen Anzahl der darin ständing lebenden Arten negative Korrelationen wie zwischen der Fläche des Bassins und der Artenzahl, so auch zwischen der Azidität und der Artenzahl festgestellt. Tab. 4. Ebenso negativ war das Verhältnis zwischen den Werten von pH und der Artenzahl in Bassins, die in einer landwirtschaftlich bebauten Landschaft lokalisiert waren.

Die festgestellten Werte von pH bedeuten bei weitem nicht die Mindest- oder Höchstwerte, an welche Amphibien adaptationsfähig sind. Es existieren Angaben von der Fortpflanzung einiger Arten von Schwanzlurchen bei pH 3,5–4 in Nordamerika, auch wenn die Mortalität der Larven hoch war (Haines, 1981). Bei einer so hohen Azidität erhöht sich noch die Konzentration von Aluminium,, Mangan und weiteren Metallen im Wasser und steigert so seine Toxizität. Bei sinkendem pH von 7,0 auf 4,7 wächst die Koncetration von Aluminium 100 fach, d. i. von 0, 01mg . l^{-1} auf 1,0 mg . l^{-1}.

Wenn wir die Artenzahl der einzelnen Amphibien mit den Angaben aus anderen Gewässern bei uns vergleichen (Tab. 5), können wir feststellen, dass von den beobachteten und abgeschätzten Arten die Erdkröte am zahlreichsten ist, die bei ihrer Vermehrung im Frühjahr eine Dichte von 52 bis 336 Individuen auf 100 m^2 erreicht. Bei 13 sebstständigen Schätzungen an 4 geschützten Tümpeln bei Čelákovice im Elbtal ist der Gesamtdurchschnitt 158 Individuen auf 100 m^2 (Hodrová, 1981). Es gibt aber keine Angaben von der Grösse der Fläche, aus welcher sich die Erdkröte bei der Vermehrung in einzelne Tümpel verteilt; diese Tatsachen hat die Autorin nicht geschätzt. Das liesse sich durch weiteres Verfolgen gekennzeichneter Tiere ermitteln. Von den Schwanzlurchen bildet der Teichmolch die zahlereichsten Populationen — 249 Individuen auf 100^2, es folgt der Bergmolch — bis 54 Individuen auf 100^2, am seltesten ist der Kammolch, mit 24 Exemplaren auf 100^2 (die einzige Angabe). Von den Fröschen ist ausser der Erdkröte die Gelbbauchunke am zahlreichsten (bis 101 Stück auf 100 m^2). Im allgemeinen kann festgestellt werden, dass in Bassins in denen der Wasserfrosch vorkommt, die Zahl der anderen Amphibienarten wesentlich niedriger ist, was mit der Predation dieser auf andere Amphibien zusammenhängt (siehe Lác, 1968; Juszyk, 1974).

DIE MÖGLICHKEIT EINER AUSNUTZUNG VERLASSENER BRÜCHE ZUR ERHALTUNG UND ZUM SCHUTZ DER AMPHIBIENBESTÄNDE

Aus 48 beobachteten Bassins in 11 verschiedenen Brüchen wurden auch nach dem Einstellen der Förderung 10 Bassins, d. i. 20,8 %, durch menschliches Einwirken beeinflusst. Durch reguläre Müllablage wurden 4 Bassins betroffen, durch wilde 4 Bassins und durch Fischzucht 2 Bassins.

Von der Bedeutung verlassener Brüche als Refugial gebiet für Amphibien spricht unter anderen auch das, dass von den gesamten 13 Amphibienarten, die in Bezirk Plzeň-sever festgestellt wurden (Hůrka, 1977; Šedo, 1981) nur vier (*Salamandra salamandra, Bombina bombina, Hyla arborea* und *Rana temporaria*) nicht in den beobachteten Brüchen gefunden wurden.

Die Fläche der Bassins in allen Brüchen betrug nur 2,658 ha und auch die Gesamtfläche der Brüche (0,3 km^2) bildet nur einen unbedeutenden Teil des untersuchten Gebietes (ca 200 km^2). Den Lebensbedingungen der Amphibien entsprechen weder die Müllablagerungen, noch Fischzucht oder Freizeitbetrieb. Zu ihrer Erhaltung ist es unvermeidlich, dass frühere Brüche samt den Bassins wenigstens in der jetzigen Form erhalten bleiben. Eventuelle Minimalkosten für Rekultivation der Brüche sollten dazu dienen, dass die Anzahl ständiger Bassins sich erhöht. So könnten die Amphibien zahlreiche Populationen bilden. Die Erklärung ausgesuchter Brüche zu Schutzgebieten für Amphibien würde die Lage verbessern.

ZUSAMMENFASSUNG

In 48 Bassins, die in 11 verlassenen Brüchen lokalisiert waren und sich im mittleren Teile des Pilsner Hügellandes befanden, wurden im ganzen 9 Amphibienarten festgestellt. Im ganzen waren 37 Bassins besiedelt, durchschnittlich mit 2,3–3,0 Arten pro Bassin.

In den in einem Mischwald sich befindenden Bassins war die Zahl der gefundenen Amphibienarten am höchsten (3,5), kleiner (1,8) war sie in den zwischen bebauten Feldern plazierten Bassins und am niedrigsten (1,4) war sie in den unter Nadelbäumen liegenden Bassins.

Die Zahl von 5 Amphibienarten wurde nach der Methode von Schnabel abgeschätzt, ihre Zahl, berechnet auf 100 m^2, führt die Tab. 2 übersichtlich an.

Bei zwei Arten, der Gelbbauchunke und dem Wasserfrosch, wurden Migrationen zwischen den einzelnen Bassins festgestellt. Die meisten Unken wanderten in eine Entfernung von 100 m, die längste Migration war 260 m, die Wassefrösche wanderten bis 350 m.

Es wurde eine gemeinsame Korrelation zwischen der Zahl der Bassins in den einzelnen Brüchen, deren Gesamtfläche und der Artenzahl der in ihnen lebenden Amphibien festgestellt. Der Anteil der Anzahl der Bassins beträgt am Steigen der Artenzahl 35,8 %, ihre Gesamtfläche 34,7 %. Diese Feststellung sollte bei der Nutzung der Brüche als Refugialgebiet für Amphibien berücksichtigt werde.

Bei Bassins in Mischwäldern wurde eine Korrelation zwischen ihrer individuellen Fläche, der Azidität und der Artenzahl der Amphibien festgestellt. In diesem Falle beteiligt sich die Fläche an der Vermehrung der Artenzahl mit 50 %.pH mit 13 %, den Rest bilden unbekannte Faktoren.

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Bol'šakov, V. N., B. S. Kubancev, 1984. *Polovaja struktura populjacij mlekopitajuščich i ee dinamika.* Moskva: Nauka, 233 str., 2,20 r.

Das Buch „Die Geschlechtsstruktur der Säugetierpopulationen und ihre Dynamik" sowjetischer Autoren V. N. Bol'šakov's und B. S. Kazancev's stellt den ersten Versuch dar, das Geschlechterverhältnis einer Tiergruppe in seinen Populationsbeziehungen komplex und umfassend zu erforschen. Das Buch ist in 7 Kapitel gegliedert, die nach einer kurzen Einleitung folgen.

Das erste Kapitel (S. 6–14) betrifft „das Begriff der Populationen und ihre Geschlechtsstruktur bei den Säugetieren". Die Autoren sind hier bemüht ein allgemein verständliches und in der Feldpraxis anwendbares Populationskonzept aufzubauen. Das Einzige, was allerdings für den interessierten Leser aus dem Studium dieses Kapitels folgt, ist, daß die Autoren nur oberflächlich über das sehr breite und komplexe Problem des Populationskonzepts unterrichtet sind. Interessanter ist der Rest dieses Kapitels, in dem die Terminologie des Geschlechterverhältnisses diskutiert wird. Die Autoren bauen hier auch ihre eigene Klassifikation der Geschlechterverhältnisse auf, in der sie primäres, sekundäres, Juvenal-, subtertiäres und tertiäres Geschlechterverhältnis unterscheiden.

Am umfangreichsten ist das zweite Kapitel, in dem „das numerische Gechlechterverhältnis der Säugetiere verschiedener taxonomischer Zugehörigkeit und deren Variabilität" besprochen wird. Auf den Seiten 14–133 werden hier vornehmlich literarische Angaben über das Geschlechterverhältnis einzelner Säugetierarten angeführt, wobei nacheinander Marsupialia, Insectivora, Chiroptera, Lagomorpha, Rodentia, Carnivora, Pinnipedia, Perissodactyla, Artiodactyla und Proboscidea behandelt werden. Das Schwergewicht wird an Rodentia gelegt, mit den die beiden Autoren viele persönliche Erfahrungen haben, während zum Beispiel die Primaten ganz unberücksichtigt blieben. Dies ist um so überraschender, daß über das Geschlechterverhältnis bei Primaten bereits viel geschrieben wurde und diese Gruppe zweifellos zu den wenigen in dieser Hinsicht eingehender erforschten Säugetierordnungen gehört.

Das dritte Kapitel (S. 133–141) behandelt sehr knapp „die Typen der Dynamik der Geschlechtszusammensetzung der Säugetierpopulationen". Es werden vier Typen unterschieden: stabiles 1:1 Geschlechterverhältnis, stabiles Überwiegen adulter Männchen, stabiles Überwiegen adulter Weibchen und unstabiles (veränderliches) Geschlechterverhältnis. Eine theoretisch sowie empirisch befriedigend untermauerte Erklärung dieser Typen, ihrer Evolution und ihrer ökologischen Zusammenhänge wird leider nicht gegeben.

Die vielleicht interessantesten Angaben werden dem Leser im vierten Kapitel (S. 142–159) vorgelegt, das „die Rolle der Dynamik der Alterszusammensetzung der Population in der Bestimmung ihrer Geschlechtsstruktur" behandelt. Hier werden seltene Angaben über den Einfluß des Alters der Weibchen und der Männchen auf das Geschlechterverhältnis ihrer Nachkommen angeführt.

In dem ebenfallls sehr kurzen fünften Kapitel (S. 159–166) über „die Bedeutung individueller Eigenschaften der Tiere für die Bestimmung der Geschlechterzusammensetzung ihrer Nachkommen" bemühen sich die Autoren zu entscheiden, ob bzw. auf wie weit die genetischen Eigenschaften der parentalen Individuen das Geschlechterverhältnis ihrer Nachkommen beeinflussen können.

Das sechste Kapitel (S. 167–182), in dem „über die Bedeutung anthropogener Einwirkungen auf die Dynamik der Geschlechtsstruktur bei Säugetieren" gesprochen wird, wirkt im Kontext der vorgehenden fünf Kapitel sehr inorganisch. Sie will Fälle der Änderung des Geschlechterverhältnisses nach Anwendung von verschiedenen Bioziden behandeln. Mehr als über das Geschlechterverhältnis wird hier allerdings überraschenderweise von Änderungen in Populationsdensität bei ausgewählten Säugetier-, vor allem Nagerarten gehandelt, d. h. über ein Thema, welches den Autoren offenbar viel näher ist, als das ganze Problem des Geschlechterverhältnisses.

Im letzten siebenten Kapitel (S. 182–207) über „die Rolle der Dynamik der Geschlechtsstruktur in homeostatischen Populationsprozessen" versuchen die Autoren Beziehungen zwischen dem Geschlechterverhältnis und der Populationsgröße zu finden. Das Buch wird mit einem recht umfangreichen Literaturverzeichnis, das 487 Titel enthält, abgeschlossen.

Zusammenfassend kann die rezensierte Publikation nur als eine Kompilation bezeichnet werden Ihr Wert liegt darin, daß in ihr viele das Geschlechterverhaltnis betreffende Publikationen zusammengefasst sind, die in sehr wenig bekannten und/ oder lokalen Zeitschriften bzw Sammelbanden erschienen sind Andererseits muß jedoch betont werden, daß viele diesbezugliche Publikationen, besonders nicht--sowjetische, aber auch manche, die in der Sowjetunion publiziert worden sind, fehlen Die Autoren des Buches befriedigen sich außerdem meistens mit einfachem Vorlegen der gesammelten Daten, welche nur ausnahmsweise entsprechend statistisch bearbeitet werden Was jedoch am meisten dem Buche fehlt ist die Absenz der theoretischen Bearbeitung der wertvollen Daten, die hier zusammengefasst wurden Die Autoren kennen praktisch keine der zahlreichen theoretischen Schriften, die bereits zu diesem Problem publiziert wurden Das rezensierte Buch kann also als ein Nachschlagwerk der schwer erreichbaren Literatur uber das Geschlechterverhaltnis bei Saugetieren dienen, als eine okologisch orientierte Monographie scheint es jedoch bedeutungslos zu sein

J Mlíkovsky

Panfil, C, 1984 *Genetica sexelor* [Genetics of the sexes] Cluj-Napoca Dacia, 256 pp 17,— Lei

The phenomenon of sex and sexual reproduction belongs to frequently discussed problems in contemporary theoretical biology and consequently, a lot of papers and even books have been published on this topics, approaching it from most various aspects

The Romanian book under review attempts to analyze the sex phenomenon purely from the point of view of classical genetics It is divided in 10 chapters, the headings of which well characterize its contents 1 Sexual reproduction a phenomenon with genetic implications (pp 11—24) 2 Phylogeny of sexual differentiation (pp 25—38), 3 Gametes, or sexual cells (pp 39—67), 4 Fertility (pp 68—100) 5 Determination of the sexes (pp 101—154), 6 Sexual differentiation (pp 155—169) 7 Heredity of characters, and features related to, or limited by sex (pp 170—191), 8 Sexual chromatin (pp 192—205), 9 Sexual incompatibility (pp 206—237), 10 Relations of sex (pp 238—251)

All the ten chapters are finely subdivided and, as a whole the book presents a well written brief review of what classical genetics thinks about the sex phenomenon From this point of view, reading this book will prove satisfying to those scientists who are not familiar with recent developments in both genetics and theoretical biology The other ones, however, will be surprized by the author's ignorance of all respective achievements made in biology since mid 1970s

Nonetheless Panfil's book may serve as a useful summary of the concepts of sex and sexual differentiation which originated in the framework of the neo-Darwinian paradigm, although the fact that merely selected bibliography (92 titles) is presented significantly lowers its value Moreover, although the recently developing beyond--neo-Darwinistic approaches to biology quickly alter our biological thought no review paper or even book respecting these developments has been published on the sex phenomenon so far according to my best knowledge Consequently, Panfil's book, though not up-to-date, will be of interest to all who are studying the sex problem in biology, and who are at least to some extent familiar with Romanian Certainly such a language is not well chosen for a book dealing with so international problem as the sex phenomenon is

J Mlikovský

Preston-Mafham, R, Preston-Mafham, K · *Spiders of the World* 191 pp, 131 figs and colour plates Blandford Press, Link House, West Street Poole Dorset, U K, 1984 Price £ 8 95

O biologii pavouků bylo již napsano větši mnozstvi popularně vědeckych knih Jejich čtenařů zrejmě neustale přibyva tak jako přibývaji nove poznatky a zejmena stale dokonalejši fotograficke snimky odhalujici podrobnosti jejich zvlastniho chovani Z toho hlediska plati Spiders of the World mezi knihy vskutku vydařene, protože autoři fotografovali pavouky v jejich přirozenem prostředi kde nejlepe projevuji sve vlastnosti Plati to např o barevnych snimcich znazorňujicich dokonale krypticke zbarveni cizokrajnych pavouku, kteři zcela splyvaji s kůrou stromu vyhlizeji jako pupen na větévce nebo mimetizuji mravence(např skakavka *Cosmophasis* sp zapřednik *Myrmecium* sp) Dale to jsou fotografie pavouků napodobujicich zvadlý utržený list, ptačí výkaly atp. Zvláště cenné jsou unikátní snímky znázorňující epigamní chování nebo páření velice málo známých tropických druhů, ale i běžných druhů středoevropské fauny.

Text knihy je členěn podle obvyklého schématu. V úvodní kapitole jsou kromě obecných informací připomenuty příbuzenské vztahy pavouků k ostatním členovcům zejména v rámci třídy Arachnida. Další dvě kapitoly jsou věnovány jednak vnější a vnitřní morfologii pavouků, jednak stručným charakteristikám podřádů Mesothelae a Orthognatha a 26 významnějším čeledím podřádu Labidognatha (podrobný seznam čeledí všech tří podřádů je uveden v závěru knihy).

Těžiště knihy spočívá v kapitolách o rozmnožování pavouků, o průběhu jejich života, o lovu kořisti a o způsobech ochrany. Text se ještě ve větší míře než fotografická dokumentace týká fauny britské a tím v podstatě i středoevropské. Fotografie jsou doplněny řadou názorných perovek, které ilustrují mnohé nesnadno pochopitelné jevy: síť sloužící samcům k přečerpání spermatu do kopulačních orgánů na jejich makadlech (křižák čtyrskvrnný), epigamní projevy samce skákavky *Euophrys frontalis*, lov potravy u našeho sklípkánka rodu *Atypus*, transport vzduchu u vodoucha stříbřitého, postup ekdyse atp.

Kniha je zakončena krátkou závěrečnou kapitolou „Pavouci a člověk" a několika dodatky: seznam čeledí, slovníček speciálních pojmů, doporučená literatura (zaměřena na anglicky psaná díla) a obsáhlý pětistránkový rejstřík.

Závěrem lze shrnout, že kniha přispívá k poznání biologie pavouků zejména originálními barevnými fotografiemi, které díky pečlivému výběru názorně zachycují charakteristické situace ze života pavouků a usnadňují tak pozorování těchto jevů v přírodě. Protože se to týká i četných druhů československé arachnofauny, lze tuto knihu plně doporučit i pro naše čtenáře.

J. Buchar

Landa, V. and Soldan, T.: *Phylogeny and higher classification of the order Ephemeroptera: a discussion from the comparative anatomical point of view.* Academia Praha, Studie ČSAV, 4/1985, 122 pp., 22 Tab. (In Englisch, Zusammenfassung in Deutsch und Tschechisch.) Preis 34 Kčs.

Nach vier Jahren erscheint wieder in der Serie „Studie ČSAV" eine umfangreiche Arbeit, die sich mit der Systematik der Eintagsfliegen (Ephemeroptera) beschäftigt. Diesmal ist dies Publikation ein Resultat der Zusammenarbeit von zwei erfahrenen Forschern auf diesem Gebiet, den Arbeitern des Entomologischen Institutes der TschAW. Die Studie fasst die Ergebnisse der Forschungsarbeit der Autoren während den letzten 30 Jahren zusammen. Im Laufe dieser Zeit haben beide Forscher ein sehr umfangreiches Material untersucht. Es wurden die Larven von mehr als 400 rezenten Arten (20 Familien, 184 Gattungen) seziert. Auf diese Weise gelang es, bis auf kleine Ausnahmen, in die Arbeit die Vertreter aller rezenten Familien einzureihen. Die meisten Ergebnisse wurden bisher noch nicht veröffentlicht. Die Autoren auf Grung des Studiums der Aufbau und der Anagenese von fünf Organsystemen (Ventralnervenband, Tracheensystem, Verdauungsrohr, Malpighische Gefässe, innere Geschlechtsorgane) diskutieren die phyllogenetischen Beziehungen in der Ordnung Ephemeroptera und stellen höhere Klassifizierung der Ordnung vom Gesichtspunkt der vergleichenden Anatomie auf.

Das Buch besteht aus zwei Hauptteilen. Am Anfang wird die Aufbau und Anagenese der erwähnten Organsystemen in Rahmen der Ordnung beschreiben. Dieses Kapitel bilden die Unterlage zu einer Diskussion, die sich sowohl mit der Problematik der Unterordnungen und Überfamilien, als auch mit den Problemen der Taxonomie auf dem Niveau der Familien beschäftigt.

Der Schluss dieses Buches bildet die eigene höhere Klassifizierung der Ordnung Ephemeroptera, die in drei Unterordnungen und 32 Familien eingeteilt wird.

Der Text wird zweckmässig von 22 Tafeln mit 118 Federzeichnungen begleitet. Eine Zusammenfassung in Englisch, Deutsch und Tschechisch ist vorhanden. Literaturverzeichnis enthält 104 Quellen. Das Buch ist logisch und übersichtlich gegliedert. Die Fakten sind sachlich und verständlich beschrieben. Die ganze Arbeit kann man als Beispiel einer modernen systematisch-zoologischen Studie, die auf gründlicher Kenntnis der Problematik und ausserordentlich umfangreichem Material beruht. Zweifelsohne gehört diese Publikation zu den Grundwerken auf diesem Gebiet.

M. Tonner

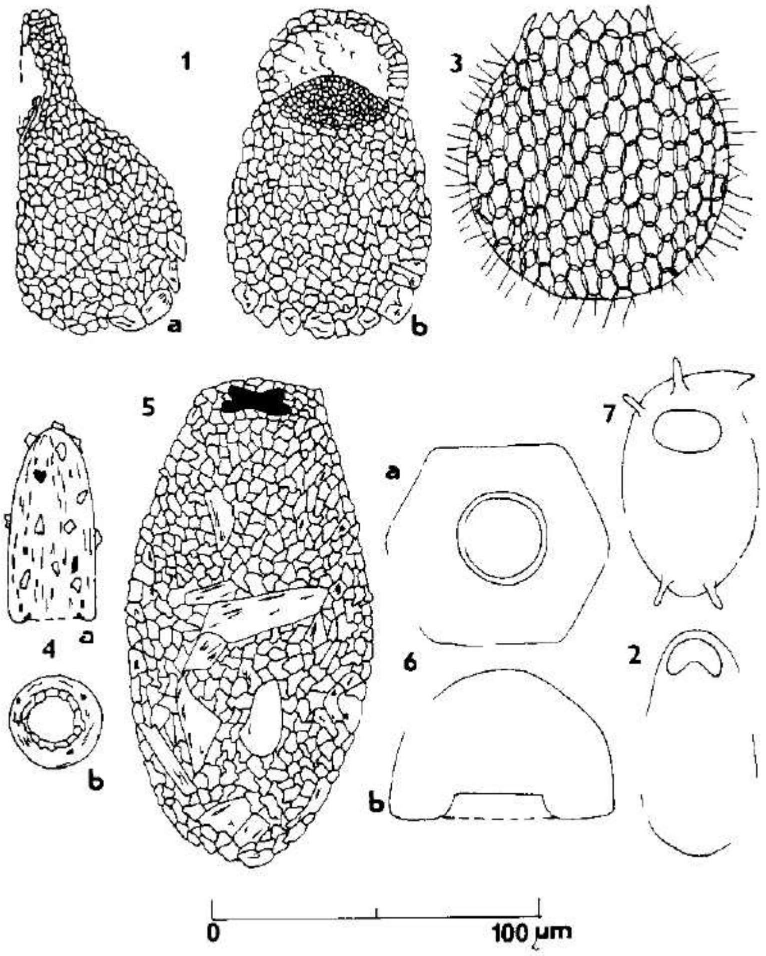


Abb 1 *Centropyxis ventricosa* Bartos a — von der Seite, b — von der Unterseite Abb 2 *Corythion renistoma* Decloitre Abb 3 *Euglypha strigosa* var *muscorum* Wailes Abb 4 *Phryganella acropodia* var *penardi* f *alta* Schonborn a — von der Seite, b — von der Unterseite Abb 5 *Schwabia robusta* Chardez Abb 6 *Cyclopyxis sexangularis* Decloitre, a — von der Unterseite b — von der Seite Abb 7 *Trinema cornuta* Decloitre

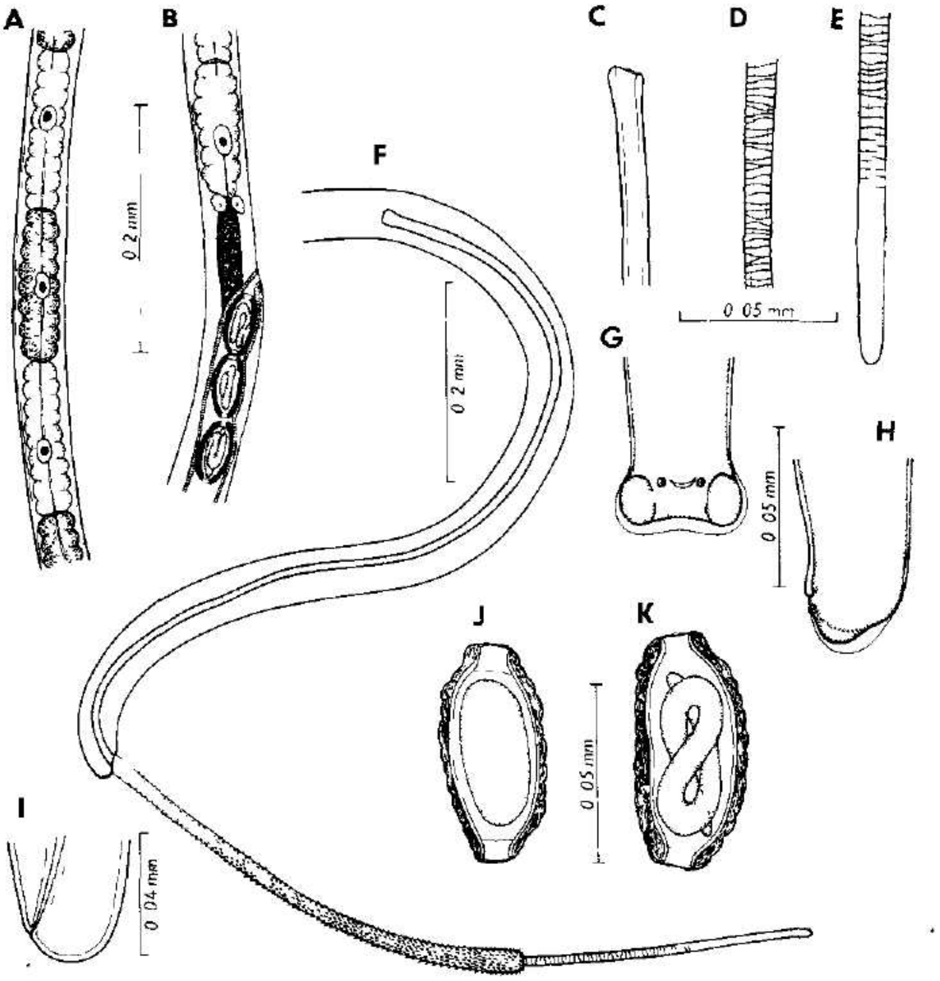


Fig. 1 *Capillaria anatis* (Schrank, 1790) from *Anas platyrhynchos* from Czechoslovakia. A — stichosome region; B — vulva region, C—E — proximal end, middle part and distal end of spicule; F — posterior end of male; G, H — tail of male, ventral and lateral views; I — tail of female; J — not fully developed egg, K — fully developed egg from female uterus

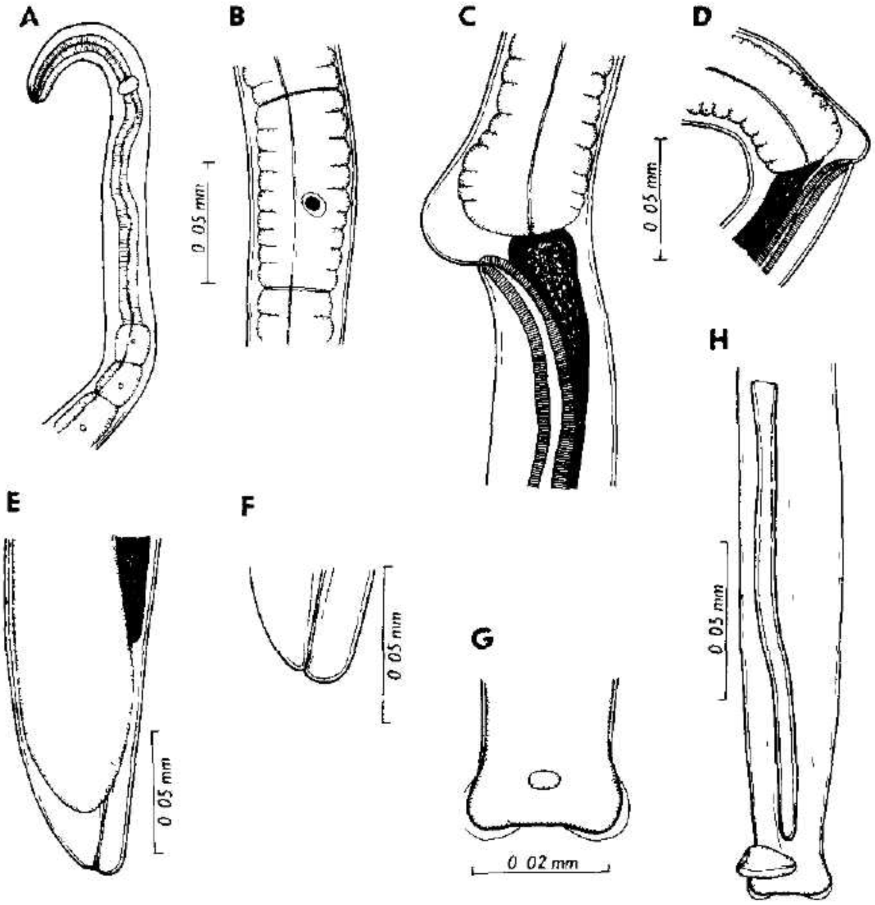


Fig. 2. *Capillaria recondita* Freitas et Lent, 1942 — type specimens from *Crossodactylus gaudichaudii* from Brazil. A — head end, B — stichocyte; C, D — vulva region; E — posterior end of female; F — tail of female; G — tail of male, ventral view, H — posterior end of male.

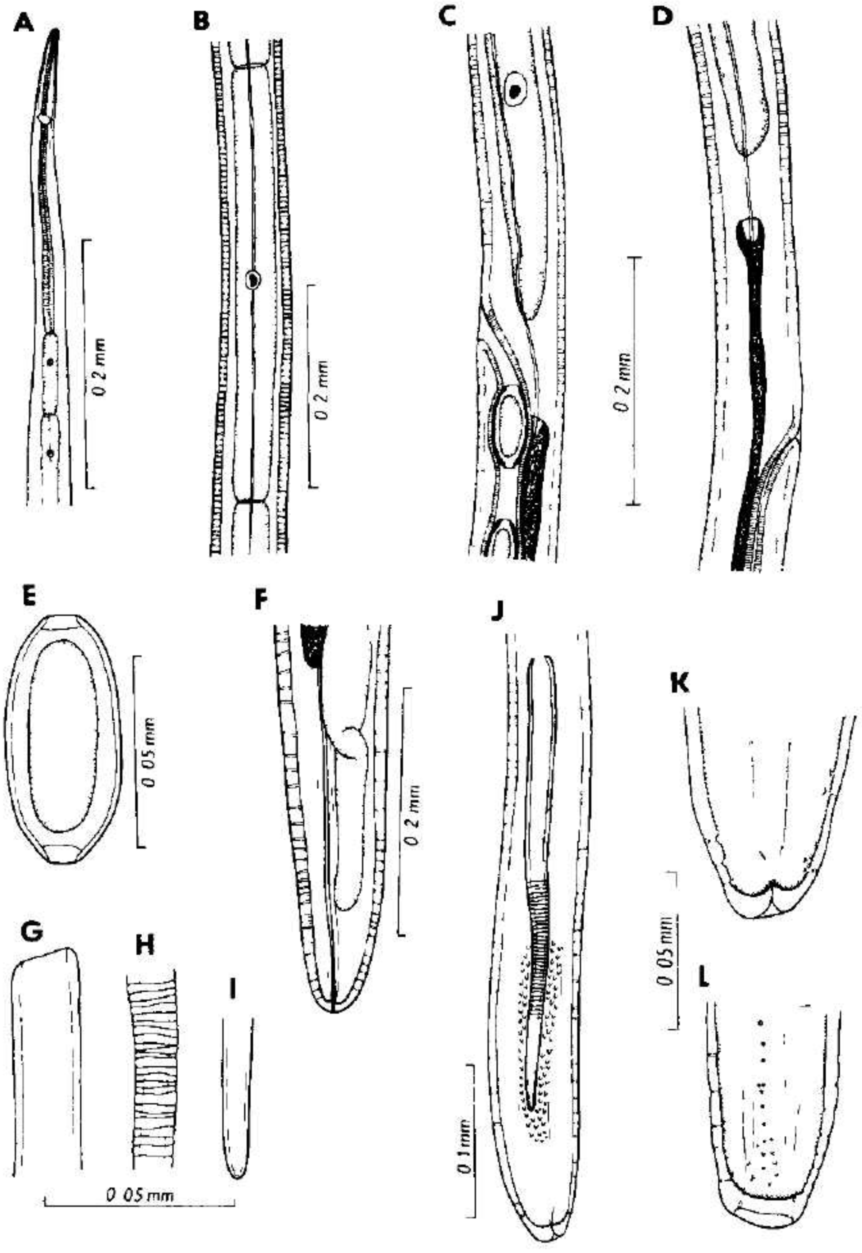
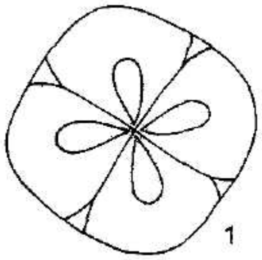


Fig. 3. *Paratrichosoma crocodylus* Ashford et Muller, 1978 from skin of *Crocodylus novaeguineae* (types). A — head end, B — stichosome region; C, D — vulva region; E — mature egg; F — posterior end of female, G–I — anterior end, middle part and posterior end of spicule; J — posterior end of male; K, L — caudal end of male, lateral and ventral views. (C — holotype; A–B and D–L — paratypes).

Sandeep B. V., Kalavati C., Narasimhamurti C. C.: Kudoa atropi sp. n.



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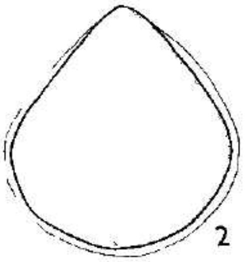

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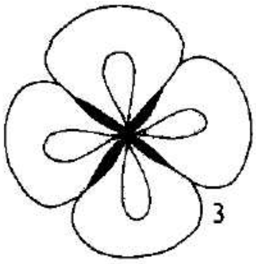

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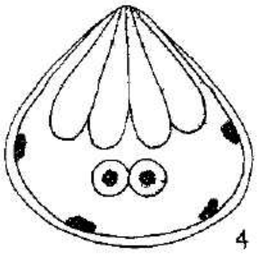

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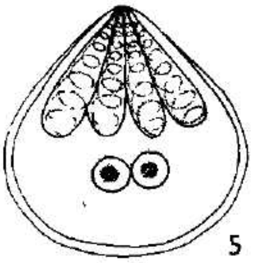

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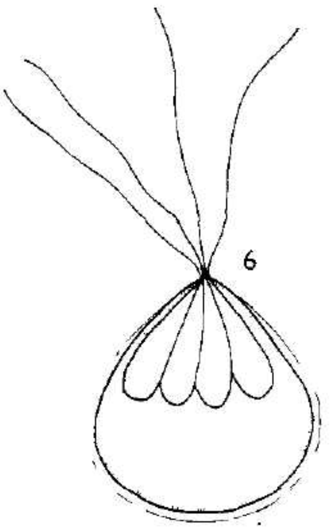

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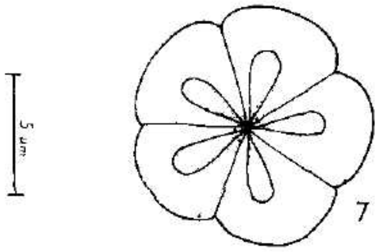

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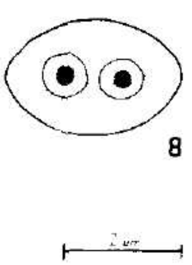
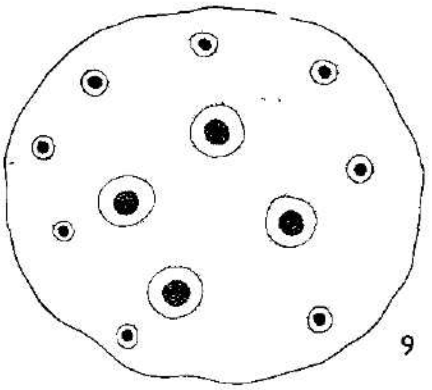
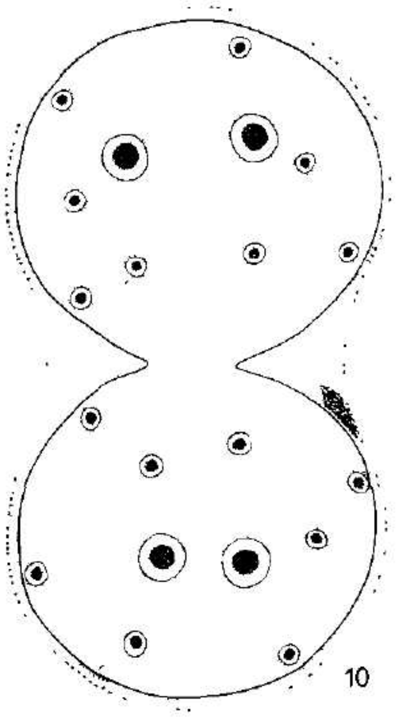
Fig 1 Polar view of the fresh spore. Fig. 2. Sutural view of the fresh spore. Fig 3 Fresh spore showing the thickening of the sutures (Giemsa). Fig. 4. Spore stained according to Feulgen's technique Fig. 5. Spore stained with Heidenhain's iron haematoxylin. Fig 6. Spore with extruded polar filaments. Fig. 7. A spore showing five valves and five capsules







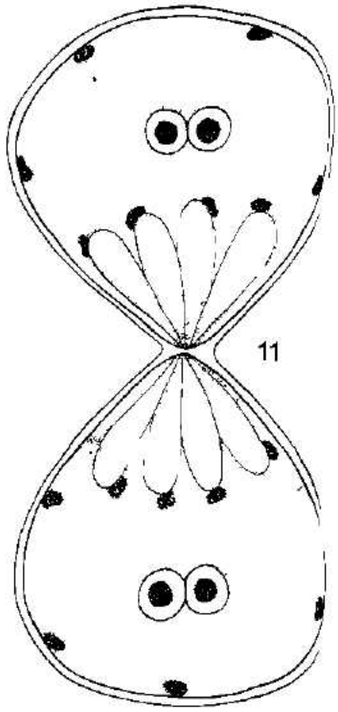


Fig. 8. Binucleated trophozoite with vesicular nuclei. Fig. 9 and 10. Trophozoites with 16 and 20 nuclei respectively. Fig. 11 Disporic pansporoblast.

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.

Formalní 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: Cyprinidae), 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. Společ. zool., 39: 111—119.*

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

Obrázky a grafy kreslete černou tuší na kladívkový nebo pausovací papír v poměru 1 : 1 až maximálně 1 : 2, 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 číslujte a v rukopise vyznačte místo, kam mají být zalomeny.

Tabulky jsou tištěny jako otevřené, tj. bez svislých linek. 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. Společ. zool., Viničná 7, 128 44 Praha 2.

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