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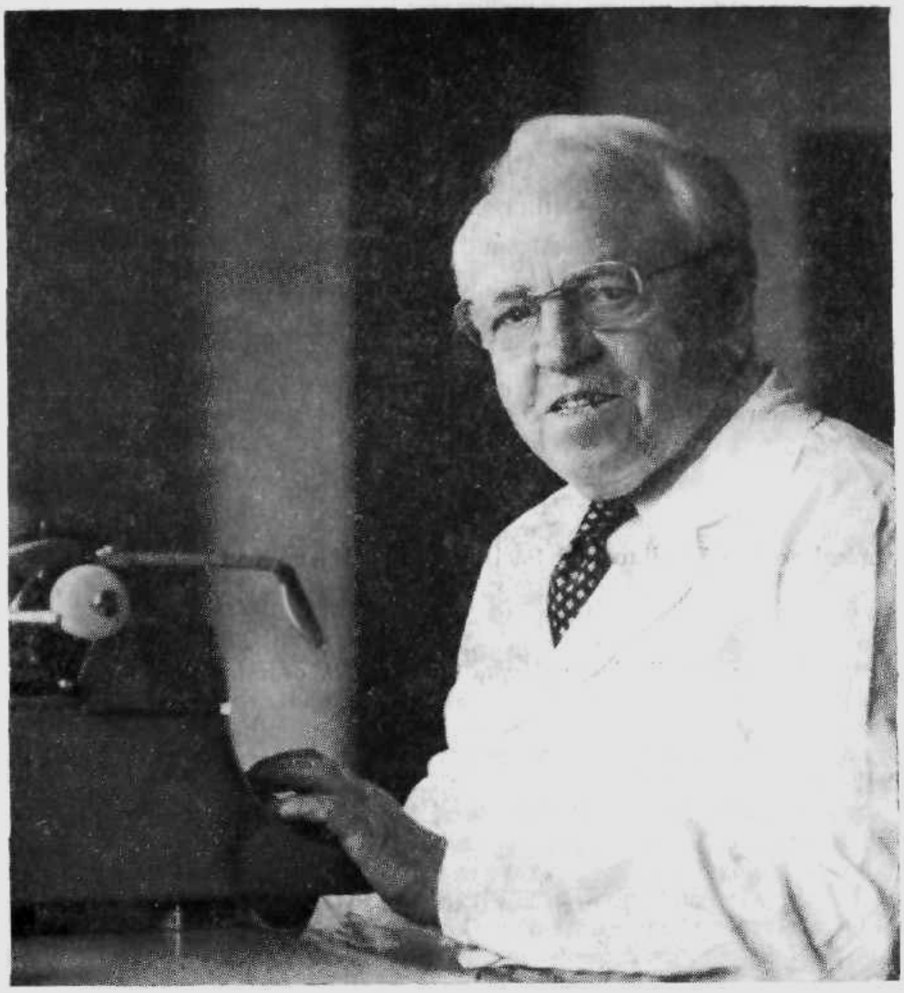

This issue is dedicated to the eminent Czechoslovak zoologist, president of the Czechoslovak Zoological Society, Academician Josef Kratochvíl on the occasion of his 80th birthday (January 6, 1989). The Editorial Board wish him good health for many further years to come, and enjoyment in his continuing work.

(Photo M. Novotný)

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ON THE BIOLOGY OF SIGANUS STELLATUS AND SIGANUS VIRGATUS (PISCES, PERCIFORMES, SIGANIDAE) FROM WATERS AROUND NORTHERN SRI LANKA

Karthigesu CHITRAVADIVELU

Department of Zoology, University of Jaffna, Jaffna, Sri Lanka

Abstract. Samples of *Siganus stellatus* and *S. virgatus* (Pisces, Perciformes, Siganidae) were obtained during 1983—1986 from twelve stations along northern coastal areas of Sri Lanka. The description, length-weight relationship, food and feeding, size ranges and fecundity were studied and are discussed.

INTRODUCTION

Siganids are marine perciform fishes which are widely distributed in the tropical parts of Indian and Pacific ocean (Marshall, 1964; Lam, 1974; Woodland and Allen, 1977; Carcasson, 1977). The fishes are meaty, tasty and considered excellent food fishes.

Siganus lineatus (Cuvier and Valenciennes, 1835), *Siganus javus* (Linnaeus, 1766), ***Siganus canaliculatus*** **(Park, 1797) (= *S. oramin*** Bloch and Schneider, 1801), *Siganus stellatus* (Forskal, 1775) and *Siganus virgatus* (Cuvier and Valenciennes, 1835) have been reported to inhabit the Nothern coasts of Sri Lanka, Thondaimannar and Jaffna lagoon (Chitravadivelu and Sivapalan, 1982).

Drew (1971) has reported on some aspects of basic ecology of *S. lineatus* and *S. oramin*. Lam (1974), has reviewed the available information on Siganids and biology with special reference to their mariculture potential. Chitravadivelu and Sivapalan (1982, 1983), Indrasena and Wijeratna (1984), Chitravadivelu (1984, 1985) have investigated various aspects of *S. lineatus*, *S. javus* and *S. canaliculatus*.

The present paper deals with some observations on the biology of *S. stellatus* and *S. virgatus*. Mendis (1954) has catalogued only *S. stellatus* while Munro (1955) has reported both the species.

MATERIALS AND METHODS

Samples were obtained from January 1983 to December 1986 using traps (Chitravadivelu and Arudpragasam, 1983), cast nets, set nets, torch and Sirahu valai (Sachithananthan and Thevathasan, 1970). Twelve stations were located along the Northern coastal areas extending from, Thalayaddy to Punakari, Jaffna lagoon. (70°50′ E to 80°38′ E long. and 9°26′ N to 9°46′ N lat.) and Thondaimannar lagoon (30°7′ to 80°28′ E long. and 9°34′ N to 9°49′ N lat.). The Jaffna lagoon has an area of approximately 160 square miles and the depths do not exceed 13 feet (Sachithananthan and Perera, 1970). The Thondaimannar lagoon is also a brackish water body which during the rainy season covers and area of about 30 square miles, with an average depth of 5 feet (Atputhanathan and Chitravadivelu, 1980).

Out of the 1,096 specimens of siganids collected during the period of investigation, there were only 23 *S. stellatus* and 22 *S. virgatus* forming only 2.0 % of the entire sample. Apparently these are sparsely occurring species in the area under investigation.

The specimens were immediately preserved in 4 % formalin and brought to the laboratory for detail analysis. The total, standard, head, snout, predorsal lengths body depths and eye diameter were measured to the nearest mm for each specimen. These lengths are defined by Hubbs and Lagler (1949) and Lowe — Mc Conel (1971). The fish was weighed to the nearest milligram and the body cavity cut open. The sex and gonad conditions were determined. The ovaries of ripe females were preserved in Gilsons fluid for fecundity studies. Fecundity was determined by the method of sub-sampling by weight (Sarojini, 1957; Nikolsky, 1963; Bagnel and Braum, 1971). The average fecundity was calculated, treating separately, three subsamples from different parts of the ovary.

The gut was removed and its length from the oesophagus to the anus was measured by placing the relaxed alimentary canal on a millimeter ruler. The stomach of each fish was cut longitudinally, the contents emptied carefully into a specimen tube and each item identified. In evaluating the different food items the method of Chitravadivelu and Sivapalan (1982 and 1983) was adopted.

RESULTS AND DISCUSSION

Description

Rabbit fish — the common name of Siganids comes from their rounded head and like mouth. There are two spines in the pelvic fins, seven in the anal fins and thirteen in the single continuous, spiny dorsal fin. Siganids are able inflict very painful wounds with these strong spines when handled carelessly and these wounds cause distress with pain for hours afterwards and are slow in healing.

Table 1. Regression equations of body measurements

	S. stellatus	S. virgatus
Total L.	$\Upsilon = 1.1604 \times + 0.5939$	$\Upsilon = 1.79 \times - 0.24$
Fork L.	$\Upsilon = 1.0805 \times + 0.6865$	$\Upsilon = 1.13 \times + 0.38$
Depth	$\Upsilon = 0.4298 \times + 0.2515$	$\Upsilon = 0.48 \times + 0.06$
Snout	$\Upsilon = 0.1120 \times + 0.0259$	$\Upsilon = 0.12 \times - 0.03$
Head L.	$\Upsilon = 0.2270 \times + 0.4640$	$\Upsilon = 0.23 \times + 0.44$
Predorsal L.	$\Upsilon = 0.1574 \times + 1.5276$	$\Upsilon = 0.26 \times + 0.78$
Eye diameter	$\Upsilon = 0.0571 \times + 0.2223$	$\Upsilon = 0.09 \times + 0.06$

Morphometrics

Drew (1971) has referred to the confusion that exists in literature on the identification of Siganids. Siganids are also sometimes called Teuthids. Woodland (1972, 1973) has proposed that the generic name *Teuthis* Linnaeus 1766, be suppressed in favour of *Siganus* Forskal, 1775.

The members of the siganids have been notoriously difficult to identify to the species level because of their morphological uniformity (Woodland and Randall, 1979). Some important morphometrics have therefore been worked out to facilitate comparison with other species. Regression equations for the various body measurements were calculated without regard to date of capture, maturity or sex for the two species and are given in Table 1.

Length-weight relationship

The length-weight relationship is shown in Fig. 1. It shows three segments (i) an initial section where the increase in length is not appreciable (ii) a second section where the gain in weight is somewhat conspicuous (iii) followed by a section where the increase in weight is very marked. The beginning of the third section indicates the size of the fish which gains rapidly in weight. This length is 150 mm in both *S. stellatus* and *S. virgatus*. From a commercial stand point, it would therefore be more economical to catch only large sized fish above 150 mm.

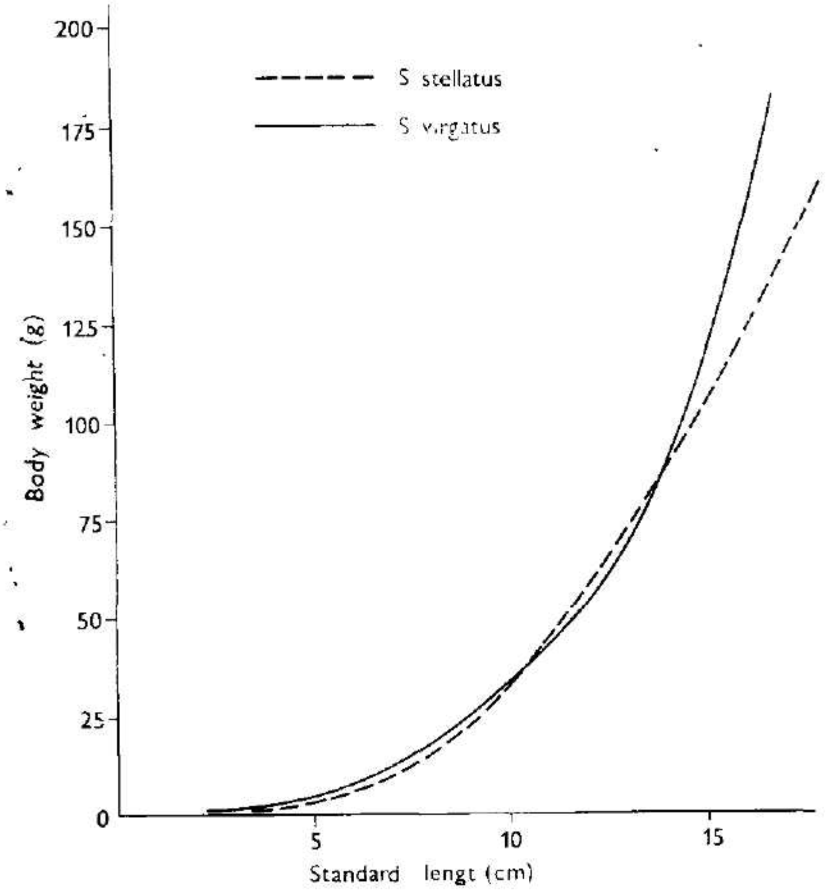
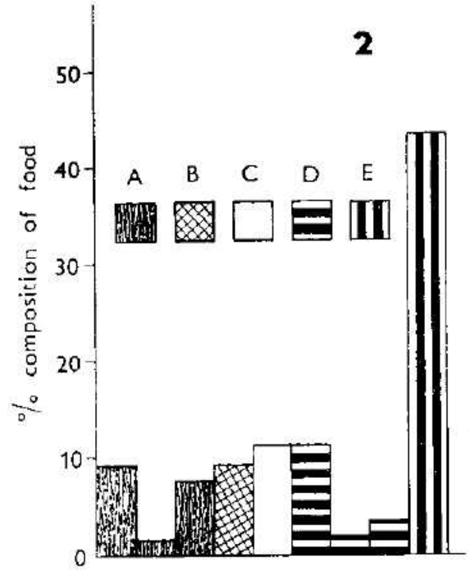


Fig. 1. Length — weight relationship of *S. stellatus* and *S. virgatus*.

The regression equations express the relationship between length and weight of the species irrespective of size and sex. *S. stellatus* $\log w = 2.9709 \log 1 - 1.4438$, $w = 1^{2.9709} \times 0.0359915$; *S. virgatus* $\log w = 3.0500 \log 1 - 3.4600$, $w = 1^{3.0500} \times 0.0003467$.

The equation with exponents very close to 3 indicate an almost isometric growth in *S. stellatus* and *S. virgatus*.



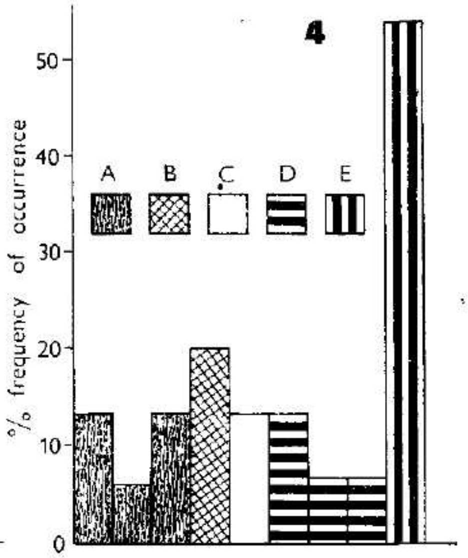


Fig. 2. Percentage composition of food of *S. stellatus*. A — diatoms *(Licmophora, Navicula, Biddulphia)*, B — blue greens *(Oscilatoria)*, C — green algae *(Cladophora)*, D — red algae *(Gracillaria, Gelidium, Dictyota)*, E — angiosperms *(Thallasia)*.

Fig. 4. Percentage frequency of occurrence of various food items in stomach of *S. stellatus*. A — diatoms *(Licmophora, Navicula, Biddulphia)*, B — blue greens *(Oscillatoria)*, C — green algae *(Cladophora)*, D — red algae *(Gracillaria, Gelidium, Dictyota)*, E — angiosperms *(Thallasia)*.

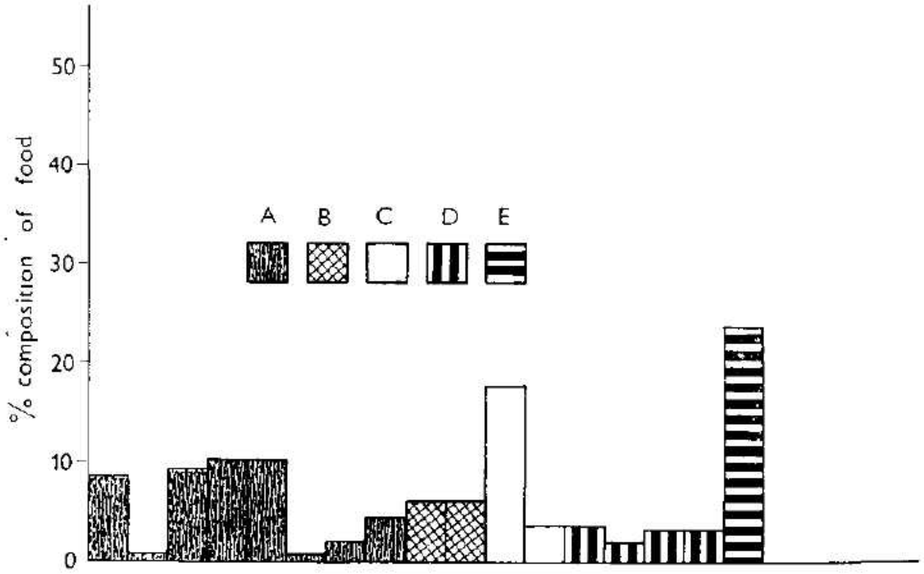


Fig. 3. Percentage composition of food of *S. virgatus*. A — diatoms *(Licmophora, Coscinodiscus, Navicula, Gomphonema, Pleurosigma, Biddulphia, Rhizosolenia, Fragilaria)*, B — blue greens *(Oscillatoria, Lyngya)*, C — green algae *(Cladophora, Chaetomorpha)*, D — red algae *(Caulerpa, Centroceras, Jania, Polysiphonia)*, E — angiosperms *(Thallasia)*.

Food and feeding

The percentage composition of food is shown in Figs. 2 and 3 and frequency of occurrence of each food item is shown in Figs. 4 and 5.

Analysis of the stomach content reveals that both *S. stellatus* and *S. virgatus* feed on diatoms, blue greens, green algae, red algae and an angiosperm, totalling nine genera in *S. stellatus* and seventeen genera in *S. virgatus*. Of the nine genera in *S. stellatus*, *Licmophora*, *Biddulphia*, *Cladophora*, *Gracillaria* and *Thallasia* were the major forms. *Thallasia* is the main food component in *S. stellatus* forming 53 % in frequency of occurrence and 43.5 % in composition.

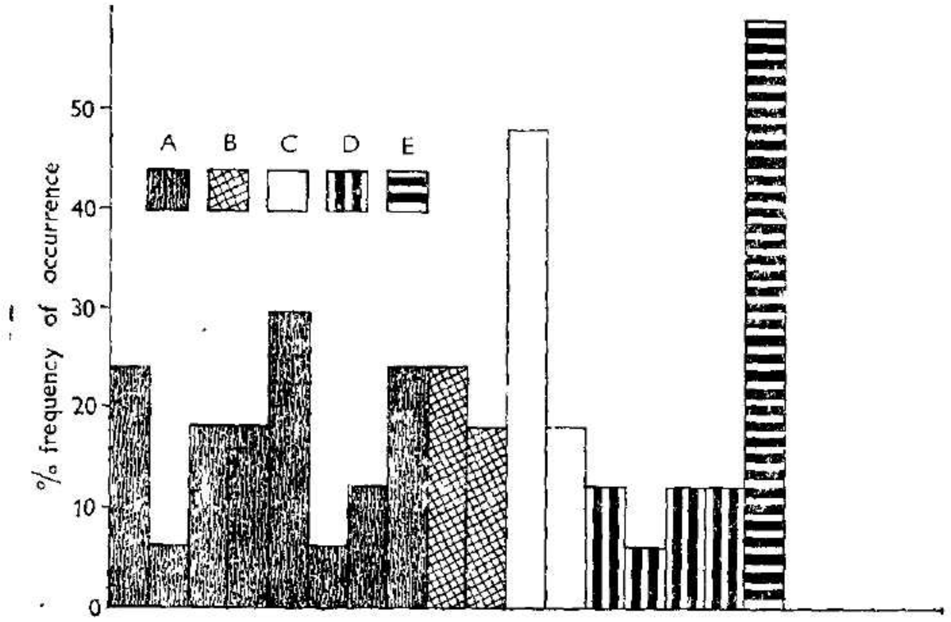


Fig. 5. Percentage frequency of occurrence of various food items in stomach of of *S. virgatus*. A — diatoms (*Licmophora, Coscinodiscus, Navicula, Gomphonema, Pleurosigma, Biddulphia, Rhizosolenia, Fragilaria*), B — blue greens (*Oscillatoria, Lyngya*), C — green algae (*Cladophora, Chaetomorpha*), D — red algae (*Caulerpa, Centroceras, Jania, Polysiphonia*), E — angiosperms (*Thallasia*).

Thallasia predominated all the other genera in *S. virgatus* also, occurring in 58.8 % and forming 23.3 % in composition. *Cladophora* comes second both in composition and frequency of occurrence. *Pleurosigma*, *Fragilaria* and *Licmophora* were the major components of the eight genera of diatoms.

Of the genera of red algae observed *Gracillaria* in *S. stellatus*, *Caulerpa*, *Jenia* and *Polysiphonia* in *S. virgatus* were the major forms amounting to between 11.8 % and 13.3 % in composition.

The results of the stomach contents analysis reveal that both *S. stellatus* and *S. virgatus* are purely herbivores.

The variations of the length of the gut with standard length are expressed by the following equations.

S. stellatus: $Y = 2.5248x + 5.5338$, *S. virgatus:* $Y = 3.0000x + 4.0500$.

The total length of the alimentary canal is 3.0 times and 2.5 times the standard length in *S. stellatus* and *S. virgatus* respectively. These ratios fit the classical herbivorous stomach and intestine.

Fecundity

Fecundity is the number of ripening eggs in the female prior to the next spawning period (Bagenal and Braum, 1971). Only three mature of *S. virgatus* and one *S. stellatus* were available for fecundity studies. The fecundity values were 7.2×10^6 in *S. stellatus* and 2.0×10^6 in *S. virgatus*.

Size range

The largest *S. stellatus* recorded in the present investigation is a female of standard length 303 mm with a depth of 139 mm, weighing 718.7 g. The length *S. virgatus* recorded is also a female of standard length 166 mm, with a depth of 77 mm weighing 176.7 g Munro (1955) has reported *S. stellatus* and *S. virgatus* of 330 mm (13.0") and 262 mm (10.5") respectively but failed to indicate the type of length.

SUMMARY

1. Siganids from twelve stations along the Northern coast, Jaffna lagoon and Thondaimannar lagoon were collected during the period January 1983 to December 1986.
2. *Siganus stellatus* and *Siganus virgatus* are two sparsely occurring species in the area under investigation. 23 specimens of the former and 22 specimens of the latter formed only 2.0 % of the 1096 specimens of Siganids collected during this period.
3. The calculated length-weight relationships of
   $w = 0.0359915 \times 1^{2.9709}$ and
   $w = 0.0003467 \times 1^{3.0500}$ of
   S. stellatus and *S. virgatus* respectively reflect an almost isometric growth.
4. The rapid gain in weight after these species reach a standard length of 150 mm suggest that it would be more economical to catch only large sized fish above 150 mm.
5. Both *S. stellatus* and *S. virgatus* are purely herbivores feeding on diatoms, blue-green, green algae, red algae and an angiosperm – *Thallasia*.
6. The ratios of 3.0 and 2.5 of the total length of the alimentary canal to the standard length in *S. stellatus* and *S. virgatus* respectively, fit the typical herbivorous stomach and intestine.
7. The mean fecundity values of *S. stellatus* and *S. virgatus* have been assessed as 7.2×10^6 and 2.0×10^6 respectively.
8. The largest specimens of *S. stellatus* and *S. virgatus* are of standard length 303 mm and 166 mm respectively.

Acknowledgements

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SOME CHARACTERS AND DIFFERENCES BETWEEN IMPORTED AND ZOO-BRED BLACK AND WHITE SPRINGBOK, *ANTIDORCAS MARSUPIALIS* (MAMMALIA: BOVIDAE)

Luděk J. DOBRORUKA

The Zoological Garden Dvůr Králové, 544 01 Dvůr Králové n. L., Czechoslovakia

Abstract. Zoo-born specimens of black and white varieties of springbok have lesser length dimensions of the skull than imported specimens. The sexual dimorphism in zoo-born specimens is developed slightly or not at all and some other characters, viz presence of P^2 and ethmoidal fissure, differ, too. These differences have three sources: decay of genetic variability in small isolated population, domestication effect and different feeding manner in zoo-born animals.

INTRODUCTION

In 1972, the Zoological Garden Dvůr Králové imported herds of both black and white varieties of springbok from the vicinity of Richmond (South Africa), the territory within the range of *Antidorcas marsupialis marsupialis*. The history was published elsewhere (Dobroruka 1974). Kruger, Skinner and Robinson (1979) compared the black springbok with the normal coloured animals of *A. m. marsupialis* and have not find differences in 6 male and 9 female skulls and slightly difference only in lesser shoulder high and lesser tail length in the black variety. Our statements on external characters agree with those of the authors mentioned, unfortunately, we can not compare skull characters because we have material of normally coloured springbook of another subspecies, *A. m. hofmeyri*, only.

We compared skull measurements of imported animals with those born in the zoo and we stated smaller length dimensions of skulls in zoo-born animals. Therefore, we tried to ascertain which part of the skull changes, if differences are significant and, what is the probably reason of such differences.

MATERIAL AND METHOD

36 skulls (12 males and 24 females) of black springbook (11 imported) and 8 skulls (2 males and 6 females) of white springbok (4 imported) were studied. Adult animals were investigated only. The criterium is the erruption of the third upper molar M^3. 19 measurements were taken and other 3 characters studied in each skull: total length, condylobasal length, basal length, zygomatic width, greatest breadth, tuber-malare-width, preorbital constriction, postorbital constriction, breadth across horn-cones at the base, width of the braincase, sutural length of nasals, length of premaxilla, rostral length (from tip of premaxillae to the oral end of the upper teeth row), preorbital length (from tip of premaxillae to anterior end of orbit), postorbital length (from fronto-parietal suture to occipital protuberances), upper teeth row, lower teeth row (both alveolar), length of diastema, capacity of braincase; presence of ethmoidal fissure, number of upper premolars, type of premaxilla contact with nasals. Measurements in mm, braincase capacity in mm^3.

Average with standard error ($M \pm s_x$), standard deviation (s) and coefficient of variability (v) for each set of measurements were computed (Tab. 1 and 2). Only in black females the number of skulls of imported versus zoo-born animals was sufficient for statistical evaluation (Tab. 3). The differences were tested by T-test. Dif-

Table 1. Skull measurements of black springbok

Character	Males					Females				
	N	min–max	M ± s_x	s	v	N	min–max	M ± s_x	s	v
total length	12	202–216	208,17 ± 1,20	4,17	2,00	23	194–217	203,52 ± 1,55	7,45	3,66
condylobasal length	12	192–205	197,33 ± 1,16	4,03	2,04	23	181–203	193,39 ± 1,39	6,67	3,45
basal length	12	178–188	183,17 ± 1,11	3,86	2,11	23	168–188	178,69 ± 1,31	6,27	3,51
zygom. width	12	77– 89	82,42 ± 1,00	3,48	4,22	24	77– 89	82,08 ± 0,71	3,46	4,22
greatest breadth	12	91– 99	93,92 ± 0,76	2,64	2,81	24	86– 97	90,67 ± 0,65	3,19	3,52
tuber-malare-width	11	58– 69	61,82 ± 0,87	2,89	4,67	24	55– 66	60,38 ± 0,63	3,06	5,07
preorbital constr.	12	42– 52	47,67 ± 0,91	3,14	6,59	24	37– 50	45,38 ± 0,56	2,76	6,08
postorbital constr.	12	54– 64	60,00 ± 0,76	2,63	4,38	24	55– 75	59,17 ± 0,80	3,92	6,62
breadth across horn-cones	11	65– 77	71,82 ± 1,06	3,52	4,90	22	52– 64	57,77 ± 0,69	3,26	5,64
width of the brain-case	12	63– 65	64,33 ± 0,31	1,07	1,66	24	59– 67	63,46 ± 0,43	2,08	3,28
length of nasals	12	65– 83	72,92 ± 1,29	4,48	6,14	24	60– 79	68,83 ± 1,05	5,15	7,48
length of premaxilla	11	62– 74	67,18 ± 1,03	3,43	5,11	24	62– 74	66,71 ± 0,68	3,36	5,04
rostral length	12	49– 61	55,00 ± 0,94	3,25	5,91	24	47– 59	54,21 ± 0,65	3,19	5,89
preorbital length	12	108–117	111,83 ± 0,87	3,01	2,69	24	102–122	109,75 ± 1,10	5,41	4,93
postorbital length	12	66– 72	68,67 ± 0,58	2,02	2,94	23	65– 74	69,04 ± 0,62	2,98	4,32
upper teeth row	12	63– 69	66,08 ± 0,59	2,07	3,13	24	58– 67	63,42 ± 0,57	2,81	4,43
lower tooth row	11	61– 68	65,27 ± 0,73	2,41	3,69	23	61– 68	64,91 ± 0,49	2,29	3,53
length of diastema	11	41– 50	45,09 ± 0,92	3,05	6,76	23	39 – 54	45,04 ± 0,80	3,86	8,57
capacity of braincase	12	105–120	114,17 ± 1,49	5,15	4,51	22	100–135	114,32 ± 2,19	10,27	8,98

Table 2. Skull measurements of white springbok

Character	Males					Females				
	N	min–max	$M \pm s_x$	s	v	N	min–max	$M \pm s_x$	s	v
total length	2	215–227	221,0 ± 6,00	8,49	3,84	6	191–217	203,17 ± 4,09	10,03	4,94
condylobasal length	2	206–217	211,5 ± 5,5	7,78	3,68	6	181–210	193,83 ± 4,45	10,89	5,62
basal length	2	190–202	196,0 ± 6,0	8,49	4,33	6	166–189	179,5 ± 4,88	11,95	6,66
zygom. width	2	84	—	—	—	6	74–79	76,5 ± 3,1	1,76	2,30
greatest breadth	2	97–98	97,5 ± 0,5	0,71	0,73	6	84–88	86,33 ± 0,61	1,51	1,75
tuber-malaro-width	1	64	—	—	—	6	56–62	58,5 ± 0,96	2,35	4,02
preorbital constr.	2	44–47	45,5 ± 1,5	2,12	2,19	6	39–46	42,33 ± 0,92	2,25	5,32
postorbital constr.	2	60	—	—	—	6	51–59	55,33 ± 1,17	2,88	5,21
breadth across horn cores	2	72–73	72,5 ± 0,5	0,71	0,98	6	53–63	56,5 ± 1,41	3,45	6,11
width of the brain case	2	63–64	63,5 ± 0,5	0,71	1,19	6	59–67	62,0 ± 1,24	3,03	4,89
length of nasals	2	76–79	77,5 ± 1,5	2,12	2,73	6	66–79	74,83 ± 1,87	4,58	6,12
length of premaxilla	1	72	—	—	—	6	62–74	68,67 ± 1,86	4,55	6,33
rostral length	2	53–64	58,0 ± 6,0	8,49	14,64	6	48–58	49,67 ± 1,20	2,94	5,92
preorbital length	2	118–124	121,0 ± 3,0	4,24	3,50	6	103–119	113,33 ± 2,35	5,75	5,07
postorbital length	2	71–73	72,0 ± 1,0	1,41	1,96	6	63–68	65,33 ± 0,95	2,34	3,58
upper teeth row	2	63–68	65,5 ± 2,5	3,54	5,40	6	62–73	66,5 ± 1,5	3,67	5,52
lower teeth row	1	62	—	—	—	6	61–69	65,5 ± 1,15	2,81	4,29
length of diastema	–	—	—	—	—	5	40–46	43,6 ± 1,12	2,51	5,76
capacity of braincase	2	110–120	115,0 ± 5,0	7,07	6,15	6	100–115	104,17 ± 2,39	5,85	5,62

Table 3. Measurements of imported and zoo born black springbok females

Character	Imported					Zoo born						T for	
	N	min–max	M ± s_x	s	v	N	min–max	M ± s_x	s	v	T	0,05	0,01
total length	10	195–217	208,9 ± 2,04	6,43	3,08	13	193–207	199,38 ± 1,47	5,28	2,65	3,89	2,07	2,81
condylobasal length	10	185–203	197,7 ± 1,80	5,70	2,88	13	185–199	190,08 ± 1,51	5,45	2,87	3,26	2,07	2,81
basal length	10	171–188	182,5 ± 1,59	5,02	2,75	13	168–186	175,77 ± 1,57	5,64	0,57	2,97	2,07	2,81
zygom. width	11	76– 88	81,91 ± 1,02	3,39	4,14	13	77– 89	82,23 ± 1,01	3,65	4,44	0,22	2,07	2,81
greatest breadth	11	86– 97	92,36 ± 0,99	3,29	1,08	13	87– 94	89,23 ± 0,66	2,39	2,68	2,69	2,07	2,81
tuber malare width	11	55– 66	60,45 ± 1,15	3,83	6,34	13	57– 66	60,31 ± 0,66	2,39	3,96	0,11	2,07	2,81
preorbital constr.	11	37– 49	45,00 ± 1,08	3,58	7,96	13	44– 50	45,69 ± 0,54	1,93	4,22	0,60	2,07	2,81
postorbital constr.	11	55– 62	58,73 ± 0,74	2,45	4,17	13	55– 62	59,54 ± 1,36	4,91	8,25	0,49	2,07	2,81
breadth across horn-conos	11	53– 64	58,55 ± 1,05	3,47	5,92	11	52– 60	57,00 ± 0,90	3,00	5,16	1,12	2,08	2,82
width of the brain case	11	59– 67	63,64 ± 0,74	2,46	3,87	13	60– 66	63,31 ± 0,50	1,80	2,84	0,38	2,07	2,81
length of nasals	11	63– 77	70,00 ± 1,31	4,34	6,20	13	60– 79	67,85 ± 1,59	5,73	8,44	1,02	2,07	2,81
length of premaxilla	11	63– 74	68,18 ± 1,13	3,59	5,27	13	62– 70	65,46 ± 0,69	2,47	3,77	2,12	2,07	2,81
rostral length	11	47– 59	55,09 ± 1,12	3,55	6,44	13	48– 58	53,46 ± 0,71	2,57	4,81	1,26	2,07	2,81
preorbital length	11	105–122	113,09 ± 1,49	4,95	4,38	13	102–113	106,92 ± 1,13	4,09	3,83	3,34	2,07	2,81
postorbital length	11	66– 74	70,82 ± 0,84	2,79	3,94	12	65– 72	67,42 ± 0,62	4,63	6,87	3,29	2,07	2,81
upper teeth row	11	58– 67	63,27 ± 0,95	3,17	5,01	13	59– 67	63,54 ± 0,72	2,50	3,94	0,23	2,07	2,81
lower teeth row	10	61– 68	65,10 ± 0,80	2,51	3,86	13	61– 68	64,80 ± 0,61	2,20	3,40	0,34	2,07	2,81
length of diastema	10	43– 54	46,40 ± 1,09	3,47	7,48	13	39– 52	44,00 ± 1,09	3,94	8,95	1,52	2,07	2,81
capacity of braincase	11	100–135	115,91 ± 3,92	13,00	11,22	11	110–125	112,73 ± 2,06	6,84	6,07	0,72	2,08	2,82

Table 4 Allometry constants for zoo-born black springbok

All measurements in correlation with basal length	Males						Females					
	N	a	log b	r	α_r 0,05	α_r 0,01	N	a	log b	r	α_r 0,05	α_r 0,01
zygomatic width	12	1,954	−2,5021	−0,245	0,576	0,708	13	1,557	−1,5786	0,328	0,553	0,684
preorbital length	12	1,272	−0,8298	0,759	0,576	0,708	13	1,190	−0,8265	0,923	0,553	0,684
postorbital length	12	1,389	−1,3063	0,139	0,576	0,708	12	0,955	−0,3147	0,102	0,576	0,708

ferences on the level of $p = 0.05$ (95 %) were considered as probably significant, differences on the level of $p = 0.01$ (99 %) as significant. For evaluation of sexual differences in zygomatic width, preorbital and postorbital length an allometry analysis (allometry constant a, integration constant log b, Tab. 4) was made (cf Bertalanffy 1957, Bohlken 1962, 1964). Following criteria were taken for correlation coefficient r : $0.30 \leq r < 0.50$ moderate; $0.50 \leq r < 0.70$ remarkable; $0.70 \leq r < 0.90$ high. The critical values of correlation coefficient αr were taken from tables in Janko (1958) and Kába (1973).

External characters

We measured occasionally the shoulder height (stock measure) of our black and white springbok The imported specimens of black springbok have 68—70 cm (N = 6) in the shoulder, the white springbok 70—75 cm (N = 3) in the shoulder. In white springbok no differences between imported and zoo-born animals were stated (N = 3), in black springbok, however, zoo-born animals were smaller, having 66—68 cm (N = 9) in the shoulder. The sample is too small for precise evaluation, but our statements correspond with those of Kruger, Skinner and Robinson (1979) and, if compared with Groves (1981), we can agree that at least black springbok are somewhat smaller than normal coloured *A. m. marsupialis*.

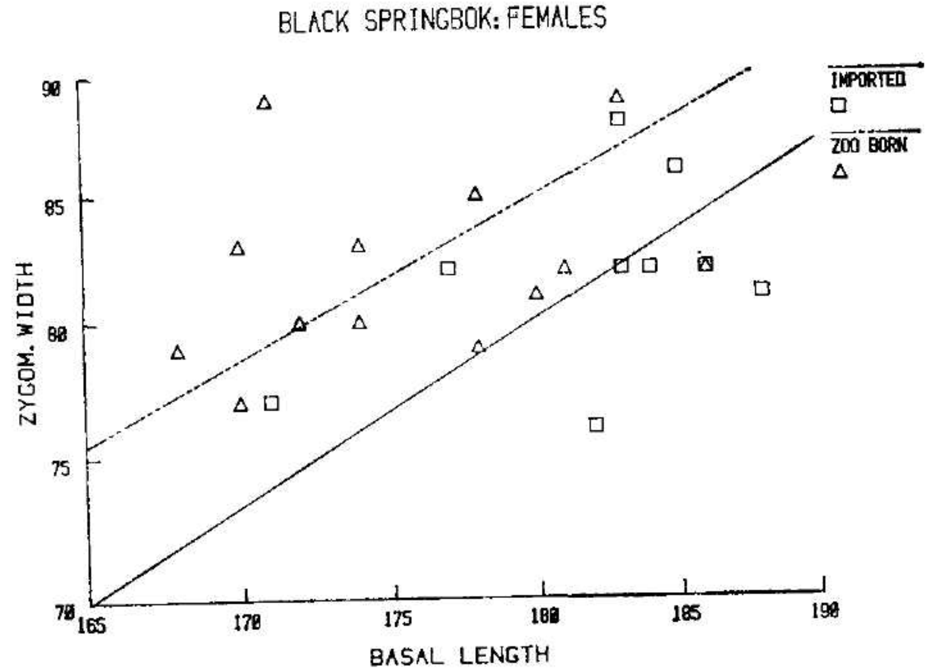

Fig 1 Logarithmic diagram of allometric relationships between zygomatic width and basal length in black springbok females.

Cranial measurements and characters

In the skull characters and measurements the black and white springbok resemble the normally coloured *A. m. marsupialis* from Orange Free State or

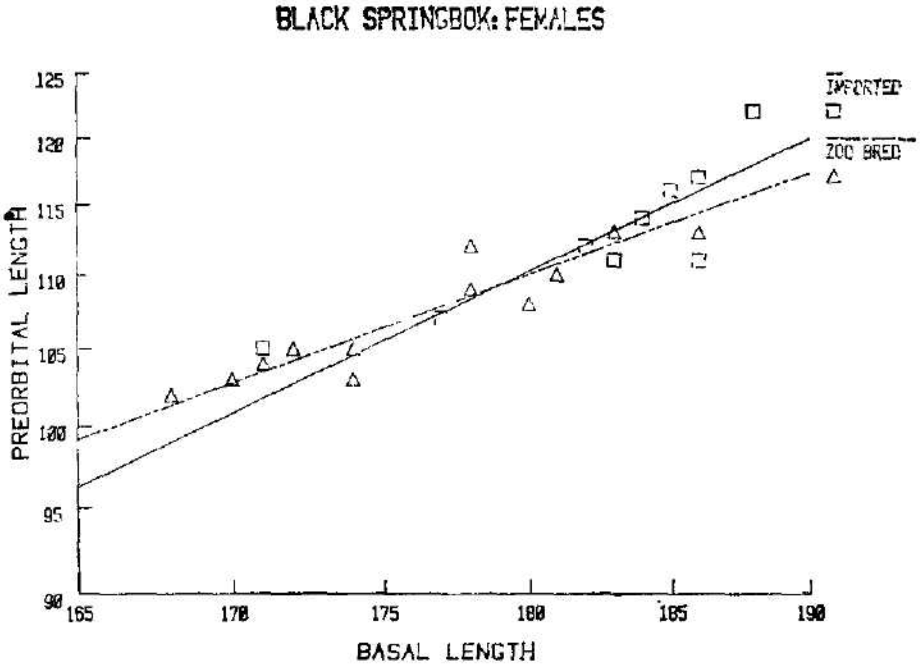

Fig. 2. Logarithmic diagram of allometric relationships between preorbital length and basal length in black springbok females.

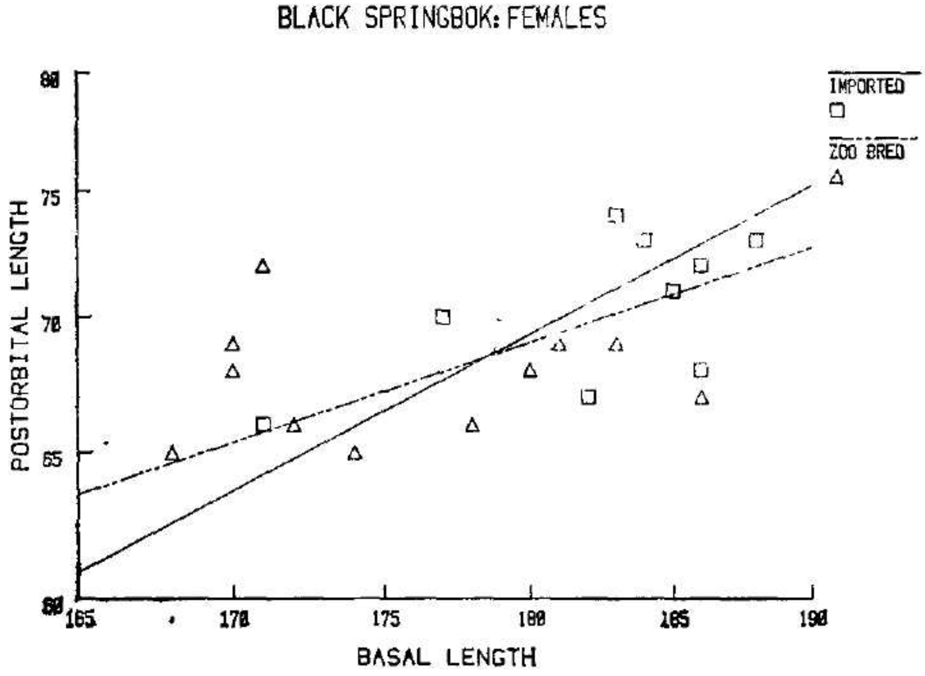

Fig. 3. Logarithmic diagram of allometric reationships between postorbital length and basal length in black springbok females.

Kimberley, but are slightly smaller (cf. Groves 1981). If compared the imported and zoo-born animals, we can find that the length dimensions in zoo-born animals are significantly smaller ($p > 0.01$ in black, $p > 0.05$ in white springbok), while the width dimensions do not differ. More detailed analysis shows that the skulls differ in both preorbital and postorbital length in black springbok ($p > 0.01$), in white springbok (in which the sample is not numerous enough, however) the skulls differ in postorbital length only ($p > 0.05$). The average difference in black springbok is $6^{0}/_{0}$ in preorbital and $5^{0}/_{0}$ in postorbital length.

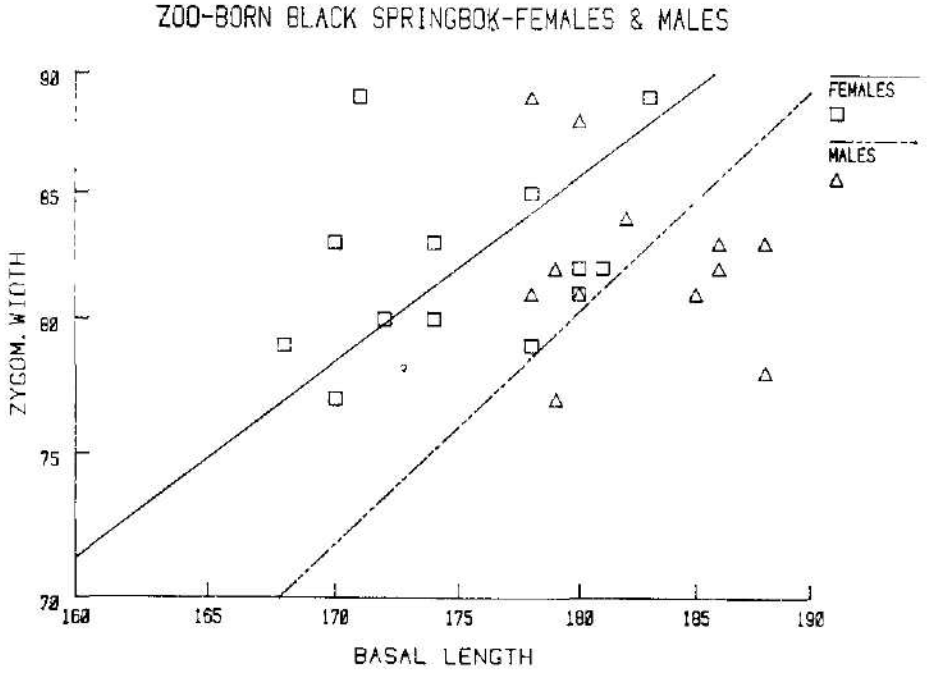

Fig. 4. Logarithmic diagram of allometric reationships between zygomatic width and basal length in zoo-born females and males of black springbok.

We compared allometric constants of zygomatic width, preorbital length and postorbital length, all in correlation with basal length in imported versus zoo-born black springbok females. In zygomatic width (Fig. 1) the trend lines are quite paralell, but in both preorbital and postorbital length (Fig. 2 and 3) the angle of the lines (exponent a) differs. Such differences, according to Meunier (1963) and Bohlken (1964), may be evaluated as phenomena of domestication. The zygomatic width and postorbital length of the skull are not correlated with the length, the preorbital length, however, shows remarkable correlation with basal length (Tab. 4).

The sexual dimorphism is expressed by slightly lesser dimensions (in zoo-born animals not significant) in females (Tab. 1 and 2). As the allometric trend lines of zygomatic width and preorbital length of males and females are only transposed and nearly paralell (Fig. 4 and 5), while the trend lines of

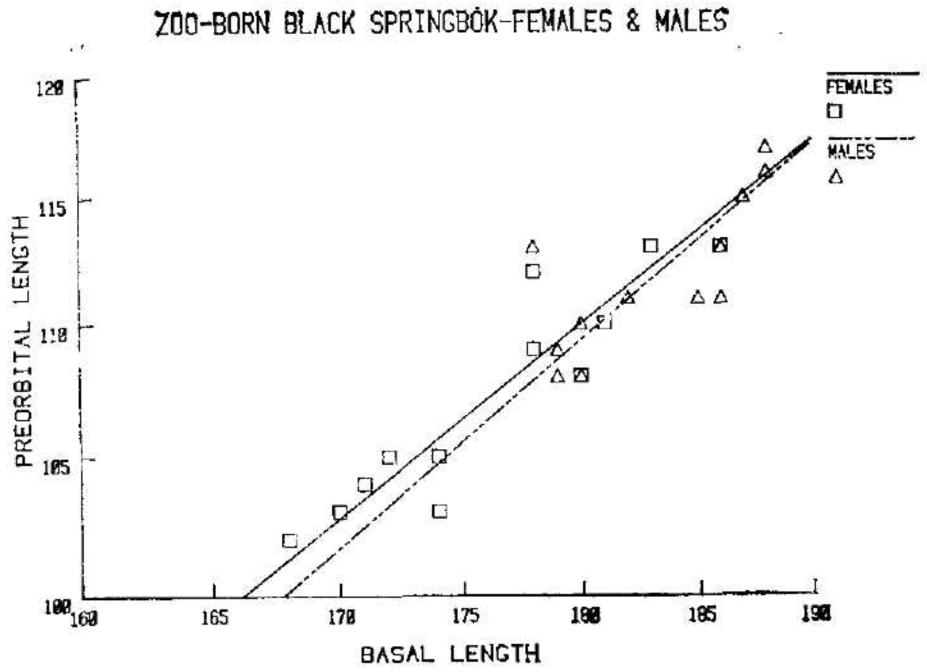

Fig. 5. Logarithmic diagram of allometric relationships between preorbital length and basal length in zoo-born females and males of black springbok.

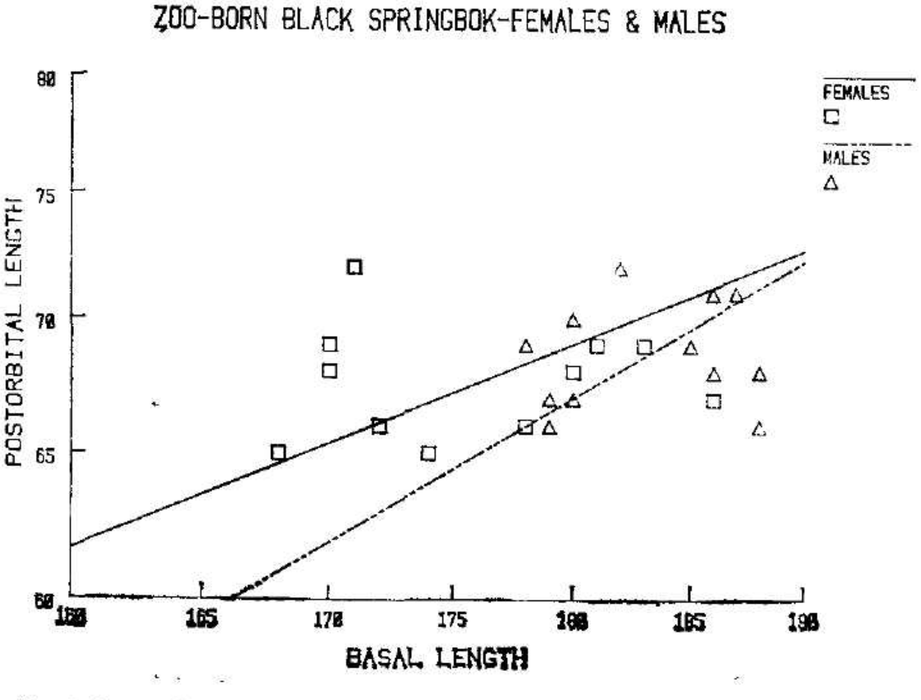

Fig. 6. Logarithmic diagram of allometric relationships between postorbital length and basal length in zoo-born females and males of black springbok.

postorbital length have different angles (Fig. 6). We can not confirm the dimensions differences in preorbital length as stated in various bovids by Lenz (1952), Bohlken (1962) and Lange (1972), including *Antidorcas* (Lange 1970).

We compared other skull characters of black and white springbok, too. The anterior upper premolar (P^2) was present in black springbok (N = 36) in 11 specimens (30.5%) on both sides and in 2 (5.5%) on one side only, while in white springbok (N = 8) P^2 was present in 5 specimens, i.e. 62.5%. No differences between imported and zoo-born animals were found.

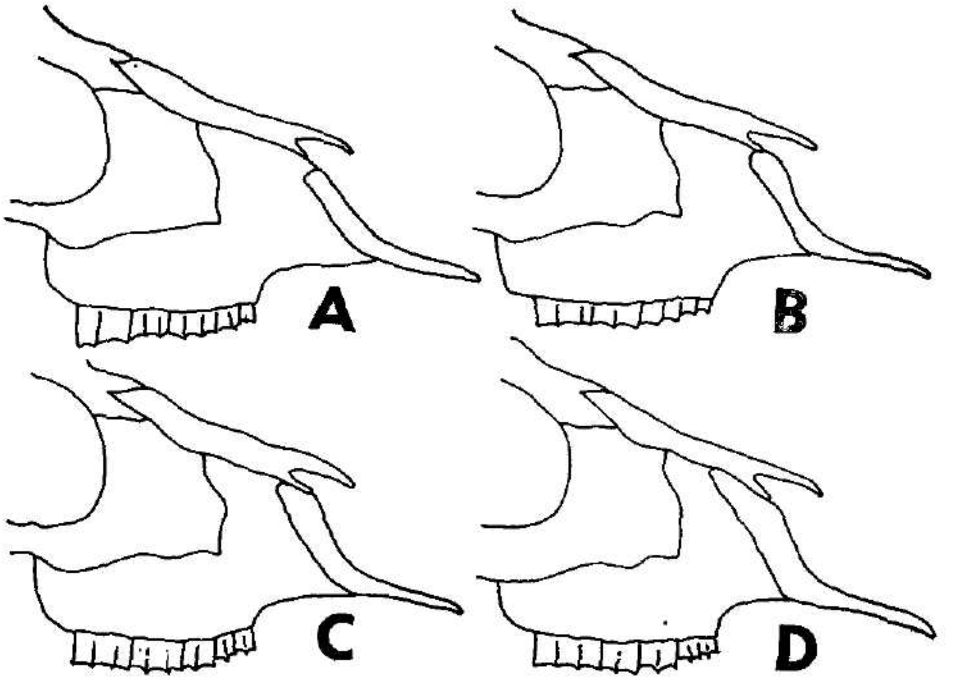

Fig. 7. Type of premaxilla-nasals contact in springbok.

As to the type of contact of premaxilla with nasals (Fig. 7): In black springbok (N = 36) 13,9 % was of the type A, 36.1 % of the type B, 44,4 % of the type C and 5.6 % of the type D. In white springbok (N = 7) 57 % was of the type A, 28.6 % of the type B and 14.3 % of the type C. The type D was not observed here. No sexual differences were found. Black springbok correspond in this way with the normally coloured *A. m. marsupialis*, while the white springbok differ, because the type A occurs in normally coloured springbok only sporadically (Groves 1981).

One of the characters in which the genus *Antidorcas* differs from *Gazella* is the absence (or rarely, presence of very small) ethmoidal fissure in the former (Sokolov 1953, Ansell 1971). According to Gentry (1971), however, the ethmoidal fissure may be absent in *Gazella rufifrons — thomsoni* group. In our sample 22.2 % of specimens have no ethmoidal fissure, while in 16.7 %

a small slit was observed and in 58.3 % a distinct ethmoidal fissure of various dimensions was present.

DISCUSSION

The differences between imported and zoo-born specimens of both colour varieties of springbok may have two main sources. The first is the domestication process sensu lato, the second the fixation of some abberative characters in isolated population by "founder effect" and decay of the genetic variability (Mayr 1942, Günther 1962, Lange 1972). It is not easy to say which character or its change has the first or second reason or whether both phenomena effect together. Probably the predominance of A-type contact of premaxilla with nasal and more often presence of P^2 in white springbok is caused by "founder effect", but the sample is too small for categorical conclusions.

The variation in presence and size of the ethmoidal fissure needs further investigation. In the genus *Gazella* the more southern species (or species group?) *rufifrons* (incl. *tilonura* and *thomsoni*) the ethmoidal fissure is very narrow, eventually small (Groves 1969, Lange 1972). If we accept the opinion that *Antidorcas* form only the southern branch of gazelles, we can suppose further (clinal ?) deminution of the ethmoidal fissure southwards. In general, the deminution of ethmoidal fissure is considered as a progressive character (Lange 1972). The 58.3 % presence of ethmoidal fissure in our springbok is with great probability caused by "founder effect", too.

As to the sexual differences in the skull: in zoo-born animals the male skulls are longer by the same zygomatic width, i.e. the female skulls are relatively broader (Fig. 4 and Tab. 4), which does not agree with the findings in wild animals (Lange 1970). Similarly, it is interesting that the facial part of the skull does not differ in both sexes (Tab. 4 and Fig. 5), which is controversial to the statemens of various authors for different bovids (Lenz 1952, Bohlken 1962, Lange 1972) including wild *Antidorcas* (Lange 1970). Both these fact may be explained by the principle according to which inbreeding or decay of genetic variability increases homogenity and morphological similarity of individuals in a populaton (Hutt 1964, Srb, Owen and Edgar 1965). The differences in postorbital length, not correlated with basal length (Tab. 4). with different exponents a in trend lines (Fig. 6). are evidently caused by sexually different dimensions of horns.

We can state that the difference between both sexes in zoo-born animals are less expressed than differences between imported versus zoo-born females. Main significant differences are in the length dimensions of the skull. Because the sample of white springbok is small and in black springbok no skulls of imported males were available, we evaluated in this way black females only (Tab. 3).

The basal length in zoo-born animals is shorter, while the zygomatic width remains nearly the same as in wild animals, i.e. the zoo-born animals have a relatively broader skull (Fig. 1). Such correlation of characters is typical for domestication (Bohlken 1962, 1964). Because the trend lines are nearly paralell. we suppose that the difference is independent of the size of the skull (Bohlken 1962). In both preorbital and postorbital length (Fig. 2 and 3) the allometry exponent a in imported and zoo-born animals differs and trend lines cross. The dispersion of dimensions is the same, but the differences are (probably) size-dependent (Bohlken 1962). In postorbital length the source of larger dimension are occipital protuberances which are less developed in zoo-born animals ($p > 0.01$). These protuberances serve for insertion of some important ligaments and muscles, which all act in stretching and rising the head. The reduction of protuberances in zoo-brn animals may be caused by different feeding manner in wild and captive-held animals. The springbok feeds in the wild on short grasses and various karroid shrubs (Gentry 1964, Bigalke 1972). This manner of feeding affects all mentioned muscles more than feeding in captivity with grass, mixed green crops or hay from racks.

Differences in preorbital length ($p > 0.01$) are not easy to explain. No differences in rostral length and upper teeth row length were found, but in zoo-born animals the premaxilla and premaxilla-maxilla contact is shorter ($p > > 0.05$). The insertions of muscles on maxilla are variable but it seems that the differences are of individual character. According to Keller (1905), Antonius (1922) and Zeuner (1963), the shortening of the facial part of the skull is a typical character of domestication.

SUMMARY

The differences and/or changes of characters in skulls of zoo-born versus imported springbok may have three sources:

1) decay of genetic variability and "founder effect" in small isolated population: abberant presence of P^2, variability of ethmoidal fissure, morphological similarity in both sexes;

2) domestication process: broader skulls and shortened facial part of the skull in zoo-born animals;

3) changes of feeding manner in captive animals (may be perhaps evaluated as one step of domestication, too): deminution of protuberantia occipitales.

Acknowledgements

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COMMENTS ON THE SHAPE AND SIZE OF CLAVICLE IN THE DOMESTIC CAT, FELIS SILVESTRIS F. CATUS

Ivan HERÁŇ & Jan PORKERT

National Museum (Natural History) 115 79 Praha 1, Czechoslovakia
DIPRA, Na Slupi 12, 128 00 Praha 2, Czechoslovakia

Abstract. Results of morphometric analysis of 212 clavicles of the Domestic cat, *Felis silvestris* f. *catus* L., are reported. The relative size of clavicles, their topography, extent of bilateral asymmetry, and individual variation in their size and shape are discussed.

INTRODUCTION

Clavicle (clavicula) of mammals is a skeletal element localized near to body surface, in an area between the cranial end of sternum (manubrium sterni) and the shoulderblade (acromion scapulae). Except for a somewhat distinctive hypotheses presented by Fuchs (1912) and Nauck (1938), it is recently considered a purely dermal bone (Romer 1970, Starck 1979, Čihák 1987, etc.). It occurs in a very different stage of development in mammal orders being fully absent in several of them.

Carnivores belong to groups where the development of clavicle is very irregular so that only vague and inaccurate data are available in a literature for several families. Although the occurrence of clavicle is referred to more or less regularly and already for a long time in the cat family (Giebel and Leche 1874—1900, Kolda 1936, Dobberstein and Koch 1953, Grassé 1967, Kowalski 1976, etc.), data bearing upon the size and shape of the respective bone are rather imperfect till now also in so familiar species as in the Domestic cat (Nejedlý 1965, Koch 1976, etc.). The present state, however, is probably caused in part also by the fact that, owing to its topography, clavicle usually pass unnoticed in the process of skeletizing thus being mostly absent in prepared skeletons (cf. Porkert and Grosseová 1985). Nevertheless, a paradox situation occurs by this way that only very incomplete knowledge exists of the bone which starts to ossify as the first or as one of the earliest bones of the postcranial skeleton, e.g. with 28th embryonic day in the Domestic cat (Curgy 1965, Müller 1968, etc.).

That is why results of investigations made by the authors in a numerous series of exactly skeletized preparations are referred to in the present paper.

MATERIAL AND METHODS

A total number of 212 clavicles of the Domestic cat, used for the aims of the present study have been acquired of two sources.
(A) Most clavicles (183 bones) were gathered of the specimens skeletized recently for the aims of school demonstrations in workshops of DIPRA Coop., Praha. The respective material of unstandardized animals had been delivered by the quarantine farm of laboratory animals VELAZ, Praha. Most animals were no younger than 2 years the remaining few specimens having been about 18 months old. Clavicles occured in all the individuals. Regarding the skeletizing technics, however, the majority of them cannot be identified with the respective skeletons now.

(B) The other 29 clavicles are the components of complete skeletons of the Domestic cat skeletized by the ceased firm of V. Frič, Praha during 1902—1909. Out of the total of 26 skeletons examined (excepting 8 subadult specimens all belong to adult animals), the both clavicles are present in 13 specimens, one clavicle in three individuals, whilst in 10 skeletons the clavicles are missing at all. According to results obtained by the authors, however, the absence of clavicles is to be explained by technical reasons only (e.g., skeletizing technics, way of deposition, etc.). In six clavicles an unilateral connection of their extremitas acromialis with a ligamentous strip is preserved the others being attached to the skeletons separately.

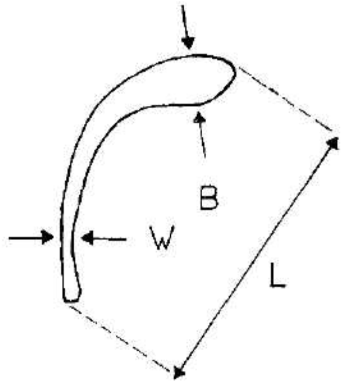

Fig. 1. Dimensions taken in clavicles of the Domestic cat. B — largest breadth, L — total length, W — lowest width; lowest value of thickness (T) was taken at right angles to the figured plane.

The *material* is deposed in Vertebrate collections of the National museum in Prague, coll. Nos 12049—12051, 12054—12056, 12058—12061, 12063, 12065, 12213, 46307—46328.

Fourth standard dimensions of clavicle have been taken (Fig. 1): L — total length (direct distance between outer points of the bone), in mm; B — largest breadth, in *mm*; W — *lowest width, in mm*; T — *lowest value of thickness, in mm.*

Relative values representing proportions of clavicle: AB — average breadth (mean of B+W+T), in mm; I_B — index of largest breadth (100B : L); I_T — index of thickness (100T : L); I_D — index of difference (B : W); G_D — gradient of difference (100 I_D : L), I_A — index of asymmetry in paired clavicles (longer bone : shorter *bone*).

Length of humerus has been measured as a distance between outer points of tuberculum majus and trochlea humeri, respectively.

Measurements were taken using a calliper, with the punctuality of 0.1 mm. Usual statistical values viz. mean (x), standard error of the mean (s_x), and coefficient of *variation (v) have been calculated.*

RESULTS AND DISCUSSION

Topography

Clavicle of the Domestic cat is a rudimentary bone which is not directly connected with other bones of the postcranial skeleton. According to the survey made in a fresh material by the second of the authors, it is situated among muscles near to the body surface, its distance from sternum being somewhat longer than that from the bones composing the glenoid joint (no detailed topographical description has been possible due to technical provisions of the workshop).

According to various authors, clavicle of the Domestic cat is inserted into musculus *sternocleidomastoideus* (Kolda 1936), m. cleidomastoideus (Nejedlý 1956) and m. brachiocephalicus (Grassé 1967, Koch 1976). As far as findings made by the authors of the present paper in a limited number of the material can be generalized, it seems the fibrous stripe attached to extremitas acromialis claviculae inserts more often upon humerus than upon the shoulderblade. (According to Koch l.c., this stripe represents a connecting part between cranial and caudal branch of m. brachiocephalicus.) In five skeletons (6 clavicles in total) of the group (B) where the connection between acro-

Tab. 1. Relative size of clavicle in the Domestic cat

	n	Mean	Min.	Max.	v
		A. Length of clavicle (L) in per cent of			
Cb-length	*33*	*23,19 ± 3 × 0,282*	19,93	26,41	6,98
Length of humerus	33	*20,41 ± 3 × 0,250*	18,31	23,56	7,04
		B. Bilateral asymmetry in dimensions of clavicle*)			
I_A	13	1,03 ± 3 × 0,007	1,00	1,09	2,43
L	13	18,17 ± 3 × 0,435	16,40	22,50	8,63
	13	17,66 ± 3 × 0,369	15,70	21,30	7,53
I_B	13	10,19 ± 3 × 0,721	5,49	15,76	25,42
	13	10,78 ± 3 × 0,426	8,45	14,11	14,24
G_D	13	9,01 ± 3 × 0,643	5,49	14,30	25,72
	13	9,62 ± 3 × 0,519	7,04	14,11	19,45

*) *In L,* I_B *and* G_D*, values in the first lines refer to the sample of longer clavicles, those in the* second lines to the sample of shorter bones.

Tab. 2. Review of actual and relative dimensions of clavicle in the Domestic cat

	n	Mean	Min.	Max.	v
		A. Standard measurements			
L	211	19,20 ± 3 × 0,137	15,6	25,0	10,36
B	212	2,05 ± 3 × 0,027	1,0	3,4	19,51
W	211	1,34 ± 3 × 0,044	0,8	2,1	48,13
T	212	0,80 ± 3 × 0,011	0,5	1,5	20,87
		B. Relative values			
AB	211	1,39 ± 3 × 0,014	0,93	2,20	15,11
I_B	211	10,71 ± 3 × 0,150	7,02	19,37	20,32
I_T	209	4,19 ± 3 × 0,056	2,45	6,94	19,43
I_D	211	1,61 ± 3 × 0,024	1,00	3,37	21,74
G_D	210	8,51 ± 3 × 0,154	4,84	17,62	26,27

mial end of clavicle and fibrous stripe have been preserved, the respective 15.0—18.4 mm long stripes insert in 5 cases upon the lateral (or dorsal) area of tuberculum majus humeri whilst only once upon the dorsal area of tuberositas supraglenoidalis scapulae (Fig. 4, 5*; clavicle is put away in the photographs as to facilitate measuring the bones). In all the cases, the lateral, mostly broaded end of clavicle is oriented towards a glenoid joint, the narrowed one towards sternum.

Size and shape

In general, clavicle occupies about one half of the area between sternum and shoulderblade (cf. **Giebel** and **Leche** 1874 – 1900). Dimensions of clavicle do not correlate with body measurements: its relative size fluctuates roughly within 6 per cent if compared with Cb-length or with the length of humerus (Tab. 1A). Bilateral asymmetry in its size and shape is quite usual in the Domestic cat (Tab. 1B). Index of asymmetry I_A computed of 13 pairs of clavicles is as high as 1.03 on the average which represents a difference 2.6 % of the length of a longer bone. The highest value of the respective index ($I_A = 1.09$) represents a difference 7.9 % of the longer bone. In general, shorter bones of the pairs are relatively broader and their gradient of difference is higher than the same characters in the longer bones. In the course of postnatal development, the relative size of clavicle decreases if compared with the length of humerus (Fig. 3).

Actual dimensions of clavicle (Tab. 2A), as well as its proportions (Tab. 2B), fluctuate in rather sizable extent which ranges within 50—120 % of the respective average values in the standard measurements. The greatest variation is known in the values of the lowest width and of the gradient of difference. Total length and average breadth of clavicle are most stabile.

Although noted morphological variability exist in the material examined (Fig. 2), most clavicles (over one half of the sample) may be identified with some 7 morphological types only (35 % of the sample with types 23, 24, and 27, 20 % with types 20, 22, 25, and 28 in Fig. 2). The other morpholoigcal types figured here occur as infrequent, more or less extreme cases only.

Proportions of clavicle are influenced, to a certain extent, also by differences in the section of various segments of the bone. More or less rounded section is found mainly in the bones of types 1—6 (Fig. 2) and further in sternal parts of the most other types Markedly flattened section is known in the enlarged acromial end of clavicle first of all (Fig. 2, types 16, 31, etc.).

Marked variations in the size and shape of clavicle may be explained by the fact that the bone has essentially no function in the Domestic cat. It might be, however, under a passive formative infliction of the neighbouring musculature, which perhaps varies according to the mode of life in various specimens (prevalently free living rural populations, home-held pets in the cities, etc.). Unfortunately, these indications have not been known in the material explored. Merely speculative conclusions may be made in this case only by analogy with a situation known in the species where clavicle is fully functional as, e. g., in diggers with extremely strained forelimbs. Clavicle of the European mole (*Talpa europaea*) is the broadest one (it ossifies as the first bone of all the elements of extremities, cf. Fig. 1 in **Porkert**, 1972); in the digging Rabbit

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*Figs 3, 4 and 5 will be found at the end of this issue.

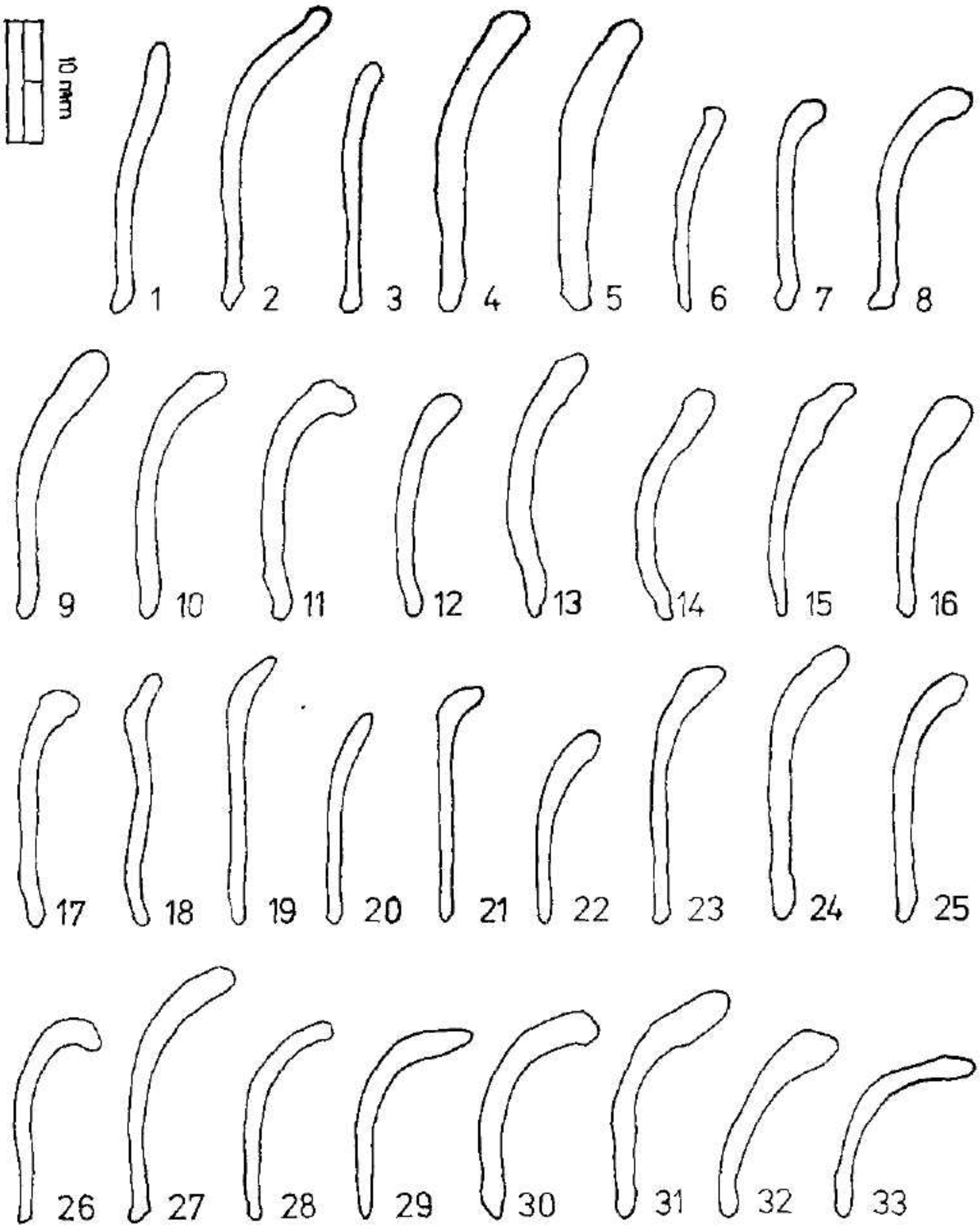

Fig. 2. Variation in shape and size of clavicle in the Domestic cat. Acromial end of clavicle is figured above, sternal end bottom in each bone.

(Oryctolagus cuniculus) it is broader than in the closely relative European hare *(Lepus europaeus)* etc. Of this viewpoint, a comparison of clavicles of the Domestic cat with those of the Wild cat seems to be very needful.

Prospective differences caused by the genetic heterogenity (various bred stocks) as well as by the less presumable sex dependence have not been analysed because of the mentioned unknown provenance of the material.

SUMMARY

Various aspects of topography and morphology were examined in the total of 212 clavicles of the Domestic cat, *Felis silvestris* f. catus L. Following results have been obtained:

Clavicles occur regularly in all the specimens examined.

The size of clavicle does not correlate with the body size if compared with Cb-length and with length of humerus.

No bilateral symmetry exists in the size, shape and proportions of clavicle.

The size, shape and proportions of clavicle vary in a rather sizable extent. The lowest values of variation are known in the total length and average breadth, the highest ones in the lowest width and in gradient of difference.

The variations in question are probably caused by the fact that clavicle is without any function in the Domestic cat. They may be inflicted by the neighbouring musculature due to the mode of life in various specimens. The influence of the genetic heterogenity migth be of a serious importance as well.

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ON THE MORPHOMETRY OF COLISA FASCIATA FROM PUNJAB, INDIA (PERCIFORMES: ANABANTIDAE)

M. S. JOHAL, J. S. CHAHAL, J. S. KINGRA and R. S. JOIR

Department of Zoology, Punjab University, Chandigarh-160014, India

Abstract. The morphometry of *Colisa fasciata* (Schneider) from a village pond near Ludhiana, Punjab (latitude 30°54' N; longitude 75°57' E) has been described. Nineteen morphometric characters and seven meristic counts have been considered. Three different types of categories have been recognised as far as range of body proportions is concerned, viz., high range, e.g., in the percentage of total length the standard length ,length of pelvic fin, length of dorsal fin, length of pectoral fin and in the percentage of head length the interorbital space; medium range, e.g., in the percentage of total length the predorsal distance, length of caudal fin and in the percentage of head length the eye diameter, preorbital distance; minimum range, e.g., in the percentage of total length distance between pectoral and ventral fins, distance between ventral and anal fins, depth of dorsal fin, length of caudal peduncle and minimum body depth. It has been concluded that the morphometric characters showing minimum range and meristic counts are genetically controlled, hence suitable for the preparation of identification keys. The other characters with medium and high range of proportions are influenced by the environmental characters, therefore, unsuitable for the preparation of taxonomic or identification keys. However these characters are useful in the determination of 'geographical' or 'local' populations.

INTRODUCTION

Colisa fasciata (Schneider) commonly known as 'Kanghi' is the inhabitant of the polluted water bodies and having low level of oxygen. Day (1878) described its occurrence in the almost dried places. Johal (1969), Johal and Tandon (1979, 1980) and Jayaram (1981) described its distribution as follows: North India, Nepal, Pakistan, N.W.F.P., Bangladesh and Burma. This fish species has less economic value but acts as a forage fish. Though the occurrence of this species is very common in Indian freshwaters including the estuaries of the Ganga (Day, 1878, very little work has been done on its systematics particularly from North India. Day (1878) described the variations in the dorsal and anal spines and in the colour bands in the young and mature specimens. Its maximum size has been a subject of controversy and it appears that the ultimate size depends upon the ecological conditions. Considering all these facts, an attempt has been made to study the morphometric characters and meristic counts in order to study the character influenced by the ecological conditions.

MATERIAL AND METHODS

Ninety six specimens of *Colisa fasciata* (Schneider) were collected during May-June 1985 from a village pond (average depth 2 meters and area 2.18 ha.) near Ludhiana 30°54' N; longitude 75°57' E), Punjab, India, using cast net. The pond is utilized for the culture of Indian major carps and obviously heavily manured by organic manures. The pond receives the water supply from the tubewell. The pond has moderate growth of aquatic weeds when the fishes were collected and the density of Indian major carps (*Labeo rohita*, *Cirrhina mrigala* and *Catla catla*) was very low because of post harvest season. During the collection period, most of the fishes moved to the surface apparently due to the deficiency of oxygen.

The living fishes were directly put in 10% formaldehyde solution, thus killed and preserved. In the laboratory, the fishes were washed in tap water in order to remove dust particles, mucous and other extrenous matter and again preserved in 10% formaldehyde solution.

For the morphometric studies linear measurements were taken on the left side of the body with vernier caliper with the accuracy of ± 0.01 mm. The following morphometric characters were noted: Total length, standard length, eye diameter, head length, head depth, predorsal distance, preorbital distance, interorbital distance, depth of dorsal fin, length of dorsal fin (including both spinose and soft rayed dorsal fin), length of pelvic fin, length of pectoral fin, length of anal fin (both spinose and soft part), depth of anal fin, maximum body depth, minimum body depth, distance between pectoral and ventral fins, distance between ventral and anal fins and length of caudal fin (for definitions see Holden and Raitt, 1974).

For the calculation of regression, standard deviation (SD) and coefficient of correlation (r) the following formulae were used.
Regression equation:

$$Y = a \pm bX$$

where X = independent variable, e. g., total length or head length.
Y = dependent variable.

$$S.D. = \sqrt{\frac{x^2}{N}}$$

where S.D. = standard deviation; X^2 = sum of the **square of the value**; **N = total** number of observations.

$$r = \frac{xy}{\sqrt{x^2 \times y^2}}$$

where xy, x^2 and y^2 are the corrected values and obtained as follows:

$$xy = XY - \frac{(X) \times (Y)}{N}$$

$$x^2 = X^2 - \frac{(X)^2}{N}$$

$$y^2 = Y^2 - \frac{(Y)^2}{N}$$

where X and Y are the original values and N = number of observations.

Various mathematical relationships were determined by using the method of least square. Linear regression model $Y = a + bX$ was fitted to the data where Y is the value of dependent value and X is the value of independent character, 'a' is the intercept or elevation of line and 'b' is the slope of the regression line or change in Y per unit increase in X.

The graphs were plotted between X (independent character) along abscissa and and Y (dependent character) along ordinate.

OBSERVATIONS AND DISCUSSION

The various body proportions in the percentage of total length and head length with minimum and maximum range, mean values and standard deviation are given in Table 1.

It is evident from Table 1 that range of variation can be divided into three broad categories, which are as follows:

1. High range (20.30—48.74 percent): The body proportions like in the percentage of total length the standard length, length of pelvic fin, length of dorsal fin, length of pectoral fin (single filament) and in the percentage of head length the interorbital space are included in this category.
2. Medium range (10.42—19.82 percent): The body proportions like in the percentage of total length predorsal distance, length of caudal fin and in the percentage of head length, eye diameter and postorbital distance, are included in this category.

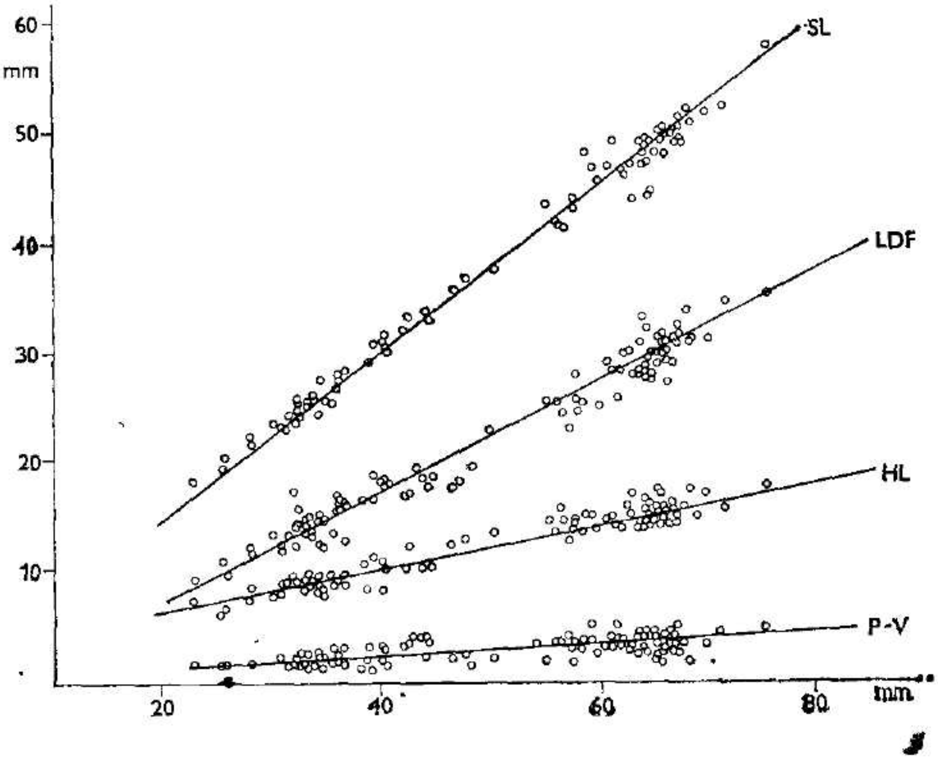

Fig. 1. Relationship between total length (mm) along abscissa and morphological characters such as standard length (SL), length of dorsal fin (LDF), head length (HL) and distance between pectoral and ventral fins (P-V) along ordinate (mm) of *Colisa fasciata* (Schn.).

3. Minimum range (less than 10 percent): The body proportions like in the percentage of total length the distance between pectoral and ventral fins, distance between ventral and anal fins, post dorsal distance, depth of anal fin, depth of dorsal fin, length of caudal peduncle and minimum body depth are included in this category.

Vladykov (1934) considered that morphometric and meristic characters can de divided in to three categories viz,
1. Characters which do not appear to be modified by the environment such as number of fin rays of caudal and ventral fins. These characters are genetically controlled.

2. Characters which appear to be slightly modified by environment such as pectoral fin rays and gill rakers on the first branchial arch.

3. Characters which appear to be strongly modified by the environment. It include morphological characters, metamerism, number of vertebrae, rays in the dorsal and anal fins, colour bars, colour spots and the size of the fish.

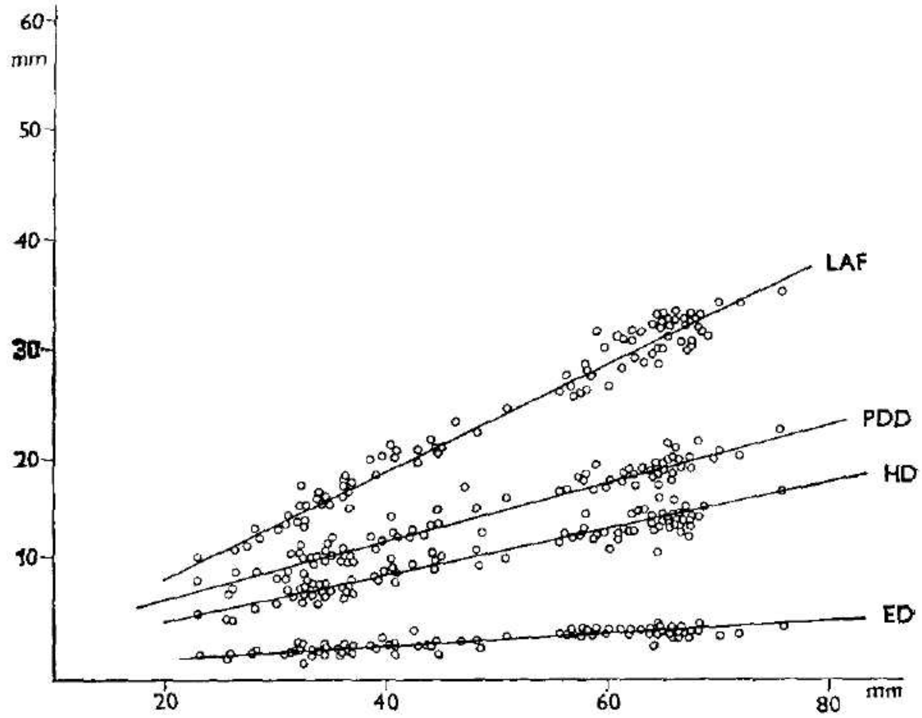

Fig. 2. Relationship between total length (mm) along abscissa and other morphological characters such as length of anal fin (LAF), predorsal distance (PDD), head depth (HD) and eye diameter (ED) along ordinate (mm) of *Colisa fasciata* (Schn.).

In general, characters belonging to the first category show minimum range of variation, second category moderate and the third category maximum range of variation of characters. On the basis of present investigations more characters could be included in each Vladykov's (1934) category.

For preparing the identification keys the characters belonging to the first category such as body proportions showing minimum range are employed. Characters belonging to the third category i.e. body proportions showing maximum range are used for the determination of different stocks and considered to be the indicators of the environmental changes.

Vladykov's (1934) explanation is applicable to *Colisa fasciata* though his observations were based on coldwater fishes. The present investigations have proved that universal similarities exist as far as impact of the environmental conditions on the morphological characters is concerned.

Table 1. Regression equations, correlation coefficient, (*r*) between different body parameters, Mean, Range and S. D. of ***Colisa fasciata*** (Schn.)

S. NO.	Parameters in the % age of total length	Regression Equation $Y = a + bx$	Mean & Range in mm	Correlation coefficient r	S. D.
1.	Head length	$Y = 1.83 + 0.2123X$	24.26 (18.14–32.60)	0.9818	2.21
2.	Standard length	$Y = 1.75 + 0.72X$	75.59 (61.60–91.60)	0.9744	3.49
3.	Predorsal distance	$Y = 3.19 + 0.2474X$	31.08 (21.31–38.69)	0.9477	2.90
4.	Postdorsal distance	$Y = 1.07 + 0.0173X$	3.83 (1.22–7.59)	0.9457	1.47
5.	Pro-anal distance	$Y = 1.28 + 0.3058X$	33.42 (25.58–39.16)	0.9691	2.11
6.	Depth of Anal fin	$Y = -0.89 + 0.1528X$	13.83 (10.0–17.67)	0.9492	2.24
7.	Length of Anal fin	$Y = -0.15 + 0.4755X$	47.64 (27.29–54.96)	0.9613	3.43
8.	Depth of Dorsal fin	$Y = -0.57 + 0.15X$	14.48 (9.45–18.20)	0.9330	2.28
9.	Length of Dorsal fin	$Y = 3.46 + 0.5087X$	43.53 (32.80–53.10)	0.9457	3.93
10.	Length of Pelvic fin	$Y = -0.52 + 0.6423X$	60.42 (25.15–73.89)	0.9436	9.72
11.	Length of Pectoral fin	$Y = 1.28 + 0.2130X$	24.07 (19.11–41.69)	0.9092	2.77
12.	Length of Caudal fin	$Y = -0.28 + 0.2518X$	11.99 (9.18–14.0)	0.9848	1.18
13.	Maximum body depth	$Y = -0.7 + 0.3860X$	18.57 (8.5–26.9)	0.9556	5.78
14.	Minimum body depth	$Y = -0.4023 + 0.1336X$	6.26 (2.6–9.0)	0.9830	1.85
	In the **%**age of head length				
15.	Head depth	$Y = -0.56 + 1.00X$	95.77 (59.50–124.39)	0.8600	11.18
16.	Pre-orbital distance	$Y = -0.52 + 0.28X$	21.74 (15.85–32.35)	0.5411	3.81
17.	Post-orbital distance	$Y = -0.64 + 0.51X$	46.42 (34.72–54.54)	0.9720	4.00
18.	Eye diameter	$Y = -1.43 + 0.60X$	30.20 (17.4–39.02)	0.9783	3.35
19.	Inter orbital distance	$Y = 0.76 + 0.23X$	49.04 (37.11–60.37)	0.9585	5.03

Some of the earlier workers like Day (1878), Munro (Reprinted edition, 1982) included this species in the genus *Trichogaster*, Bloch and Schneider but Jayaram (1981) placed this genus in *Colisa* while describing the freshwater fishes of Indian and neighbouring countries. Jayaram (1981) while describing *Colisa fasciata* he described the number of rays in the dorsal fin (15—18 spines 7—12 rays) and anal fin (15—20 spines 11—19 rays) and the variation in the lateral line scales has been observed to be between 27—31. While comparing the present observation little variation has been observed in the meristic counts. Jayaram (1981) used the number of colour bars on the lateral side and the shape of the caudal fin for the identification of different species of the genus *Colisa* Cuvier, but Vladykov (1934) considered that number of colour bars bands is subjected to change depending upon the environment.

The plotting of graphs between total length along abscissa and other parameters such as length of anal fin, predorsal distance, head depth, eye diameter, standard length, length of dorsal fin, head length and distance between pectoral and ventral fins indicate (Figs. 1 and 2) high scatter pattern in higher size groups than the lower size groups. It clearly indicate that the fish had stiff competetion as far as space is concerned in the higher size groups. This observation is only applicable to morphological characters but not to the meristic counts.

The present observations also indicate that relative size of caudal fin, pelvic fin, anal fin and interorbital spece increase with the increase in size of the fish. The maximum range of variations in these body proportions (Table 1) is attributed to this fact. As in these parameters unproportionate increase has been responsible for their unsuitability for the purpose of species identification. However, these characters can be successfully employed for the identification of local populations. From the morphometric and meristic data given by various workers it is clear that there is no variation in the number of pectoral ventral fin rays and little variation in the dorsal and anal fin rays (both spinose and soft rays) and caudal fin rays. There is moderate range of variation in the number of lateral line scales but very little variation in the number of lateral transverse scales. Considering small variations in the meristic counts, these characters could be employed for the preparation of key authentically.

Hamilton (1822) described the different species of the genus *Colisa* Cuvier under the generic name *Trichopodus*. *Trichopodus colisa* of Hamilton (1822) seems to be very similar to *Colisa fasciata* of Jayaram (1981) and *Trichogaster fasciata* of Day (1878) and the present sample. Authors are surprised to note the high number of soft rays in the dorsal fin in almost all species of *Trichopodus* as described by Hamilton (1822) when compared with the present sample. Day (1878) considered *Trichopodus colisa*, *T. bejeus* and *T. cotri* as the synonyms of his *Trichogaster fasciatus*.

In Table 1 the regression equations and coefficient of correlation between different body parameters are given. There is no significant difference (using t-Student test) between the observed and the calculated values indicating the practical applicability of these equations.

The values of coefficient of correlation (Table 1) have been found to be high i.e. above 0.9 except the value between head length and preorbital distance. From these observations it is clear that most of the characters included in the present studies increase indirect proportion to each other.

The meristic counts of **Colisa fasciata** (Bl. & Schn.) in the present sample have been found to be D.15-17/9—14; P.10; V.1; A.16—17/15—16; C.15; Ll.29——30; Ltr. $5^{1}/_{2}$/11—12.

The body proportions expressed in terms of percentages seem to be better than ratios as described by earlier workers such as Day (1878), Srivastva (1980) and Misra (1959). In the past no such attempt has been made on the similar lines as described here on the genus *Colisa* Cuvier from any locality, therefore, the present attempt is the first in this regard.

The variations observed in the values of various meristic counts and morphological characters in the present sample and earlier published data are attributed to the different ecological conditions. Considering this fact, it is suggested to prepare the identification manuals for smaller geographical regions as most of the existing manuals or handbooks cover vast areas.

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DISTRIBUTION OF THE FIELD VOLE (MICROTUS AGRESTIS) IN YUGOSLAVIA

Boris KRYŠTUFEK[1], Nikola TVRTKOVIĆ[2] & Jozsef MIKUSKA[3]

1) Slovene Museum of Natural History, Prešernova 20, YU-61000 Ljubljana; 2) Croatian Natural History Museum, Demetrova 1, YU-41000 Zagreb; 3) Department of Ecology, Teacher's training Faculty, University of Osijek, Jože Vlahovića 9, YU-54000 Osijek

Abstract. *The field vole has been found in 70 localities in Yugoslavia. It is* distributed over the northern part of the country, as far as Danube. The vertical range of localities is between 70 and 1520 m above sea level. Factors affecting its microdistribution appear to be the same as in Central and Northern Europe.

INTRODUCTION

The southern border of the field vole distribution area also reaches the northwestern parts of Yugoslavia. Since 1923, when the species was first recorded in Yugoslavia (Montagu 1923), a number of new localities have been recorded. However, even at the beginning of the present decennium, the border of the area in Yugoslavia was imperfectly known (Krapp & Niethammer 1982). The purpose of this article is to fill the lacuna in our knowledge of a part of the southern border of the field vole distribution area.

RESULTS

The field vole has been found in 70 localities in Yugoslavia. In 43 of them, it was caught by snap traps, in 14 it was ascertained by analysis of owl pellets, and in the remaining localities, data on the collecting methods were not available. Most of the data based on findings in owl pellets originate from the eastern part of the Yugoslav area (to the east of the 18th parallel of latitude). This is the result of more intensive studies of the diet of owls and less extensive snap trapping in this part of the country.

The collected data allow the conclusion that the field vole inhabits the norhern part of Yugoslavia, along the Kupa (= Kolpa), the Sava, and the Drava rivers, to the Danube in the east. The area measures about 47,000 km^2. It consists of two large geographic regions: the mountains and hills in the west and the margins of Pannonia in the east. Approximately two thirds of the Yugoslav area is in the sub-Pannonian and Pannonian lowlands. The vertical range of localities is between 70 and 1520 m above the sea level. More than half (= 59 %) of them are situated below 400 m. In the mountains and hills, the field vole inhabits the Alps (points 1—11 in Fig. 1), the Dinarids (points 23—29), and the pre-Alpine and pre-Dinaric hills (points 12—22). It is widespread in the Alps and hills. In the Dinarids, it is restricted to their extreme northwestern part. The vertical range of finds was between 380 and 1520 m in the Alps, between 490 and 1050 m in the Dinarids and between 150 and 410 m in the hills. Below 900 m, the field vole inhabits open field habitats, i.e. moist places with a lush growth along slow running streams or stagnant waters (lakes, ponds), swamps and fens. The majority of the populations are limited to nar-

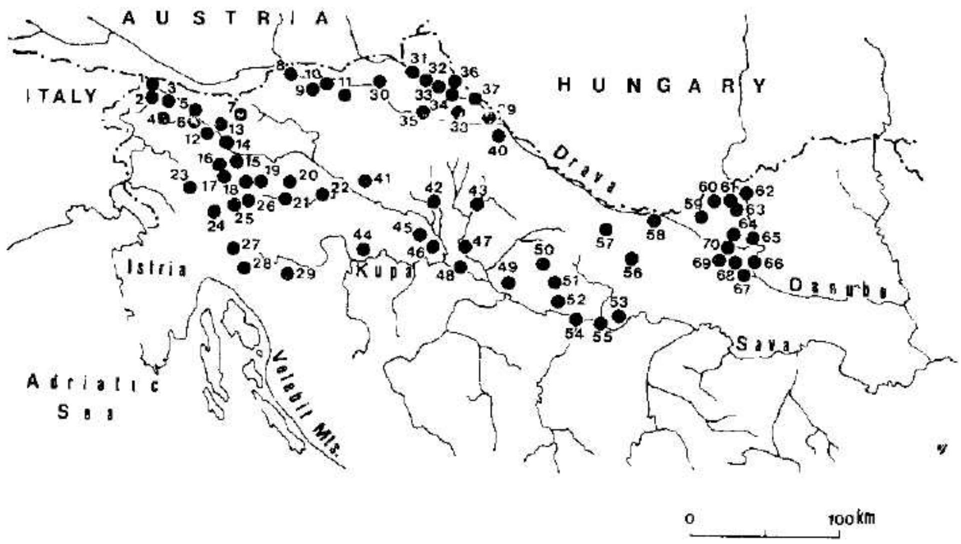

Fig. 1. Distribution of *Microtus agrestis* in Yugoslavia. List of localities: 1 — Podkoren, Zelenci, 834 m; Rateško močvirje, 850 m; 2 — Kranjska gora, gostišče "Jasna", 827 m; 3 — Pokljuka; 4 — Bohinjsko jezero, Zlatorog, 523 m; 5 — Bled; Lesce; 6 — Jelovica, Goška ravan, 970 m; 7 — Kamniška Bistrica, 600 m; 8 — Dravograd, Črneče, 380 m; 9 — Pohorje, Velika Kopa, 1500 m; 10 — Pohorje, Lovrenška jezera, 1520 m; 11 — Pohorje, Osankarica, 1195 m; 12 — Kranj, Žabnica, Sv. Duh, 370 m; 13 — Kranj, Bobovek, 410 m; 14 — Kranj, Trboje, 350 m; 15 — Ljubljana, Kozlerjeva gošča, 290 m; 16 — Bevke, 290 m; 17 — Goričica pri Preserju, 290 m; Vnanje Gorice, 290 m; 18 — Ig, 290 m; Kremenica, 290 m; 19 — Grosuplje, Mlačevo, 220 m; 20 — Dol pri Trebnjem, 250 m; 21 — Žužemberk, 190 m; 22 — Kostanjevica, Šentjakob, 150 m; 23 — Hotedršica, Ravnik, 630 m; 24 — Cerknica, Gorenje jezero, 550 m; 25 — Travna gora, 1050 m; 26 — Ribnica, Goriča vas, 490 m; 27 — "between Risnjak and Snežnik"; 28 — Crni lug; 29 — Ravna gora; 30 — Maribor, Pernica, 250 m; 31 — Hrastje-Mota, Turjanci, 195 m; 32 — Bunćovci, Veržej, 180 m; 33 — Ljutomer, Mota, 170 m; 34 — Dolnja Bistrica, 170 m; 35 — Ormož, 195 m; 36 — Lendava, Črni log, 162 m; 37 — Murska šuma, 156 m; 38 — Čakovec; 39 — Donji Vidovec; 40 — Legrad; 41 — Brežice, Dobovsko polje, 160 m; 42 — Dugo selo; 43 — Časma; 44 — Draganić; 45 — Turopolje, Pešćenica, 70 m; 46 — Sela; 47 — Stružec; 48 — Gušče; 49 — Jasenovac; 50 — Pakrac; 51 — Psunj, Strmac, 475 m; 52 — Nova Varoš; 53 — B. Drenovac; 54 — Bardača; 55 — Kaniža; 56 — Našice; 57 — Podravska Slatina; 58 — Donji Miholjac; 59 — Beli Manastir; 60 — Topolje; 61 — Draž: 62 — Bezdan; 63 — Zmajevac; 64 — Kopačevo; 65 — Apatin, Mesarske livade; 66 — Dalj; 67 — Tordinci; 68 — Korodž; 69 — Laslovo; 70 — Tenja.
Corresponding references: (4) — Mirić 1965; (5) — Montagu 1923; Felten & Storch 1965; (7) — Rosický 1958; (23, 27) — Petrov 1968; (29) — Tvrtković et al. 1985; (38) — Kovačević & Danon 1958; (47, 48, 55) — Borčić et al. 1982; (53, 59—61, 63, 64) — Mikuska & Vuković 1980; (62) — Mirić 1980; (65) — Mikuska 1977; (66—70) — Mikuska et al. 1986.

row marginal habitats along waters and to individual spots in swamps. Only on the Ljubljansko barje (marshland) (points 14—17) is a large population known continuously to inhabit 160 km^2 of marshy surfaces. Suitable habitats are meadows of Molinietum ceruleae, Junco-Molinietum, Geranio palustris-Filipenduletum, and Caricetum gracilis types. All of them are high density habitats.

In the sub-Pannonian and the Pannonian lowlands, the field vole is limited mainly to dense grassy undergrowth of the flooded lowland forests: Genisto elatae-Quercetum roboris, Carici elongatae-Alnetum medioeuropaeum, Leucoio-Fraxinetum angustifoliae, Carici-Salicetum albae and others. All of them are low density habitats. The field vole also lives in open habitats with a lush growth of forbs and reeds. The vertical range of localities in the sub-Pannonian and Pannonian lowlands was between 60 and 475 m. Practically all of them lie below 200 m.

DISCUSSION

Field vole distribution in Yugoslavia is mainly of a mosaic character. This is particularly obvious in the heterogenous landscapes of the mountainous area. However, this tendency also persists in the more homogeneous landscape of the Pannonian lowlands. In owl pellet samples, the field vole was recorded in only 12 (= 32 %) out of 38 sampling points (Mikuska & Vuković 1980; Mikuska et al. 1986). The micro-distribution of the field vole can be explained by the structure of the landscape. Suitable habitats should be provided with a continuous ground cover with plenty of lush graminides and forbs, which corresponds to the condition elswhere in Europe (Anděra 1980; Hansson 1977). The absence of the field vole from dry lowland habitats in Yugoslavia is ascribed to competitive exclusion on the part of *Micrctus arvalis*. The mechanism appears to be identical with that described by Myllymäki (1977) in Scandinavia. Dry reforestations are inhabited in the Alps above 900 m. *M. agrestis* is restricted to smaller clear-cut forest grounds and reforestations, and *M. arvalis* to larger pastures. A similar relation of the two species is also known in Finland (Sulkava S. & P. 1967).

It is difficult to explain macrodistribution of the field vole in Yugoslavia. The average annual temperature of the field vole distribution area attains up to 11 °C, while the minimum annual precipitation is 700 mm. As in Czechoslovakia, climatic factors (isohyetes, isotherms) and the field vole area do not coincide (Anděra l.c.). The distribution area also does not correspond with the distribution of plant associations in Yugoslavia. This is particularly obvious in the Dinarids. The field vole was found in clearings and reforestations after Abieti-Fagetum only in the extreme northwest of the Dinarids, as far south as Gorski Kotar (points 28 and 29). In similar habitats more to the south (e.g. in northern Velebit), it can no longer be found. In the Pannonian lowlands, most of the area is in forests of Genisto-Quercetum roboris and Quercetum petraeae communities. However, these forest communities are more widespread than the field vole area.

In two cases, the border of the field vole area corresponds to biogeographic borders. The field vole does not inhabit the sub-mediterranean lowlands in northern Istria. This is surprising, considering that in France it lives on the coast of the Medditeranean (Saint Girons 1973). There is no apparent geographic barrier to prevent the field vole from populating the banks of slow running rivers of northwestern Instria. The eastern border on the Danube coincides with the western border of the steppe of Eurasia (in the sense of Petrov 1979). The field vole no longer invades the steppe, not even along the banks of streams.

The water vole *(Arvicola terrestris)*, one of the important competitors of the field vole (Myllymäki 1977), is a rare species within the limits of the field vole area in Yugoslavia. Water voles, living sympatrically with the field vole, are small fossorial animals with protruding incisors *(A.t.* cf. *scherman)*. Large water voles, mainly aquatic in their habits, live to the south *(A.t. illyricus)* and to the east *(A.t. martinoi)* of the field vole area. Aquatic populations of water voles are permanently associatel with dense, lush sedge-tall forb stages along slow-running and stagnant waters or swamps (Petrov 1949; Kryštufek & Tvrtković 1984). In Scandinavia, the increasing population of *A. terrestris* may "result in the total exclusion of *M. agrestis* from its favourite habitats" (Myllymäki l.c.). The competition with large aquatic water voles could exert a restricting influence upon the distribution of the field vole. In drier parts of Yugoslavia (steppe regions to the east and the karstic ones to the south of the field vole area), moist habitats are more localized and rarer. This leads to scramble competition between aquatic water voles and the field vole, resulting in the exclusion of the latter.

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BRAIN SIZE IN BIRDS: 2. FALCONIFORMES THROUGH GAVIIFORMES

Jiří MLÍKOVSKÝ

Department of Evolutionary Biology, Czechoslovak Academy of Sciences,
Sekaninova 28, CS — 128 00 Praha 2

Abstract. Brain size in 241 bird species and its relation to body size in 11 families of birds are estimated. The following avian orders are considered: Falconiformes, Galliformes, Gruiformes, Charadriiformes and Gaviiformes.

INTRODUCTION

This is a continuation of my review of the brain size in birds (Mlíkovský 1989). See the latter paper for the sections on Material and Methods.

RESULTS AND DISCUSSION

Falconiformes

The data on the brain size and the body size in Falconiformes are presented in Table 1 and Figures 1—2. The data were sufficient for the calculation of regression *equations in the following falconiform families*: *Cathartidae*, *Accipitridae and* Falconidae.

In Cathartidae, brain size and body size are positively correlated ($r_S = 1.000$; $p < 0.05$) and their allometrical relation is $E = 0.0406\ S^{0.732 \pm 0.0438}$ ($n = 4$). The slope of this regression is significantly higher than the Dubois' constant ($t_s = 3.927$; $p < 0.05$), but does not significantly differ from the Jerison's constant ($t_s = 1.492$; $p > 0.05$).

In Accipitridae, brain size and body size are positively correlated ($r_H = 2.265 \pm 0.144$; $p < 0.001$) and their allometrical relation is $E = 0.169\ s^{0.553 \pm 0.0160}$ ($n = 49$). The slope of this regression is significantly lower than the Jerison's constant ($t_s = -7.104$; $p < 0.001$), but does not significantly differ from the Dubois' constant ($t_s = -0.438$; $p > 0.05$).

In Falconidae, brain size and body size are positively correlated ($r_H = 2.301 \pm 0.258$; $p < 0.001$) and their allometrical relation is $E = 0.241\ s^{0.494 \pm 0.0232}$ ($n = 16$). The slope of this regression is significantly lower than both the Dubois' constant ($t_s = -2.845$; $p < 0.05$) and the Jerison's constant ($t_s = -7.443$; $p < 0.001$).

Galliformes

The data on the brain size and the body size in Galliformes are presented in Table 2 and Figure 3. The data were sufficient for the calculation of the regression equation in the family Phasianidae only.

In this family, brain size and body size are positively correlated ($r_H = 1.867 \pm 0.162$; $p < 0.001$) and their allometrical relation is $E = 0.0951\ s^{0.528 \pm 0.0252}$

(n = 39). The slope of this regression is significantly lower than the Jerison's constant ($t_s = -5.503$; $p < 0.001$), but does not significantly differ from the Dubois' constant ($t_s = -1.270$; $p > 0.05$).

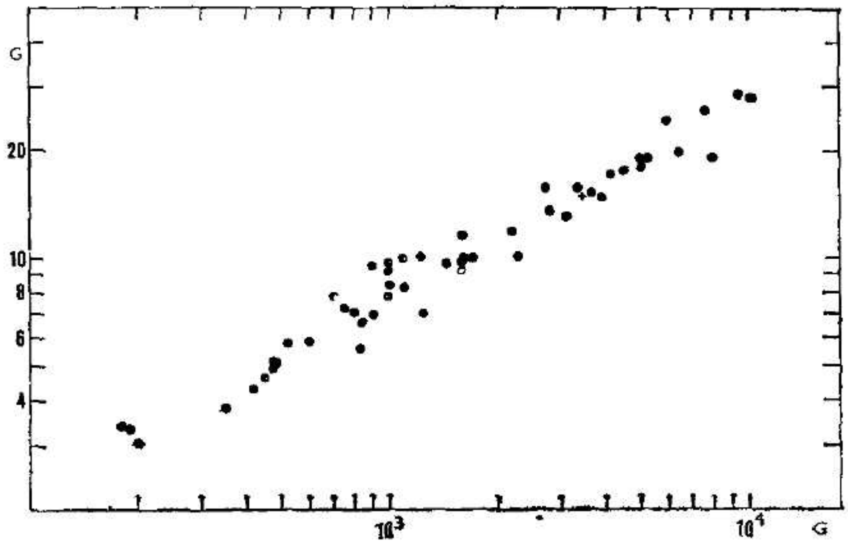


Fig. 1. Relationship between the brain size (Y yxis) and the body size (X axis) in Accipitridae (●) Pandion (○) and Sagittariidae (+). See Table 1 for exact data.

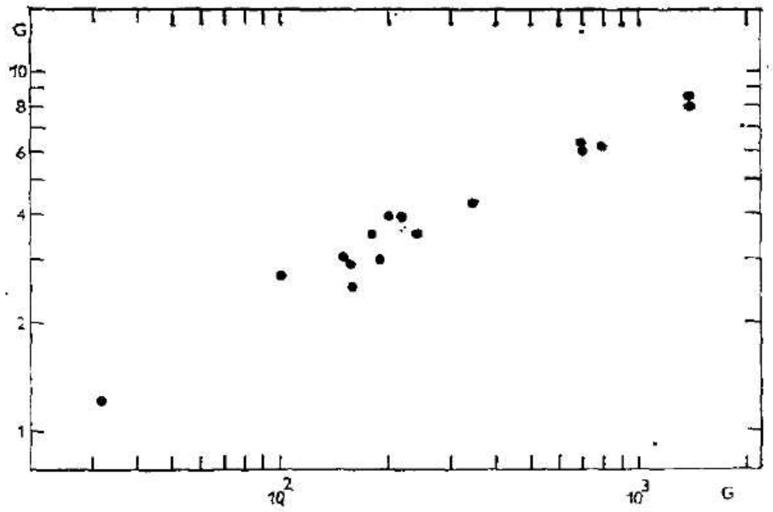


Fig. 2. Relationship between the brain size (Y axis) and the body size (X axis) in Falconidae. See Table 1 for exact data.

Table 1. Brain size and encephalization in *Falconiformes*

n = number of measured brains or cava cranii, S = body mass (g), E = brain mass (g), I_{rel} = relative brain mass (%), Q_r = coefficient of relative encephalization. See Mlíkovský (1989) for the calculation of these indices. Author = who measured brains or cava cranii. The figure in parentheses after the family name gives number of extant species of that family (after Wolters 1975–1982).

Taxon	n	S	E	I_{rel}	Q_r	Author
Cathartidae (7)						
Coragyps atratus	2	1900	10.0	0.53	−1.95	13
Cathartes aura	7	1900	10.0	0.53	−1.95	1, 6, 13
Vultur gryphus	2	11000	35.3	0.32	−4.29	13
Sarcoramphus papa	2	4500	20.7	0.46	7.97	13
Accipitridae (225)						
Aegypius monachus	4	9500	27.3	0.29	2.00	8, 13
Gyps fulvus	2	7500	26.0	0.35	10.71	13
Gyps coprotheres	2	8000	19.0	0.24	−21.93	13
Gyps himalayensis	1	10000	28.0	0.28	1.69	13
Gyps benghalensis	1	5200	19.0	0.37	−0.94	13
Gyps africanus	1	6400	19.7	0.31	−8.43	6
Neophron percnopterus	4	2200	11.0	0.50	−7.71	13
Gypohierax angolensis	1	1700	10.0	0.59	−3.24	13
Gypaetus barbatus	6	6000	24.1	0.40	16.06	13
Haliaeetus albicilla	56	5000	19.0	0.38	1.24	13
Haliaeetus leucocephalus	2	5000	18.3	0.37	−2.49	13
Haliaeetus vociferus	1	3100	13.0	0.42	−9.77	13
Milvus milvus	4	1100	8.0	0.73	−1.53	12, 13
Milvus migrans	16	850	6.6	0.78	−6.31	4, 13
Pernis apivorus	3	750	7.2	0.96	9.53	13
Aviceda leuphotes	1	180	3.4	1.89	13.87	13
Accipiter gentilis	27	1000	7.8	0.78	1.21	8, 10, 13
Accipiter striatus	1	520	5.7	1.10	6.18	6
Accipiter nisus	19	200	3.0	1.50	−5.21	2, 3, 5, 7, 9, 10, 13
Accipiter tachiro	1	420	4.3	1.02	−9.86	13
Accipiter brevipes	1	190	3.3	1.74	7.27	13
Melierax canorus	3	900	6.8	0.76	−6.48	13
Kaupifalco monogrammicus	2	350	3.8	1.09	−11.89	13
Leucopternis schistacea	1		7.0			13
Buteogallus coronatus	1		4.6			13
Buteo magnirostris	2	480	4.9	1.02	−4.59	13
Buteo lineatus	2	800	7.0	0.88	2.75	1, 13
Buteo albicaudatus	1		15.0			13
Buteo jamaicensis	2	1100	9.9	0.90	21.86	6, 11
Buteo auguralis	1	1260	7.0	0.56	−20.07	13
Buteo rufofuscus	3	1000	9.5	0.95	23.26	13
Buteo rufinus	1	900	9.5	1.06	30.66	13
Buteo lagopus	6	1000	9.1	0.91	18.07	13
Buteo buteo	22	1000	8.2	0.82	6.40	2, 3, 6, 9, 10, 12, 13
Aquila audax	3	3400	15.2	0.45	0.24	13
Aquila chrysaetos	7	4500	17.6	0.39	−0.60	1, 8, 13
Aquila heliaca	1	2750	15.5	0.56	14.95	13
Aquila verreauxii	1	4200	17.0	0.40	−0.25	13
Aquila rapax	10	2800	14.0	0.50	2.79	6, 11
Aquila clanga	2	2200	11.8	0.54	−1.00	13
Aquila pomarina	4	1600	11.3	0.71	13.06	13
Lophaetus occipitalis	1	1450	9.0	0.62	4.91	13
Hieraaetus pennatus	1	820	5.5	0.67	−20.36	13

Table 1 — continuation

Taxon	n	S	E	I_{rel}	Q_r	Author
Nisaetus cirrhatus	1	2300	10.0	0.43	−18.14	13
Spizaetus ornatus	1	1215	10.0	0.82	16.50	13
Spizaetus melanoleucus	1		13.0			13
Butastur liventer	1	480	5.0	1.04	−2.65	13
Butastur teesa	1	480	4.9	1.02	−4.59	13
Dryotriorchis spectabilis	1		7.0			13
Circaetus cinereus	1	3900	14.5	0.37	−11.36	13
Circaetus fasciolatus	1		9.5			13
Spilornis cheela	1		8.0			13
Circus aeruginosus	8	600	5.8	0.97	−0.18	13
Circus cyaneus	8	450	4.6	1.02	−7.18	13
Polyboroides radiatus	3	700	7.7	1.10	21.69	13
Pandion haliaeetus	7	1600	9.6	0.60	−3.95	8, 13
Sagittariidae (1)						
Sagittarius serpentarius	1	3500	15.0	0.43		13
Falconidae						
Herpetotheres cachinnans	1	700	6.0	0.86	−2.13	13
Microhierax fringillarius	1	32	1.2	3.75	−10.13	13
Falco peregrinus	3	800	6.2	0.78	−5.32	13
Falco rusticolus	2	1400	8.0	0.57	−7.34	13
Falco biarmicus	1	700	6.3	0.90	2.76	13
Falco columbarius	7	190	3.0	1.58	−6.80	13
Falco sparverius	5	100	2.7	2.70	15.17	1, 6, 13
Falco naumanni	2	155	2.9	1.87	−0.38	13
Falco tinnunculus	11	200	3.8	1.90	15.10	7, 8, 12, 13
Falco moluccensis	1	180	3.5	1.94	11.67	13
Falco rupicoloides	1	240	3.9	1.63	7.95	13
Falco vespertinus	3	160	2.5	1.56	−15.46	13
Falco subbuteo	5	240	3.5	1.46	−3.12	13
Milvago chimango	1	350	4.3	1.23	−1.22	13
Polyborus plancus	1	1400	8.5	0.61	−1.55	13
Phalcobaenus albogularis	1	150	3.0	2.00	4.74	13

1 = Hrdlička 1905, 2 = Lapicque and Girard 1905, 3 = Girard 1908, 4 = Waterlot 1912, 5 = Dosse 1937, 6 = Crile and Quiring 1940, 7 = Portmann and Vischer 1943, 8 = Portmann 1947, 9 = Vaughien 1949, 10 = Skvorcova 1952, 11 = Spector 1956, 12 = Senglaub 1963, 13 = Mlíkovský this paper

Gruiformes

The data on the brain size and the body size in Gruiformes are presented in Table 3 and Figures 4–6. The data were sufficient for the calculation of regression equations in the following gruiform families: Rallidae, Gruidae and Otididae.

In Rallidae, brain size and body size are positively correlated ($r_H = 1.379 \pm 0.333$; $p < 0.01$) and their allometrical relation is $E = 0.0639\,S^{0.659\pm0.0976}$ ($n = 10$). The slope of this regression does not significantly deviate from either the Jerison's constant ($t_s = -0.079$; $p > 0.05$) and the Dubois' constant ($t_s = 1.014$; $p > 0.05$). Remarkable is that the Fulicinae (*Gallinula* and *Fulica*) and *Crex* are markedly less encephalized than other rallids ($Q_r = -27.67$ to -16.55, and 4.60–32.88, respectively). It is improbable that this difference is caused by some measurement or other

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

Taxon	n	S	E	I_{rel}	Q_r	Author
Cracidae (43)						
Penelope superciliaris	1	1000	4.6	0.46		13
Crax alector	1		7.0			13
Opisthocomidae (1)						
Opisthocomus hoatzin	1	530	4.0	0.75		13
Megapodiidae (12)						
Leipoa ocellata	1		3.7			13
Phasianidae (203)						
Bonasa umbellus	1	500	2.7	0.54	6.69	1
Tetrastes bonasia	4	400	2.0	0.50	−11.09	13
Lagopus mutus	2	460	2.5	0.54	3.23	13
Lagopus lagopus	30	700	4.0	0.43	32.33	4, 11, 13
Lyrurus tetrix	8	1050	3.7	0.35	−1.18	8, 13
Tetrao urogallus	8	4500	6.0	0.13	−25.69	8, 13
Pavo cristatus	11	4000	6.7	0.17	−11.69	1, 2, 5, 7, 8, 13
Pavo muticus	1	4950	6.5	0.13	−23.44	13
Polyplectron bicalcaratum	2	600	3.1	0.52	11.25	13
Argusianus argus	1		5.4			13
Chrysolophus pictus	7	600	3.1	0.52	11.25	7, 8, 10, 13
Phasianus colchicus	532	1500	3.9	0.26	−13.72	2−5, 7, 8, 10, 12, 13
Lophura edwardsi	1		3.4			13
Gennaeus nycthemerus	3	1450	4.4	0.30	−0.90	8, 13
Crossoptilon crossoptilon	1	1850	6.1	0.33	20.80	13
Crossoptilon auritum	3	1750	5.9	0.34	20.32	13
Gallus gallus (wild)	3	850	3.2	0.38	−4.45	13
Gallus sonneratii	1	850	3.3	0.39	−1.46	13
Galloperdix spadicea	2	200	2.0	1.00	28.21	13
Tetraogallus himalayensis	3	1800	6.2	0.34	24.57	13
Perdix perdix	18	400	1.8	0.45	−19.98	5, 7, 8, 13
Alectoris graeca	4	600	2.1	0.35	−24.63	13
Alectoris rufa	4	335	2.0	0.60	−2.36	9, 13
Alectoris barbara	1	335	2.8	0.84	36.70	13
Bambusicola thoracica	2	400	1.8	0.45	−19.98	13
Francolinus leucoscepus	1	660	3.2	0.48	9.21	13
Francolinus swainsonii	1	600	3.8	0.63	36.38	13
Francolinus levaillantoides	1		2.7			13
Francolinus levaillantii	4	360	2.5	0.69	17.50	13
Francolinus sephaena	2	300	1.9	0.63	−1.68	4, 13
Francolinus pondicerianus	1	150	1.7	1.13	26.85	13
Ammoperdix heyi	1	190	1.5	0.79	−1.21	13
Coturnix coturnix	26	90	0.8	0.89	−21.82	5−9, 13
Excalfactoria chinensis	3	45	0.5	1.11	−29.55	13
Rollulus roulroul	1	165	1.9	1.15	34.82	13
Colinus virginianus	22	120	1.2	1.00	0.74	1, 13
Callipepla squamata	1	150	1.5	1.00	11.93	1
Callipepla californica	3	150	1.3	0.87	−3.00	1, 4
Guttera pucherani	1	1350	4.0	0.30	−6.45	13
Numida meleagris (wild)	8	1300	3.8	0.29	−9.33	1, 4, 9, 13

Table 2 — *continuation*

Taxon	n	S	E	I_{rel}	Q_r	Author
Meleagris ocellata	1	3500	5.8	0.17	−17.97	13
Meleagris gallopavo (wild)	3	4000	7.3	0.18	−3.78	13

1 = Hrdlička 1905, 2 = Lapicque and Girard 1905, 3 = Girard 1908, 4 = Crile and Quiring 1940, 5 = Portmann and Sutter 1940, 6 = Sutter 1943, 7 = Portmann and Vischer 1943, 8 = Portmann 1947, 9 = Vaughien 1949, 10 = Senglaub 1963, 11 = Sazikova 1975, 12 = Werner 1975, 13 = Mlíkovský this paper

error(s). Encephalization needs to be studied in more rallid species before an explanation of this phenomenon can be found.

In Gruidae, brain size and body size are positively correlated ($r_S = 0.946$; $p < 0.01$) and their allometrical relation is $E = 0.0192\ S^{0.788 \pm 0.0441}$ ($n = 8$). The slope of this regression is significantly higher than both the Jerison's constant ($t_s = 2.751$; $p < 0.05$) and the Dubois' constant ($t_s = 5.170$; $p < 0.01$).

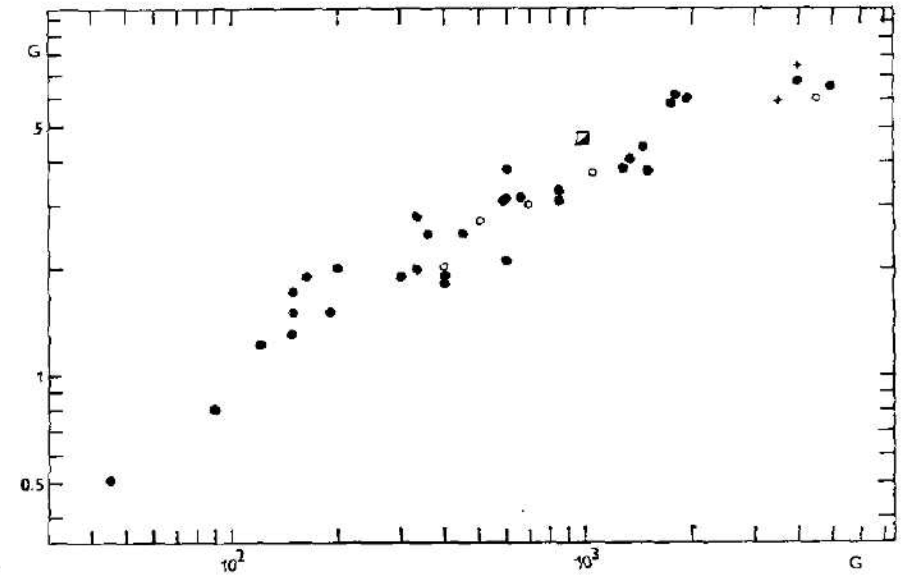
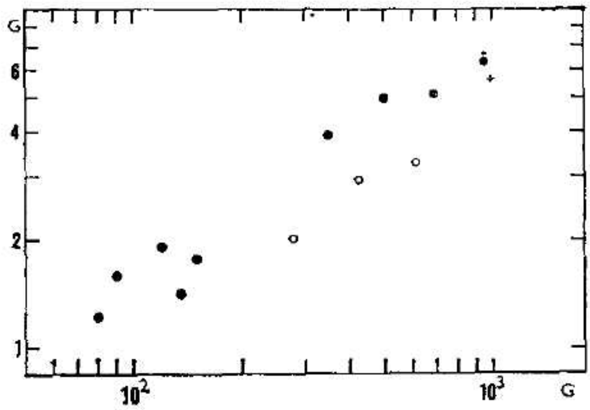


Fig. 3. Relationship between the brain size (Y axis) and the body size (X axis) in *Galliformes*. ○ = Tetraoninae, * = Numidinae, + = Meleagrinae, ● = other Phasianidae, □ = Cracidae. See Table 2 for exact data.

In Otididae, brain size and body size are positively correlated ($r_S = 1.000$; $p < 0.01$) and their allometrical relation is $E = 0.157\ S^{0.493 \pm 0.0503}$ ($n = 5$). The slope of this regression is significantly lower than the Jerison's constant ($t_s = -3.453$; $p < 0.05$), but does not significantly differ from the Dubois' constant ($t_s = -1.332$; $p > 0.05$).



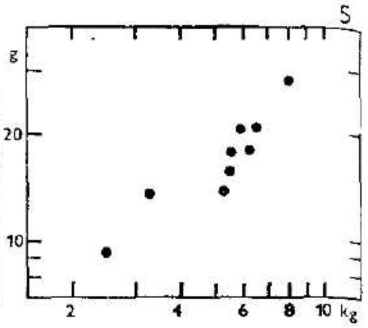
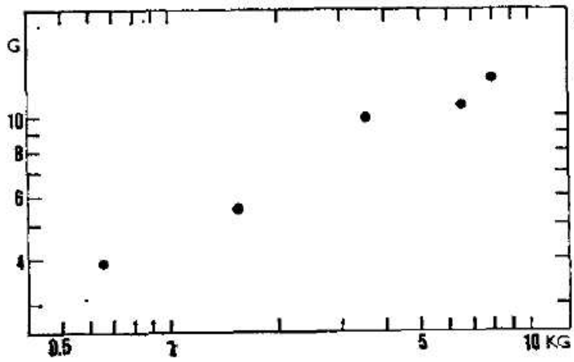


Fig. 4. Relationship between the brain size (Y axis) and the body size (X axis) in Rallidae (●; ○ = Fulicinae), Heliornithidae (∗), Aramidae (♀) and Psophiidae (+). See Table 3 for exact data.

Fig. 5. Relationship between the brain size (Y axis) and the body size (X axis) in Gruidae. See Table 3 for exact data.



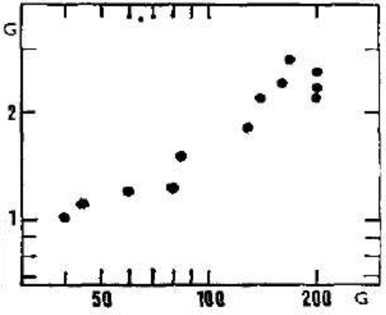


Fig. 6. Relationship between the brain size (Y axis) and the body size (X axis) in Otididae. See Table 3 for exact data.

Fig. 7. Relationship between the brain size (Y axis) and the body size (X axis) in Charadriidae. See Table 4 for exact data.

Charadriiformes

The data on the brain size and the body size in Charadriiformes are presented in Table 4 and Figures 7—10. The data were sufficient for the calculation of regression equations in the following charadriiform families: Charadriidae, Scolopacidae, Laridae and Alcidae.

In Charadriidae, brain size and body size are positively correlated ($r_H = 1.743 \pm \pm 0.302$; $p < 0.001$) and their allometrical relation is $E = 0.0938\ S^{0.624 \pm 0.058}$ ($n = 12$). The slope of this regression does not significantly deviate from either the Jerison's constant ($t_s = -0.731$; $p > 0.05$) and the Dubois' constant ($t_s = 1.096$, $p > 0.05$).

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

Taxon	n	S	E	I_{rel}	Q_r	Author
Rallidae (127)						
Crex crex	5	150	1.4	0.93	−19.35	5
Rallus aquaticus	21	120	1.6	1.38	10.10	5, 7, 9
Gallirallus australis	2	700	5.1	0.73	6.45	9
Aramides cajanea	1	350	3.9	1.11	28 54	9
Porzana porzana	9	80	1.2	1.50	4.60	5, 6, 9
Limnocorax flavirostris	6	90	1.6	1.78	29.05	2, 9
Tribonyx mortierii	2		4.2			9
Porphyrio porphyrio	6	500	5.1	1.02	32.88	4, 5, 9
Gallinula chloropus	7	280	2.0	0.71	−23.64	1, 5, 9
Fulica americana	1	430	2.9	0.67	−16.55	9
Fulica atra	21	650	3.3	0.51	−27.67	1, 5, 9
*Montirallus gypsorum**	1		3 1			8
Heliornithidae (1)						
Heliornis fulica	1	135	1.4	1.04		9
Rhynochetidae (1)						
no data						
Eurypygidae (1)						
Eurypyga helias	1		2.7			9
Mesoenatidae (3)						
no data						
Turnicidae (16)						
Turnix sylvatica	2		0.6			9
Turnix nigricollis	1		0.9			9
Pedionomidae (1)						
no data						
Gruidae (14)						
Grus antigone	5	8000	20.6	0.26	−9.86	5, 9
Grus grus	4	5500	17.6	0.32	3.47	9
Grus japonensis	3	6500	20.7	0.32	6.68	9
Grus canadensis	1	5500	15.5	0.28	−8.88	3
Grus leucogeranus	1	5900	20.5	0.35	14.03	9
Tetrapteryx paradisea	3	5300	13.3	0.25	−19 50	9
Anthropoides virgo	7	2500	9.4	0.38	2.86	5, 9
Balearica pavonina	10	3250	13.7	0.42	21.91	3, 5, 9
Aramidae (1)						
Aramus guarauna	2	950	6.3	0.66		9
Psophiidae (3)						
Psophia crepitans	3	1000	5.7	0.57		1, 9
Psophia leucoptera	1		5.2			9
Cariamidae (2)						
Chunga burmeisteri	1		7.5			9

Table 3 — *continuation*

Taxon	n	S	E	I_{rel}	Q_r	Author
Otididae (22)						
Chlamydotis undulata	1	1550	5.5	0.35	−6.32	9
Otis tarda	19	6600	10.8	0.16	−9.95	9
Ardeotis arabs	1	3500	10.0	0.29	13.99	9
Ardeotis kori	4	8000	13.4	0.17	1.62	3, 9
Eupodotis cafra	1		4.2			9
Eupodotis afra	2	650	3.9	0.60	1.95	9
Eupodotis vigorsii	1		3.4			9

* Eocene species (see Mlíkovský 1981 for its taxonomic position)
1 = Girard 1908, 2 = Waterlot 1912, 3 = Crile and Quiring 1940, 4 = Portmann and Vischer 1943, 5 = Portmann 1947, 6 = Skvorcova 1952, 7 = Sigmund 1958, 8 = Jerison 1973, 9 = Mlíkovský this paper

In Scolopacidae, brain size and body size are positively correlated ($r_H = 2.176 \pm \pm 0.213$; $p < 0.001$) and their allometrical relation is $E = 0.0912\ S^{0.587 \pm 0.0263}$ ($n = 23$). *The slope of this regression is significantly lower than the Jerison's constant* ($t_s = -3.029$; $p < 0.01$), but does not significantly deviate from the Dubois' constant ($t_s = 1.027$; $p > 0.05$).

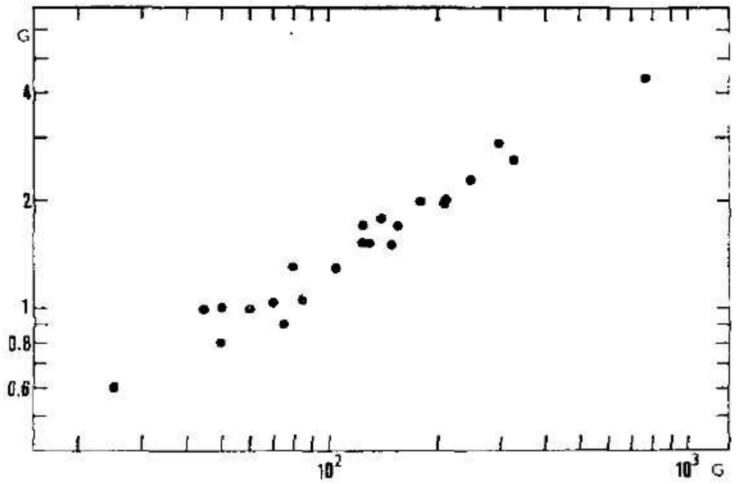


Fig. 8. Relationship between the brain size (Y axis) and the body size (X axis) in Scolopacidae. See Table 4 for exact data.

In Laridae, brain size and body size are positively correlated ($r_H = 2.134 \pm \pm 0.224$; $p < 0.001$) and their allometrical relation is $E = 0.117\ S^{0.577 \pm 0.0283}$ ($n = 21$). *The slope of this regression is significantly lower than the Jerison's constant* ($t_s = -3.168$; $p < 0.01$), but does not significantly deviate from the Dubois' constant ($t_s = 0.601$; $p > 0.05$).

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

Taxon	n	S	E	I_{rel}	Q_r	Author
Jacanidae (8)						
Actophilornis africanus	3	125	1.5	1.20		4, 11
Rostratulidae (2)						
Rostratula benghalensis	1	100	1.4	1.40		11
Haematopodidae (8)						
Haematopus ostralegus	7	550	3.9	0.71		7, 11
Haematopus longirostris	1		4.4			11
Ibidorhynchidae (1)						
no data						
Recurvirostridae						
Recurvirostra avocetta	2	340	2.0	0.59		11
Dromadidae (1)						
Dromas ardeola	3	280	3.9	1.39		11
Burhinidae (9)						
Burhinus capensis	2	430	3.8	0.88		11
Burhinus oedicnemus	7	400	3.5	0.88		7, 11
Burhinus bistriatus	1		4.3			11
Glareolidae (17)						
Rhinoptilus chalcopterus	3		1.5			11
Cursorius cursor	1		1.3			11
Cursorius temminckii	1		1.3			11
Charadriidae (65)						
Microsarcops cinereus	1	170	2.8	1.65	21.10	11
Stephanibix coronatus	3	140	2.2	1.57	7.41	11
Belonopterus cayenensis	1	160	2.4	1.50	7.80	11
Vanellus vanellus	11	200	2.2	1.10	−14.02	6, 7, 9, 11
Pluvialis apricaria	1	200	2.3	1.15	−10.12	11
Pluvialis dominica	1	130	1.8	1.38	−7.96	11
Pluvialis squatarola	6	200	2.6	1.30	1.61	8, 11
Charadrius leschenaultii	1	85	1.5	1.76	−0.02	11
Charadrius vociferus	1	80	1.2	1.50	−16.93	1
Charadrius dubius	1	40	1.0	2.50	6.69	11
Charadrius hiaticula	7	60	1.2	2.00	−0.59	8, 11
Charadrius alexandrinus	1	45	1.1	2.44	9.04	11
Charadrius tricollaris	2		1.0			11
Scolopacidae (85)						
Philohela minor	1	105	1.3	1.24	−7.21	11
Scolopax rusticola	19	330	2.6	0.79	−5.24	3, 6−9, 11
Philomachus pugnax	11	155	1.7	1.10	−3.46	7, 8, 11
Calidris canutus	1	150	1.5	1.10	−13.16	11
Calidris ferrugineus	2	75	0.9	1.20	−21.73	8
Calidris minutus	3	25	0.6	2.40	−0.56	8, 11
Calidris alpinus	6	45	1.0	2.22	17.37	8, 11
Calidris maritimus	2	80	1.3	1.63	8.85	11
Gallinago gallinago	14	130	1.6	1.23	0.75	3, 7, 8, 11

Table 4 — continuation

Taxon	n	S	E	I_{rel}	Q_r	Author
Gallinago media	2	210	2.1	0.95	−0.21	11
Lymnocryptes minimus	9	60	1.0	1.67	−0.86	7, 8, 11
Limosa limosa	2	300	2.9	0.97	11.77	11
Limosa lapponica	2	250	2.3	0.92	−1.34	11
Numenius arquata	8	760	4.3	0.57	−3.96	3, 7, 11
Numenius tahitiensis	1		3.7			10
Numenius phaeopus	1	480	4.7	0.98	37.47	11
Tringa erythropus	2	140	1.8	1.29	8.52	11
Tringa totanus	3	125	1.7	1.36	9.54	11
Tringa nebularia	2	180	2.0	1.11	−4.04	11
Tringa melanoleuca	1	210	2.0	0.95	−4.96	11
Tringa glareola	4	70	1.2	1.71	8.67	8, 11
Tringa ochropus	3	85	1.3	1.53	5.05	11
Tringa solitaria	2	50	1.0	2.00	10.33	11
Actitis hypoleucos	10	50	0.8	1.60	−11.73	8, 9, 11
Arenaria interpres	2	125	1.5	1.20	−3.35	11
Thinocoridae (4)						
Thinocorus orbignyianus	1	135	1.2	0.89		11
Chionididae (2)						
Chionis minor	3	430	3.6	0.84		11
Pterocletidae (16)						
Syrrhaptes paradoxus	3	300	1.6	0.53		11
Syrrhaptes orientalis	2	510	2.4	0.47		11
Syrrhaptes gutturalis	1		1.5			11
Syrrhaptes exustus	1		1.4			11
Pterocles coronata	1		1.4			11
Stercorariidae (4)						
Stercorarius skua	1	800	7.5	0.94		11
Laridae (85)						
Larus canus	9	450	4.1	0.91	3.20	9, 11
Larus glaucoides	1	900	7.5	0.83	26.55	11
Larus fuscus	1	870	5.7	0.66	−1.92	11
Larus argentatus	13	1130	6.6	0.58	−2.34	1, 2, 5, 7−9, 11
Larus marinus	4	1660	7.9	0.48	−6.36	7, 11
Larus dominicanus	1	1000	5.9	0.59	−6.32	11
Larus hyperboreus	1	1400	8.0	0.57	4.61	11
Larus hemprichii	1	470	2.9	0.62	−28.81	11
Larus leucophthalmus	3	320	3.2	1.00	−1.94	11
Larus ridibundus	22	300	2.85	0.95	−9.35	6−9, 11
Larus philadelphia	1	220	2.5	1.14	−4.90	5
Larus atricilla	3	300	3.2	1.07	1.78	11
Larus minutus	1	125	1.9	1.52	0.15	11
Rissa tridactyla	2	410	3.8	0.93	0.93	11
Chlidonias leucoptera	2	65	1.4	2.15	7.62	11
Sterna sandvicensis	2	250	2.8	1.12	−1.06	11
Sterna sumatrana	1	95	2.0	2.11	23.51	11
Sterna hirundo	3	135	1.7	1.26	−14.28	7, 11
Sterna paradisea	2	110	2.0	1.82	13.49	9, 11
Sterna albifrons	2	40	0.9	2.25	−8.45	9, 11
Phaetusa simplex	2	220	3.2	1.45	21.73	11

Rynchopidae (3)						
Rynchops niger	1	290	2.0	0.69		11
Alcidae (22)						
Cepphus grylle	4	430	3.2	0.74	−13.12	11
Uria aalge	3	1050	5.3	0.50	−3.63	5, 11
Uria lomvia	1	990	5.1	0.52	−4.78	11
Alca torda	5	720	4.9	0.68	5.55	11
*Pinguinus impennis**	1	5000	10.5	0.21	−5.26	11
Alle alle	1	100	1.9	1.90	−0.70	5
Fratercula arctica	5	490	4.4	0.90	12.65	7, 11
Lunda cirrhata	1	980	5.9	0.60	10.66	11

* Extinct species

1 = Hrdlička 1905, 2 = Lapicque and Girard 1905, 3 = Girard 1908, 4 = Waterlot 1912, 5 = Crile and Quiring 1940, 6 = Portmann and Vischer 1943, 7 = Portmann 1947, 8 = Skvorcova 1952, 9 = Senglaub 1963, 10 = Jerison 1973, 11 = Mlíkovský this paper

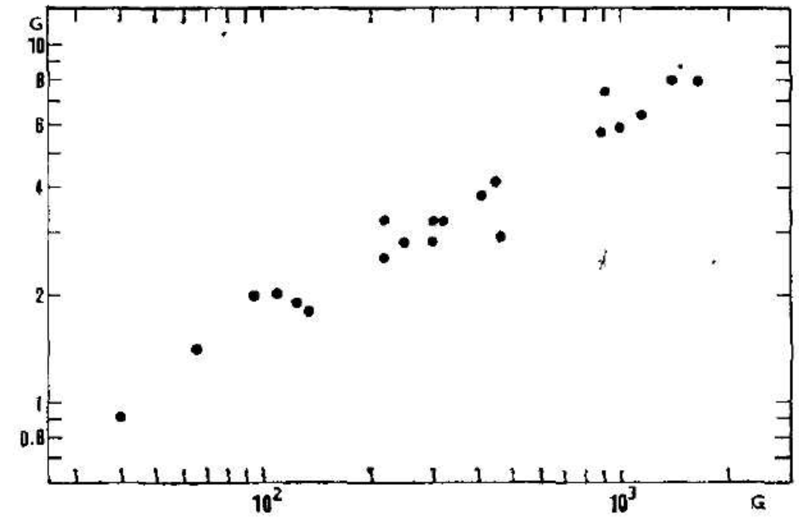


Fig. 9. Relationship between the brain size (Y axis) and the body size (X axis) in Laridae. See Table 4 for exact data.

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

Taxon	n	S	E	I_{rel}	Q_r	Author
Gaviidae (5)						
Gavia stellata	5	1600	5.3	0.33		1−3
Gavia arctica	10	2500	7.5	0.30		3
Gavia immer	2	4000	13.0	0.33		3

1 = Crile and Quiring 1940, 2 = Portmann 1947, 3 = Mlíkovský this paper

In Alcidae, brain size and body size are positively correlated ($r_S = 0.929$; $p < 0.01$) and their allometrical relation is $E = 0.242\ S^{0.449 \pm 0.00326}$ ($n = 8$). The slope of this regression is significantly lower than both the Jerison's constant ($t_s = -6.677$; $p < 0.001$) and the Dubois' constant ($t_s = -3.405$; $p < 0.01$).

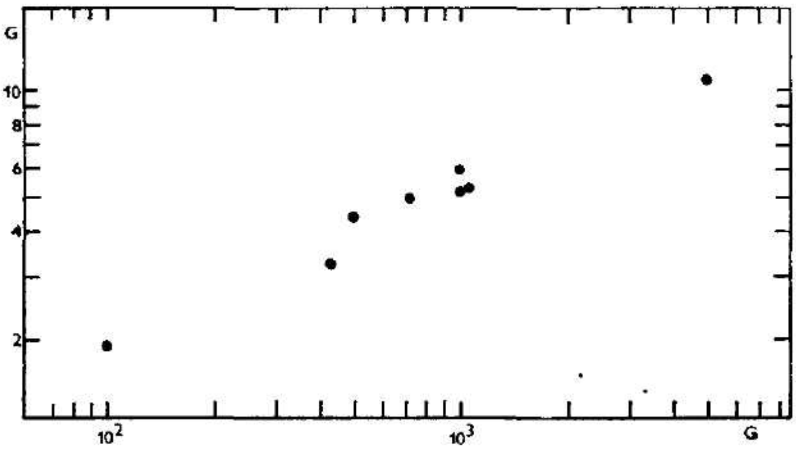


Fig. 10. Relationship between the brain size (Y axis) and the body size (X axis) in Alcidae. See Table 4 for exact data.

Gaviiformes

The data on the brain size and the body size in Gaviiformes are presented in Table 5. The data do not allow the calculation of the regression equation for the Gaviidae, the only living gaviiform family.

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ON THE SYSTEMATICS OF THE PERCH (PERCA FLUVIATILIS) (PISCES, PERCIFORMES)

Ota OLIVA, Lubomír HANEL, Václav ŠAFRÁNEK

Department of Zoology, Charles University, Viničná 7, 128 44 Praha 2, Czechoslovakia

Abstract. Meristic characters of almost 2000 specimens of the common perch *(Perca fluviatilis)* from Czechoslovakia were studied. Results are compared with the variability of these characters within the area of geographical distribution of the perch, using literary date based on further almost 300 specimens. Systematical position of the forms *P. fluviatilis* infrsp. *vulgaris* sensu Pokrovsky, 1951 and *P. fluviatilis* infrsp. *gracilis* Pokrovsky, l. c. is discussed. Authors came to conclusions that, the first form represents geographical taxonomical unit, the second represents stunted specimens, which can occur in various water bodies within its area of distribution. The first to give a virtual description of "infrsp. vulgaris" was Vladykov (1931) rather than Schaefer (1761). But the designation of this aberrant form of the common perch by the using of the species name *"vulgaris"*, which is the junior synonym of the species name *fluviatilis*, complicated later status of taxonomical units below the species level at the common perch and unfortunately contributed to the false concept about the small variability of the common perch.

INTRODUCTION

From our point of view it is very interesting that Vladykov (1931) described from the territory of Czechoslovakia a new taxon. *"Perca fluviatilis* natio *vulgaris* Schaefer, 1761", inhabiting the drainage of the Danube. He presented also the key for determination of "typical" perch and this "natio". Later Pokrovsky (1951) revised this description and pointed out following Vladykov (1931), that the river Morava, the affluent of the central drainage of the Danube from north, is inhabited by the perch which is near to the "typical" form and not to *"vulgaris"* Vladykov, lives according to Pokrovsky (1951) also in the lake Sjaberskoe ozero (the drainage of the river Luga), near Leningrad, in the Kutchurgansky liman of the Dniestr, but the Yugoslav river Vardar (with regard to Karaman (1924)) is inhabited by the "typical" perch. From above mentioned facts Pokrovsky (1951) concluded that, the natio *vulgaris* does not posseses a certain limited geographical area and represents rather an infraspecies (according to the classification of ichthyological taxonomic units by Berg (1948—49)). Pokrovsky believed that we have to do with an ecological Form arising under certain specific conditions within the broad area of the species. Balon et Holčík (1964) repeated Pokrovsky's data (1951) and added a note about the designation of the perch of the Danube delta as typical form by Busnitza (1959). Banarescu (1964) paid no attention to subspecies of the perch; Oliva et al. (1968) respected Vladykov's data (1931).

Having an opportunity to study large material of the perch recently we think it will be useful to contribute with new data to a better understanding of this problem, which can be divided into two requests. The first one is nomenclatorial, the usage of the species name, which is the junior synonym of the valid

Table 1. Number of nonramified rays in 1st dorsal fin in the perch from Czechoslovakia

Locality	n	Ranges	M ± m	S
Vltava drainage (S. Bohemia ponds)	372	13–15	13,962 ± 0,025	0,486
r. Danube	76	13–15	13,987 ± 0,069	8,599
Labe drainage (C. Bohemia, back-waters)	235	13–15	14,043 ± 0,030	0,460
Máchovo jezero (Labe drainage, pond)	132	13–15	14,106 ± 0,039	0,449
Odra drainage	179	13–15	14,151 ± 0,037	0,491
Kličava reservoir (Vltava drainage)	454	12–15	14,247 ± 0,028	0,606
Slapy reservoir (Vltava drainage)	206	13–15	14,316 ± 0,034	0,486
Pastvinská nádrž (Labe drainage, reservoir)	152	14–15	14,796 ± 0,033	0,404

species name, for the designation of the taxon, lower than subspecies, as by Vladykov (1931). The second concerns the actual geographical variability within the species of the common perch in various localities, namely the differences shown previously in the Danube perch by Vladykov (1931).

MATERIAL AND METHODS

Localities of the perch used for our study are enumerated in Tables 1—5. Counting of lateral line scales and fin rays was performed after Vladykov (1931). The last not ramified ray in the second dorsal and the anal fin was counted as a single ray. Altogether around 1,800 specimens, mainly from 10 ponds in Southern Bohemia and several back-waters of the Elbe in Central Bohemia were used for the present study. Samples were collected in the period 1949—1963 (the perch from the drainage of the Labe, its back-waters in Central Bohemia). Other samples from the drainage of the

Table 2. Number of nonramified rays in 2nd dorsal fin in the perch from Czechoslovakia

Locality	n	Ranges	M ± m	S
Labe drainage (C. Bohemia, back-waters)	237	1–3	1,919 ± 0,020 *a*	0,315
Vltava drainage (S. Bohemia, ponds)	372	1–4	1,957 ± 0,017	0,326
Odra drainage	179	1–3	2,011 ± 0,014	0,183
Máchovo jezero (Labe drainage, pond)	132	1–3	2,015 ± 0,019	0,213
r. Danube	76	1–3	2,026 ± 0,032	0,282
Kličava reservoir (Vltava drainage)	454	1–3	2,029 ± 0,012	0,260
Pastvinská nádrž (Labe drainage, reservoir)	152	1–3	2,092 ± 0,030	0,370
Slapy reservoir (Vltava drainage)	206	1–3	2,121 ± 0,029	0,430

Table 3. Number of ramified rays in 2nd dorsal fin in the perch from Czechoslovakia

Locality	n	Ranges	M ± m	S
r. Danube	76	13–15	13,816 ± 0,074	0,647
Pastvinská nádrž (Labe drainage, reservoir)	152	13–16	13,888 ± 0,051	0,626
Odra drainage	179	13–15	13,916 ± 0,037	0,496
Máchovo jezero (Labe drainage, pond)	132	13–15	13,939 ± 0,034	0,386
Labe drainage (C. Bohemia, back-waters)	237	13–16	13.962 ± 0,039	0,599
Slapy reservoir (Vltava drainage)	206	13–15	13,995 ± 0,033	0,468
Kličava reservoir (Vltava drainage)	454	13–16	14,068 ± 0,021	0,458
Vltava drainage (S. Bohemia, ponds)	372	13–16	14,382 ± 0,029	0,568

Vltava, namely from the Southern Bohemia artificial ponds, come from the years 1949—1957. In the drainage of the Danube samples were collected in 1948—1960, in the drainage of the Odra in *1950—1952. The sample from the artificial pond Máchovo* jezero in Northern Bohemia comes from 1951, from the Klíčava reservoir from 1956—1964. On the riverine lake "Slapská nádrž", drainage of the Vltava, samples were obtained within 1957—1963, from the riverine lake "Pastvinská nádrž", drainage of the Labe, in 1949—1957. The plates with illustrations showing some examples of specimens studied will be found at the end of this issue.

Table 4. Number of ramified rays in the anal fin in the perch from Czechoslovakia

Locality	n	Ranges	M ± m	S
Odra drainage	179	7–10	8,106 ± 0,044	0,595
r. Danube	76	7– 9	8,408 ± 0,068	0,593
Slapy reservoir (Vltava drainage)	206	7–10	8,490 ± 0,039	0,565
Pastvinská nádrž (Labe drainage, reservoir)	152	7–10	8.519 ± 0,044	0,539
Kličava reservoir (Vltava drainage)	454	7–10	8,529 ± 0,027	0,574
Labe drainage (C. Bohemia, back-waters)	237	7–10	8.527 ± 0,036	0,556
Vltava drainage (S. Bohemia)	327	7–10	8,637 ± 0,029	0,555
Máchovo jezero (Labe drainage, pond)	132	8–10	8,803 ± 0,044	0,501

RESULTS AND DISCUSSION

The research history of the Danubian perch begins with the descriptions of fishes compiled by Marsili (1726) who, in the inserted plate 23, Fig. 1 depicted as "Perca I" evidently the species *Perca fluviatilis* and called it "Perca I, Berschling, Wretensa". The fish was synonymized with "Perca fluviatilis Rondeletii, Gesneri ex Aldrovando etc." It is of interest that in the picture of this

Table 5. Number of scales in the lateral line in the perch from Czechoslovakia

Locality	n	Ranges	M ± m	S
Odra drainage	178	46—65	58,225 ± 0,232	3,100
r. Danube	69	51—67	58,623 ± 0,426	3,540
Slapy reservoir (Vltava drainage)	201	54—66	59,418 ± 0,174	2,471
Labe drainage (C. Bohemia, back-waters)	235	52—66	60,115 ± 0,172	2,646
Máchovo jezero (Labe drainage, pond)	127	54—68	60,142 ± 0,289	3,258
Vltava drainage (S. Bohemia, ponds)	369	52—67	60,146 ± 0,146	2,818
Kličava reservoir (Vltava drainage)	441	54—68	61,243 ± 0,112	2,362
Pastvinská nádrž (Labe drainage, reservoir)	150	51—69	62,680 ± 0,222	2,718

"Danube perch" the vertical bands are not clearly marked. From the point of nomenclature Marsili's work was still not fully binominal. Bloch (1784) published very solidly arranged synonymics for the common perch. He knew apparently from the autopsy all the authors he cited, including Prelinnaean ones. He quoted also the vernacular names (p. 95). Very interesting is his note concerning the number of dark transversal bands at the perch, ... "weil nicht nur die Anzahl, sondern auch die Farbe derselben verändern ist: denn so habe ich z. B. Barsche mit dunkelgrünen, und wieder andere mit dunkelblauen, auch mit mehr und weniger als sechs, auch sogar einen ohne alle Streifen gesehen." However the name *Perca vulgaris* did not appear in synonymics in Bloch (1784), although he cited Schäfer (1761) (here we follow the original spelling of Bloch's). According to Jordan and Evermann (1917), who used the Schaefer's ortography descriptions in this work are exact and very elaborate ("in universum describiendibus"). The nomenclature is eccentric-in part monomial, and the names are perhaps not exactly uesd in the esnse of genera. The perch is called *Perca vulgaris* and again *Perca fluviatilis*. Two spemies of the perch are listed in Bonaparte (1846), namely: *Perca fluviatilis*, L. (*Perca major*, Schonevelde — *P. italica*, Cuv.) with the locality "Fluv. Eur. occ. et m.", and *Perca vulgaris*, Schaeff. (*Perca fluviatilis*, Auct.) Pisc. Bav. Pent. tab. 1, "Fluviis Eur. or. et med."

Two species of the common perch are mentioned in the Gronow's (1854) catalogue. Under the name *Perca helvetica* the common perch inhabiting "Helvetica ad Basilaeam" is included apparently the elongated specimens of it ("gracilior vulgari, cujus forman aequat: macula atra in extreme pinnae dorsi anterioris. Corpus pone caudam admodum gracile" (pp. 113—114). The following species is *Perca vulgaris*, where Gronow evidently noted the transverse bands of it ("Perca sex-costata: dorso dipterygio..."). As locality rivers and lakes of Europe including the brackish water are quoted. (Habitat in fluminibus lacubusque Europaeis, intrat et aquae subsalsas..."

In his synonymics to the species *Perca fluviatilis* Boulenger (1895) mentioned also *Perca vulgaris* Agassiz, Isis, 1828: 1047 and Gronow, Catal., 1854: 114.

Table 6. Number of nonramified rays in 1st dorsal fin in the perch

Locality	Author	n	Ranges	M ± m	S
Canada	Čihař, 1975	36	12–14	12,583 ± 0,101	0,604
USA	Čihař, 1975	16	12–15	13,250 ± 0,233	0,931
Roumania	Čihař, 1975	34	12–14	13,500 ± 0,097	0,564
r. Tisa	Vladykov, 1931	15	13–15	13,80	
Austria	Čihař, 1975	39	13–16	13,821 ± 0,096	0,601
Italy	*Čihař, 1975*	28	13–14	13,821 ± 0.074	0,390
England	Čihař, 1975	29	12–15	13,828 ± 0,100	0.539
Poland	Čihař, 1975	30	13–15	14,000 ± 0,096	0,525
G.F.R.	Čihař, 1975	34	13–15	14,029 ± 0,089	0,521
Dniepr basin	Žukov, 1965	172	13–16	14,15 ± 0,05	0,62
G.D.R.	Čihař, 1975	39	13–15	14,154 ± 0,078	0.489
Norway	*Čihař, 1975*	6	14–15	14,167 ± 0,167	0,408
Czechoslovakia	own data	1806	12–15	14,185 ± 0,013	0,558
North America	Pokrovskij, 1951	4	14–15	14,2	
r. Neman	Žukov, 1965	44	13–15	1 ,25 ± 0,07	0,48
Sweden	Čihař, 1975	24	13–15	14,378 ± 0,118	0,576
r. Kama	Menšikov Bukirev, *after Pokrovskij, 1951*	10	14–15	14,4	
Ladoga Lake	Čihař, 1975	50	13–15	14,600 ± 0,076	0,535
r. Ob	Čihař, 1975	20	13–16	14,650 ± 0,196	0,875
Sjaberskoe Lake	Pokrovskij, 1951	40	13–16	14,70 ± 0,09	0,569
r. Zap. Dvina	Penjaz, after Žukov, 1965	112	13–16	14,72 ± 0,05	0,59
r. Neva	Pokrovskij, 1951	70	14–16	14,8	
Onega Lake	Pokrovskij, 1951	100	14–16	15,17 ± 0,05	0,55
r. Kolyma	Čihař, 1975	17	13–17	15,294 ± 0,268	1,105
Kerefozero White Sea Basin)	Alexandrov, after Pokrovskij, 1951	30	15–17	15,5	
Lekozero Lagoda Lake Basin	Alexandrov, after Pokrovskij, 1951	30	14–16	15,5	
r. Lena	*Borisov,* after Pokrovskij, 1951	25	15–17	15,6	
r. Kolyma	Pokrovskij, 1951	6	15–17	15,8	

The fact that, the nomenclature of Schäfer is not always binominal was recently quoted also by Collette and Banarescu (1977). Guarding, apparently Schäfer's priority, Vladykov (1931) revived the latter's species name *"vulgaris"* for his own taxonomical unit within the species *Perca fluviatilis*. Therefore it is rather Vladykov (1931) who must be recognized as the real author of the new redescription. The description of the single typical specimen of the perch, designated by the late Professor V. D. Vladykov himself as "Perca f. n. vulgaris Chaefer" from the Terechva at Teresovka is as follows: LT = 129 mm. SL = 107 mm. In $^0/_0$ of the body length: total length 120.6, head length 33.6, preorbital distance 9.3, eye diameter 7.5, interorbital distance 9.3, postorbital distance 17.8, head depth 22.4, head width 18.7, predorsal distance 34.6, preventral distance 36.4, preanal distance 71.0, body depth 30.8, body width 18.7, length of the caudal peduncle 23.4, depth of the caudal distance 12.1, min. depth of the caudal distance 9.3, P-V distance 13.1, V-A distance 35.5, length of the base of D_1 33.6, length of the base of D_2 19.6, length of the base A 11.2, length of the ventral fin 20.6, height of the D_1 16.8, height of the D_2 14.9, height of the anal fin 16.8, spines in D_1 XIII, rays in D_2 II/12, rays in

A II/7, rays in C 17, rays in V 1/5, scales in the lateral line 56, scales above the lateral line 6, scales below lateral line 11. Using Vladykov's (1931) published data of 2 meristic characters for statistical evaluation, we shall receive the following data:
spined rays *in the first* dorsal 13—15, M $\pm$ m 13.867 $\pm$ 0.192, 0.74, n = 15; lateral line scales 48—58, M $\pm$ m 54.560 $\pm$ 0.487, 2.434, n = 25.

Vladykov (1931): 337 wrote, verbatim that it is necessary to note that, 2 specimens of *Perca fluviatilis*, originating from the river Morava, collected by Jeitteles, No. Coll. 1358 of the Paris Museum Collections, have the fin formula D XIV-XV, I 14, A II 8, 1.1.60—61. According to the number of lateral line scales are these specimens are near to the typical form, even though the river Morava belongs to the Danube drainage. Vladykov (l.c.) may have suspected that the labelling for these specimens is possibly wrong. Concerning another form, *Perca fluviatilis* var. *macedonia*, Vladykov (1931) believed that this form has all marks of the typical form and it is conspecific with it. Banarescu (1946) repeated Vladykov's (1931) description of *Perca fluviatilis* natio

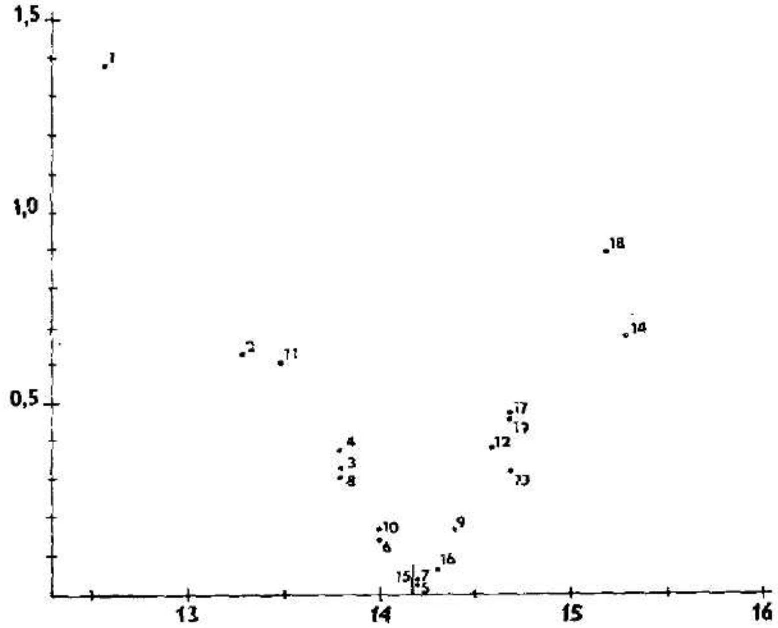

Fig. 1. *Statistical comparison of average values of the number of spines in the* first dorsal fin on some localities within the area of the distribution of the common perch. On the abscissa (x) the average number of spines (spined rays) is given, on *the ordinate (y) C. D.* coefficient (see Holčík, Hensel, 1972) is compared with the average frequency within Czechoslovakia (n = 1806, 14.185 $\pm$ 0.013, *s = 0.558*). The list localities: 1 — Canada, 2 — USA, 3 — England, 4 — Italy, 5 — Norway, 6 — GFR, 7 — GDR, 8 — Austria, 9 — Sweden, 10 — Poland, 11 — Roumania, 12 — *Lake Ladoga, 13 — the river Ob, 14 — the river Kolyma, 15 — the river Dniepr,* 16 — the river Neman, 17 — the river Zapadnaja Dvina, 18 — Lake Onega, 19 — Lake Sjaberskoe. In the graph the average value in Czechoslovakia is represented by the vertical line to the abscissa.

Table 7. Number of scales in the lateral line in the perch

Locality	Author	n	Ranges	M ± m	S
Canada	Čihař, 1975	36	50–59	53,750 ± 0,413	2,477
r. Tisa	Vladykov, 1931	25	48–58	54,56	
USA	Čihař, 1975	15	52–62	56,267 ± 0,759	2,939
Roumania	Čihař, 1975	34	53–66	58,412 ± 0,522	3,046
North America	Pokrovskij, 1951	4	51–61	59,0	
r. Kolyma	Čihař, 1975	17	57–66	60,235 ± 0,627	2,587
r. Kolyma	Pokrovskij, 1951	6	56–64	60,8	
Czechoslovakia	own values	1770	46–69	60,294 ± 0,071	2,970
Sweden	Čihař, 1975	24	55–66	60,917 ± 0,558	2,733
Dniepr Basin	Žukov, 1965	37	5[illegible]–67	61,06 ± 0,20	2,62
G.D.R.	Čihař, 1975	39	56–67	61,615 ± 0,402	2,509
r. Zap. Dvina	Penjaz, after Žukov, 1965	112	56–68	62,56 ± 0,33	3,57
Norway	Čihař, 1975	6	61–65	63,000 ± 0,775	1,897
r. Neman	Žukov, 1965	37	59–67	63,03 ± 0,36	2,21
Sjaberskoe Lake	Pokrovskij, 1951	40	57–68	63,17 ± 0,33	2,09
G.F.R.	Čihař, 1975	34	55–68	63,265 ± 0,455	2,655
England	Čihař, 1975	30	61–67	63,700 ± 0,249	1,368
r. Kama	Menšikov, Bukirev after Pokrovskij, 1951	10	59–69	64,0	
Lagoda Lake	Čihař, 1975	50	58–70	64,080 ± 0,387	2,739
r. Neva	Pokrovskij, 1951	70	59–71	64,1	
Aral Sec	Nikolskij, after Pokrovskij, 1951	25	60–71	65,1	
r. Lena	Borisov, after Pokrovskij, 1951	25	61–71	65,3	
Lekozero (Lagoda Lake Basin)	Alexandrov, after Pokrovskij, 1951	30	62–68	66,0	
Austria	Čihař, 1975	38	61–72	66,368 ± 0,495	3,053
Končozero Lake (Onega Lake Basin)	Meljancev, after Pokrovskij, 1951	20	64–72	66,9	
Onega Lake	Pokrovskij, 1951	100	62–74	67,52 ± 0,24	3,55
Kerefozero (Onega Lake Basin)	Meljancev, after Pokrovskij, 1951	30	61–74	67,7	
Poland	Čihař, 1975	30	62–76	68,233 ± 0,538	2,944
Italy	Čihař, 1975	28	62–72	68,357 ± 0,475	2,512
r. Ob	Čihař, 1975	20	64–78	71,500 ± 0,724	3,236

vulgaris. Although the rivers Bega and Timis belong to the Danube drainage, their perch has up to 62 scales in the lateral line, and not 56/58/, as it was proclaimed for natio vulgaris. Banarescu (1946) is sceptical about the validity of the form *"vulgaris"*, because the species *Perca fluviatilis* has the holarctic range and no local form has been established.

We have compared the data of Pokrovsky (1951), which he cousiders important for the characteristic of infrsp. vulgaris, with meristic counts of the perch from the drainages of the rivers Labe, Tisa and Visla. We can conform that the Bohemian perch has the tendency to the decrease of the number of spines in the first dorsal fin, the perch from the Tisa has the intermediate position among the South Bohemian pond perch and the Labe perch. The Russian perch has a tendency to the increase of the number of spinese from west to east, which can be seen best in the perch from river Lena and Kolyma. The last population cited was enlisted with the subspecies *flavescens* by Pokrovsky (1951). The difference between the Kolyma perch and North American perch is apparent, but Pokrovsky had only 4 specimens of the latter at hand. Čihař (1975) studied a larger material from North America (53 sp.) and obtained the same results (see his table of frequency distribution, op. cit. p. 65), Finally, Collette and Banarescu (1977), separated both forms as indenpendent species.

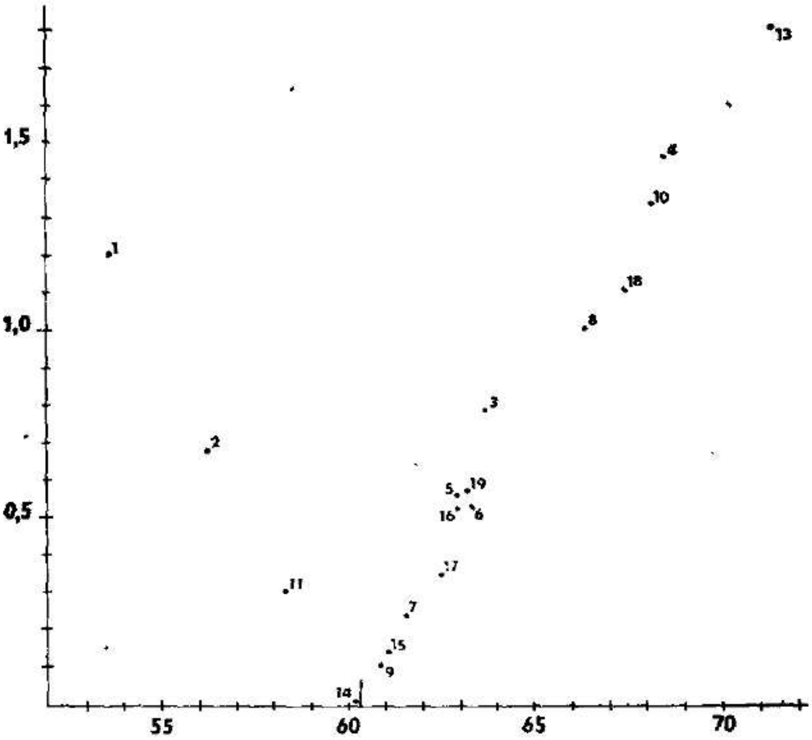

Fig. 2. Statistical comparison of average values of the number of scales in the lateral line of the common perch within the whole area of its distribution. On the abscissa the average number of scales, on the ordinate the C. D. coefficient compared with the average value of this character from Czechoslovakia. (n = 1770, 60.294 ± ± 0.071, s. = 2.970). The last cited value is represented graphically by the vertical line to the abscissa. The designation of localities is the same as in Fig. 1.

As regards the soft rays in the second dorsal fin, the smallest number is noted in the perch from the Tisa, the highest from South Bohemia ponds. These counts are not comparable with other lacalities, because Pokrovsky (1951) listed, with regard to single exception, the total number of all rays, both hard and soft. According to Pokrovsky (1951) and Čihař (1975), the similarity of the perch from the Lena, Kolyma and North America (the smallest number of anal rays) is evident. The South Bohemian pond perch seems to be most similar to infrsp. *vulgaris* (sensu Pokrovsky) from the lake Sjaberskoe, the Labe perch also to the same infraspecies sensu Pokrovsky (1951), but from the lake Onega.

From Table 7 it is evident that the perch from Bohemia stands near to the North American perch, but the smallest number of lateral line scales was found in the Tisa perch (Vladykov, 1931). Using this single character, however, we cannot say that this perch is identical with natio *vulgaris* Vladykov, 1931 from the Tisa drainage. We suppose that, the Bohemian perch differs, in this character, from all Russian populations, including the "typical form" [sensu Pokrovsky (1951)] from lake Onega, and "infrsp. *vulgaris*" [sensu Pokrovsky (1951)] from lake Syaberskoe, and, finally from infrsp. *gracilis* Pokrovsky, 1951 from lake Lyubivo. For *Perca flavescens*, Jordan and Evermann, 1986 have shown 54—62 lateral line scales (scales only with the lateral line canal!), the lower limit in the perch from the Tisa is even smaller (48), the same for the perch from Bohemia (52). According to these facts we suppose that Pokrovsky (1951) is not right in his conclusions concerning the Vladykov's form of the perch from the Tisa. Near of the southern ranges of its area the perch is establishing geographical forms, maybe of subspecies rank, which have tendency to the diminishing of lateral line scales, similarly as can be seen in some cyprinids. Unfortunately, the perch from Macedonia is little known from this aspect.

According to our view, *Perca fluviatilis* infrsp. *gracilis* Pokrovsky, 1951, a stunted morpha (sensu Berg, 1948) of the perch, which can change under normal food conditions into the "typical form" (see Alm, 1946; Shentyakova, 1959).

Svetovidov et Dorofeeva (1963) published a detailed analysis of the differences of species described within the genus *Perca*. Within the species *P. fluviatilis* they recognized 3 subspecies, *P. f. fluviatilis*, *P. f. intermedius* subsp. nova and *P. f. flavescens*. The new by described subspecies (terra typica river Kolyma, Siberia, USSR) is characterized by the interorbital difference being 20.6—29.0 % of the head length (21.4—26.1 % in the typical form), and by a shorter first dorsal spine as compared with the length of the second (37—84 % of the length of the latter); the length of the first anal spine is 33—121 % of the length of the first dorsal spine. The begining of the insertion of the dorsal fin lies, most frequently, directly above the insertion of pectoral fins; in typical subspecies this insertion of dorsal fin is shifted more cranially or rarely directly vertically above pectorals. From the description it is evident that this subspecies has some characters of the separated form inhabiting the river Kolyma, but the marks presented seem to us unsufficient for establishing this population as a distinct subspecies.

Rusov (1921) found another character for the distinction of various perch population, viz., the difference in the depth of the first dorsal fin and the maximum body depth. The dorsal fin depth enters 1.37—1.97 times into the body depth in the perch from the Ukrainian rivulet Zvantchik, but 2.5 times following data of Heckel and Kner (1858). Larger values, higher than 2.0, were found in Norway (2.18), in the river Kolyma (2.06), in the German Democratic Republic (2.06), in Sweden (2.04), in the German Federal Republic (2.01) and in Canada (2.06); data based on Čihař (1975). Extreme values were found in the perch from Azerbaidzhan (calculated from the figure et Derzhavin (1949) — 3.06). Lower values were found in Rumania (1.98), in Italy (1.94), Poland (1.88), separately here also in Lake Wzdydze (1.88), based on Čihař (1975), in the river Biebrza (Poland, Witkowski, 1984), in the river Zapadnaja Dvina (USSR, 1.88. Zhukov, 1965), in lake Ladoga (1.81, Čihař, 1975), in England (1.81), Austria (1.79), Czechoslovakia (1.73), in the river Ob, USSR (1.73) — all data based on Čihař (1975), and in the river Neman (1.72,) Zhukov, (1965), in USA (1.69, Čihař, 1975).

Concerning sexual differences in this character, Oliva (1953) found, in the average, 1.73 in males and 1.81 in females from the drainage of the Labe.

In our topotypical specimen "*Perca fluviatilis* natio *vulgaris*", this value is 1.81. However, from the facts presented above it is evident that this value has a wide range and our opinion is that it cannot be used for taxonomical purposes. Sexual dimorphism of the perch, which is almost inconsiderable, was studied by Oliva (1953) from the drainage of the Labe, where he found somewhat longer pectoral and ventral fins at males, but these differences cannot be proved statistically.

Finally, we can conclude that, Vladykov (1931) himself probably wushed to hold the priority of Schäfer as regards the separate position of the Danube perch. But Schäfer is concept of establishing species cannot be compared with recent approach to ichtyological taxons, compared e. g. by Berg 1916, 1923, 1932—33, 1948—49. Unfortunately, it also does not correspond with the rules of the International Code of Zoological Nomenclature (1961) which excludes names of infrasubspecific forms. *Perca vulgaris* Schäfer, 1761 is a subjective synonym of *Perca fluviatilis* Linnaeus, 1758. The existence of real differences among the perch from some part of Danube drainage (the river Tisa) found originally by Vladykov (1931), but connected with a name which is a nomenclatorically invalid unit and is a subjective synonym of the typical form of the perch, probably brought subsequent authors to the negation of real differences within the species *Perca fluviatilis* in the Central Europe. We felt obliged to call attention to this fact.

As to the morphological changes due to enviromental conditions it must be noted that the perch was acclimatized (Nikolsky, 1956) in the drainage of the Amur (lake Kenon, drainage of the Ingoda) in the year 1919 and has reproduced here sucessfully. It has also penetrated into the river Ingoda and some other lakes. Naturally, the perch was not a the native species here previously. Differences were found when 23 specimens from lake Kenon were compared with the local population within the original area of distribution of the perch (lake Ivan, drainage of the Vitim). According to Nikolsky (1956) these changes are caused by the conditions of the new habitat.

SUMMARY

Comparison of meristic characters of the common perch (*Perca fluviatilis*) brought the following results:

1. The average number of rays in the 1st dorsal fin has en evident tendency to increase from west to east and from south to north with regard to the geographical area of the distribution of the perch. These tendencies, especially the commonly cited north-south relation, are not valid without exceptions. Apparently, local conditions play some role here, and they mask these relationships (e. g., microclimate, the elevation, physical and chemical conditions of the locality).
2. The average number of lateral line scales has the less evident tendency to increase from west to east and from south to north.

3. Two forms of the perch can be recognized, the North-American and the Euro-Asiatic, i. e. *Perca flavences* and *Perca fluviatilis* sometimes united into a single species or subspecies. The perch of the Kolyma represents an integrade between them. This is true as regard the number of lateral line scales, but not the number of spined rays in the first dorsal fin.
4. A separate position within the Euro-Asiatic distribution is held by perch populations from the river Ob and from Italy, Poland and Roumania.
5. Very interesting is the perch from river Danube, which can be listed as a separate taxonomical unit, but not on the subspecies level. Therefore the designation "natio vulgaris" has no nomenclatorical validity.
6. According to our view the taxonomical unit *Perca fluviatilis* infrsp. *gracilis* is a stunted form (morpha), which can occur elsewhere within the area of the distribution, and since it is below the subspecific level, it is also nomenclatorically in valid.
7. Obviously the designation "natio vulgaris Schäffer" was used by Vladykov (1931) with the aim of the conservation of Schäffer's priority. In the fact this name, the subjective synonym for typical perch, caused that subsequent authors ignored small, but factual differences within the species *Perca fluviatilis*, i. e. between the local population of the Danubian perch, and the rest of the Central European population.

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AN ADDITION TO THE CZECHOSLOVAK RECORDS OF MONOCYSTID GREGARINES

Václav PIŽL

**Institute of Soil Biology, Czechoslovak Academy of Sciences,
Na sádkách 7, 370 05 České Budějovice, Czechoslovakia**

Abstract. Two new species of monocystid gregarines, ***Nematocystis octodrili*** sp. n. and ***Rhynchocystis peristaltica*** sp. n. are described from South Bohemia, Czechoslovakia, parasiting lumbricid earthworms *Octodrilus argoviensis* and *Dendrobaena vejdovskyi*, respectively. Seven other species are reported as new for Czechoslovakia.

INTRODUCTION

Altogether twenty seven monocystids belonging to nine genera have now been identified from various host animals in Czechoslovakia. The first record of this group of acephaline gregarines (Protozoa, Apicomplexa, Monocystidae) was made in our country by Hahn (1928), who described a new species. *Monocystis mrazeki* from lumbriculid worms *Rhynchelmis limosella* and *R. komareki*. Since then, *Erhardová* (1955) described *Gregarina corolla* — by Levine (1977) placed into the new genus *Acarogregarina* — from oribatid mite *Scutovertex minutus*, and Pižl (1989) listed twenty five monocystid species from fourteen species of lumbricid earthworms.

During my recent investigation of the systematics and distribution of the parasites of terrestrial oligochaete worms in Czechoslovakia, additional nine monocystid species were found, two of these — *Nematocystis octodrili* and *Rhynchocystis peristaltica* — were new, and other seven were for the first time recorded in Czechoslovakia although they had been found by other European authors in the same or related hosts. The present paper is a review of the above species.

MATERIAL AND METHODS

Earthworms were dissected alive under tap water or earthworm's saline (0.65% NaCl solution). Each worm was opened by a median dorsal incision and the body cavity, nephridia, blood vessels, spermathecae and seminal vesicles were examined immediately for monocystid gregarines. Subsequently, smears were prepared from the lobes of seminal vesicles.

From enchytraeids, after having been found in their coelom, the parasite was released in water by the ruption of body wall.

Isolated trophozoites were observed and photographed alive and their dimensions recorded. Permanent smears, used in the study of morphological details, were occasionally made, fixed in sublimat-alcohol, stained in Ehrlich's hematoxylin, counterstained with eosin and mounted in Canada balsam.

Behind the names of localities, numbers of the quadrangles on the faunistic map of Czechoslovakia (Buchar, 1982) are given. Where there is no other indication, there applies leg. V. Pižl.

RESULTS

Nematocystis octodrili sp. n.

(Fig. 1)

Description: Elongated trophozoites are vermiform, each typically double-S-like shaped, measuring 1064—1140 × 57—76 μm (one specimen was only 659 μm long). Both anterior and posterior poles are convex with diameter of 55—68 μm depending on the size of trophozoite. The ectoplasm of the trophozoites is 3—4 μm thick. The epicyte is relatively thick, without any processes or cytopilia. The endoplasm is densely packed with small and spherical paraglycogen granules ranging from 2 to 4 μm in diameter. It also contains relatively large spherical nucleus, 24—32 μm, with a nucleolus 11.5—17 μm in diameter. The numerous cytoplasmic granules sometimes obscure the nucleus. Trophozoites move very slowly without evident peristaltic contractions.

Some observed associations of oocysts and gematocysts can not be simply considered as belonging to *M. octodrili* for all the host specimens studied were infected also by other gregarine species.

Diagnosis: Trophozoites vermiform, typically double-S-like shaped; body length 1064—1140 μm, breadth 57—76 μm; nucleus spherical, 24—32 μm; nucleolus 11.5—17 μm; paraglycogen granules 3—4 μm; with other characteristics of the genus.

Host: *Octodrilus argoviensis* (Bretcher, 1899) (Oligochaeta, Lumbricidae)
Location in host: seminal vesicles
Locality: Bohemia mer., Český Jílovec (7251), 9. 7. 1984, 28. 5. 1986, 27. 4. 1988
Type material: Syntype slides deposited in Institute of Soil Biology, Czechoslovak Academy of Sciences, České Budějovice, Czechoslovakia.

Etymology: The name of the new species is derived from the generic name of its type host *Octodrilus argoviensis.*

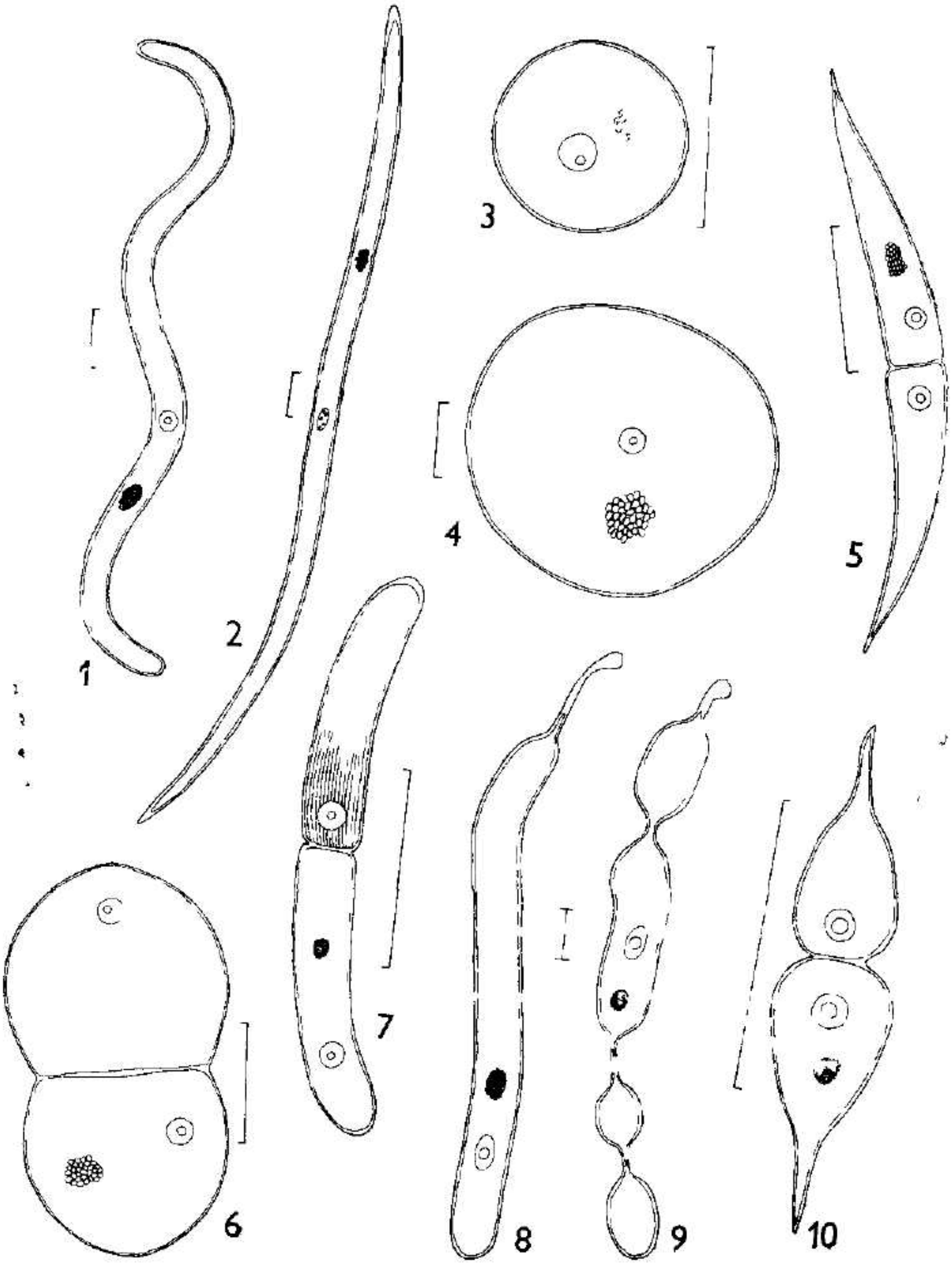
Remarks: Segun (1971) described *Nematocystis dendrobaenae* from the seminal vesicles of *Satchellius mammalis* (Savigny, 1826) and *Dendrodrilus rubidus subrubicundus* (Eisen, 1874). This elongated gregarine, the trophozoite of which measured 55—1568 × 14—110 μm, resembles somewhat to *N. octodrili.* But although the body dimensions of *N. octodrili* fall in the range of those of *N. dendrobaenae,* the trophozoites of the latter differ essentially in their shape (straight body, convex on the anterior pole but V-shaped on the posterior one) as well as in the shape and dimensions of the nucleus (*N. dendrobaenae* possess an elongated, ovoid, nucleus, 23—77 × 7.5—40 μm, containing several nucleoli) from the former. For these reasons, *N. octodrili* does not correspond to any of previously described *Nematocystis*-species.

Nematocystis vermicularis Hesse, 1909

(Fig. 2)

Trophozoites elongated, very slim, without mucron. The measurements vary from 1917 to 2582 μm long and 38 to 72 μm wide. Nucleus ovoid, 45—50 × × 20 μm, with several nucleoli. Paraglycogen granules 4 μm.

Host: *Aporrectodea longa* (Ude, 1885) (Oligochaeta, Lumbricidae)
Location in host: seminal vesicles
Localities: Bohemia mer., České Budějovice (7052), 28. 6. 1984, 13. 7. 1988; Bavorov (6850), 26. 4. 1984



Figs 1—10 Trophozoites of monocystid gregarines. 1. *Nematocystis octodrili* sp. n.; 2. *N. vermicularis* Hesse, 1909; 3. *Apolocystis dudichi* Bereczky, 1967; 4. *A. granulata* Tuzet et Loubatiéres, 1946; 5. *Zygocystis legeri* Hesse, 1909; 6. *Z. pagesi* Tuzet et Loubatiéres, 1946; 7. *Z. henleae* Meier, 1956; 8. *Rhynchocystis peristaltica* sp. n.; 9. Moving *R. peristaltica;* 10. *Oligochaetocystis mesenchytraei* Meier, 1956 (Scale = = 0.1 mm).

Other hosts: *Lumbricus terrestris* L., 1758; *L. rubellus* Hoffm., 1843; ***Pheretima barbadensis*** (Čern., 1934)

Distribution: India (Bhattia and Chatterjee, 1925), France (Hesse, 1909), Sweden (Berlin, 1924); new species for Czechoslovakia.

Apolocystis dudichi Bereczky, 1967

(*Fig.* 3)

Trophozoites oval to spherical, without any polar differentiations, 120—110 μm in diameter, nucleus 20—22 μm, excentrically located nucleolus 12 μm in diameter. Very small paraglycogen granules, 1—2 × 1 μm.

Host: ***Fitzingeria platyura platyura*** (Fitzinger, 1833) (Oligochaeta, Lumbricidae)
Location in host: seminal vesicles
Locality: Bohemia mer., Bavorov (6850), 7. 5. 1984
Other host: ***Fitzingeria platuyra depressa*** (Rosa, 1983)

Distribution: Hungary (Bereczky, 1967); new species for Czechoslovakia.

Apolocystis granulata Tuzet et Loubatiéres, 1946

(Fig 4)

Oval or spherical trophozoites do not possesss any ectoplasmic processes. Body dimensions of the oval forms vary from 440×350 μm to 535 × 380 μm, spherical forms 390—460 μm in diameter. Spherical nucleus 20—30 μm in diameter. Paraglycogen granules oval, large, 13 × 7—11 μm.

Host: ***Allolobophora chlorotica*** (Savigny, 1826) (Oligochaeta, Lumbricidae)
Location in host: seminal vesicles
Locality: Bohemia mer., České Budějovice (7052), 11. 11. 1985, 11. 5. 1987
Other host: ***Scherotheca gigas*** (Ant. Dug., 1828)

Distribution: France (Tuzet and Loubatiéres, 1946), Hungary (Bereczky, 1967); new species for Czechoslovakia.

Zygocystis legeri Hesse, 1909

(*Fig.* 5)

Trophozoites elongated, piriform, mostly in frontal syzygy, but solitary specimens relatively common. Body surface with indistinct striation, without ectoplasmic processes. Length of body 160—190 μm, breadth 31—43 μm. Nucleus spherical, 18—20 μm in diameter, nucleolus 7—12 μm, paraglycogen granules 6—8 × 3—5 μm. Oocysts 165—186 × 123—157 μm, sporocysts 17.7 × × 5.2 μm.

Host: ***Octodrilus argoviensis*** (Bretcher, 1899) (Oligochaeta, Lumbricidae)
Location in host: seminal vesicles
Locality: Bohemia mer., Český Jílovec (7251), 9. 7. 1984; 28. 5. 1986, 27. 4. 1988
Other host: ***Allolobophora chlorotica*** (Sav., 1826), ***Pheretina diffrigens*** (Baird, 1869)

Distribution: England (Miles, 1963), France (Hesse, 1909) Germany (Meier, 1956), USA (McMahan, 1975); new species for Czechoslovakia.

Zygocystis pagesi Tuzet et Loubatiéres, 1946

(Fig. 6)

Trophozoites early in frontal syzygy, no solitary specimens observed. Body spherical or oval, dimensions of the pair vary from 205 × 128 μm to 336 × × 205 μm, body without any ectoplasmic processes on the surface. Nucleus varies from 15.8 to 24.5 μm, nucleolus from 7.5 to 12.5 μm. Paraglycogen granules variably shaped, 4.7—5 μm in diameter.

Host: ***Allolobophora chlorotica*** (Savigny, 1826) (Oligochaeta, Lumbricidae)
Location in host: seminal vesicles
Locality: Bohemia mer., České Budějovice (7052), 17. 9. 1984, 10. 4. 1985, 15. 5. 1985, 10. 11. 1985
Other host: ***Scherotheca gigas*** (Ant. Dug., 1828)

Distribution: France (Tuzet and Loubatiéres, 1946); new species for Czechoslovakia.

Zygocystis henleae Meier, 1956

(Fig. 7)

Oval trophozoites in frontal syzygy, solitary specimens uncommon. Epicyte thin, with fine longitudinal striation. Length of the pair 280—307 μm, breadth 30—36 μm, nucleus spherical, 20—24 μm in diameter, with one nucleolus. Paraglycogen granules small, 1—2 μm in diameter.

Host: ***Cognettia sphagnetorum*** (Vejdovský, 1877) (Oligochaeta, Enchytraeidae)
Location in host: coelom
Locality: Bohemia mer., Libějovice (6950), 29. 5. 1985, leg. J. Chalupský jr.
Other host: ***Henlea ventriculosa*** (Udek., 1854)

Distribution: Germany (Meier, 1956); new species for Czechoslovakia.

Rhynchocystis peristaltica sp. n.

(Figs. 8, 9)

Description: Elongate trophozoites with rostrum forming cylindroconical trunk. Their bodies measure 1016 × 57 μm to 1197 × 133 μm. The ectoplasm is 2—3 μm wide in most specimens, the epicyte is very thin without any hair-like structures. Longitudinal myonemes are visible only in living animals. The irregular, but uniformly distributed paraglycogen granules in the endoplasm of the larger trophozoites are small, 2—4 μm long. The nucleus is large, ovoid, 54—66 μm long and 26—28 μm wide, and contains one spherical nucleolus, 22—24 μm in diameter. Trophozoites undergo very conspicuous peristaltic movement with the characteristic irregular beads formation along their whole length. There may be seen up to six such beads at a time (Fig. 9). During this movement, the bulge of endoplasmic content divides and one part of it then pours through a narrow contracted passage into a relaxed portion of the trophozoite, resulting in a new swelling. When this portion of body is partly filled, another passage is formed and the content pours into the next bulge. The contractions move from one end to the other, causing progressive movement of the trophozoite.

No oocysts and/or spores were found.

Diagnosis: Very active trophozoites with cylindroconical trunk; body length 1016—1197 μm, breadth 57—133 μm; nucleus oval, 54—66 × 26—28 μm; nucleolus 22—24 μm in diameter; paraglycogen granules small, 2—4 μm; with other characteristics of the genus.

Host: *Dendrobaena vejdovskyi* (Černosvitov, 1953) (Oligochaeta, **Lumbricidae**)
Location in host: seminal vesicles
Locality: Bohemia mer., Purkarec (6852), 20. 5. 1985
Type material: Syntype slides deposited in Institute of Soil Biology, Czechoslovak Academy of Sciences, České Budějovice, Czechoslovakia.

Etymology: The species name is derived from the conspicuous peristaltic movements of trophozoites.

Remarks: This monocystid parasite belongs to the genus *Rhynchocystis* on the account of its metabolic rostrum. Trophozoites of *R. peristaltica* resemble those of *Rhynchocystis porrecta* (Schmidt, 1854) Hesse, 1909 in their body dimensions, however, the former possess much larger nucleus and nucleolus than the latter. Moreover, there are differences in the shape of the posterior pole of the body (convex in *R. peristaltica* against V-shaped in *R. porrecta*).

Oligochaetocystis mesenchytraei Meier, 1956

(Fig. 10)

Trophozoites club-shaped, always in frontal syzygy. Body length 150—170 μm, breadth 36—41 μm, spherical nucleus 11—13 μm in diameter, nucleolus 6 μm in diameter. Paraglycogen granules 1—2 × 2 μm.

Host: *Mesenchytraeus glandulosus* (Levinsen, 1884) (Oligochaeta, Enchytraeidae)
Location in host: coelom
Locality: Bohemia mer., Libějovice (6950), 8. 5. 1985, leg. J. Chalupský jr.
Other host: *Mesenchytraeus flavidus* (Mich., 1887)

Distribution: Germany (**Meier**, 1956); new species for Czechoslovakia.

SUMMARY AND CONCLUSIONS

Two new species of monocystid gregarines are described parasiting Czechoslovak earthworms — *Nematocystis octodrili* sp. n. from *Octodrilus argoviensis* and *Rhynchocystis peristaltica* sp. n. from *Dendrobaena vejdovskyi*. Seven other species — *Nematocystis vermicularis, Apolocystis dudichi, A. granulata, Zygocystis henleae, Z. legeri, Z. pagesi* and *Oligochaetocystis mesenchytraei* are new to the Czechoslovak record. As new hosts, *Allolobophora chlorotica* for *Z. pagesi, Octodrilus argoviensis* for *Z. legeri, Cognettia sphagnetorum* for *Z. henleae* and *Mesenchytraeus glandulosus* for *O. mesenchytraei*, are established. Monocystid gregarines of *Dendrobaena vejdovskyi, Octodrilus argoviensis, Cognettia sphagnetorum* and *Mesenchytraeus glandulosus* are reported for the first time. Together with the records presented here, the list of Czechoslovak Monocystidae contains 36 species now.

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JÄHRLICHE ÄNDERUNGEN IN ABHÄNGIGKEIT VON DER HORMONMENGE IM BLUTPLASMA BEI DER ROSTGANS (TADORNA FERRUGINEA) (AVES)

Zdeněk VESELOVSKÝ

Zoologischer Garten, 171 00 Praha 7-Troja, Tschechoslowakei

Abstract. In consideration of the importance of the influence of hormons on the behaviour, the level of testosteron in males as well as in females has been demonstrated graphically. The annual level of LH-hormon attains, like the testosteron, a peak in springtime I have found a similar positive correlation in the lutenisation hormon and in estradiol in females. Another hormon, where at breeding time the highest level in males as in females is to be found is the prolactin, in males nursing the youngs while the females are moulting the period of high level of prolactin is longer than in females. The last hormon, the annual level of which has been identified, is the progesteron, where in females the level is higher in winter and early spring. This hormon evidently inhibits the secreation of LH. The hormons have been ascertained in periodical monthly blood samples collected from specified pairs. The hormonal level correlates positively with the identified behaviour and it shows that an identification of the levels of the individual hormons have fundamental significance for understanding the motivation of the behaviour. This survey served to show the mutual connection and hormonal induction of the organism.

EINLEITUNG, MATERIAL, METHODIK

Wenn wir den circaannualen Verlauf des Verhaltens der Rostgans verfolgen, können wir deutlich eine ganze Reihe von Motivationen zu den einzelnen Verhaltenselementen finden. Diese Motivationen, welche mit dem Bilden des Paares, dem Schutz des Territoriums, dem Nestverhalten und der Migration im Zusammenhang stehen, haben sehr enge Beziehungen zu dem hormonalen Spiegel und selbstverständlich auch den endogenen Zyklen. Da vor allem die Hormone eine tragende Rolle als Integrationssystem des Organismus durch Motivierung der längerdauernden Änderungen des Verhaltens spielen, versuchte ich an drei Paaren der Rostgans ihren Blutspiegel zu messen Diese Messungen habe ich ein ganzes Jahr durch vorgenommen, den Spiegel der Steroide hat Dr. Píchová, CSc., vom Forschungsinstitut für Biofaktoren und Veterinararzneimittel in Jílové bei Prag festgesetzt. Die übrigen Hormonspiegel habe ich durch die Liebenswürdigkeit der Zoological Society London, Wildfowl Trust in Grossbritanien erhalten, da ich persönlich die benötigten Radioimmunoassays und Antiserum nicht zur Verfügung hatte. Ich würde gerne bereits in der Einleitung bemerken, dass es erst um eine erste Versuchsübersicht geht, in welcher ich die Rostgans als Vorlage benutzt habe; und zu einer absolut genauen Festlegung müssen auch bei anderen Arten ähnliche Werte erhalten werden. Eine weitere schwerwiegende Realität, welcher wir uns bewusst sein müssen, ist, dass die Hormone, vorrallem ihr Einklang oder Antagonismus auf die Rezeptoren wirken und direkt bestimmte Gebiete des zentralen Nervensystems aktivieren. Die bisherigen Erkenntnisse über den Einfluss der Hormone (Balhazart, 1983) zeigen auch die Rückbindung der Hormone aus den Erfahrungen des Tieres, aber auch aus der Tatsache, dass die Bildung der Hormone stark durch das Verhalten der Tiere beeinflusst wird. Dieser gegenseitige Zusammenhang zwischen dem Verhalten und den hormonalen Einflüssen ist einer der interessantesten, aber auch sehr wenig erforschten Gebieten bei freilebenden Arten. Die bisherigen Erkenntnisse wurden vor allem bei Laboratoriumsvögeln oder Säugetieren gewonnen.

Das Lutenisationshormon

Das LH der Adenophyse auf der Abbildung 1 hat einen sehr hohen Wert bei beiden Geschlechtern in der Vorfrühlings- und Frühlingsperiode (ng/ml auf der senkrechten Achse), welche im April vor der Eierlegung kulminiert. Zu diesem Zeitpunkt haben wir ein Maximum an agressivem und sexuelem Verhalten festgestellt. Den zweiten Höhepunkt finden wir sowohl bei den Männchen wie auch den Weibchen im Mai und Juni, wenn die Weibchen die Eierbebrütung beenden und beide Elterntiere gemeinsam anfangen, die Jungen zu betreuen. Im Laufe der Inkubation ist bei beiden Geschlechtern ein sichtbarer Rückgang zu bemerken. Dieser Verlauf entspricht den ermittelten Daten Donhhams (1976), und Farners und Folletts (1979) bei *Anas platyrhynchos* und vor allem Dittamis (1981) bei *Anser indicus*. Diesen Verlauf finden wir nach den angegebenen Autoren bei erfolgreich nistenden Paaren, wobei bei Paaren, welche nicht gebrütet haben, der zweite Höhenpunkt nicht vorhanden ist. Nach den gegenwärtigen Erkenntnissen gibt es einen Bezug zwischen LH und Testosteron und Oestradiol, welche offensichtlich unter seiner Kontrolle stehen. Bei dem Vergleichen der Abbildung 3. sehen wir einen klaren Zusammenhang zwischen dem Höhepunkt des Testosteronspiegels und dem LH-Spiegel. Eine ähnliche positive Korrelation finden wir auch im Oestradiolspiegel und dem LH bei den Weibchen (Abbildung 4.). Nach Farner und Follett (1979) beschränkt der Lutenisationshormon das Vermehren der Produktion von gonadotropen Hormonen und verursacht eine Regression der Gonaden. Diese Frage ist bisher jedoch noch nicht bei allen Vögeln zufriedenstellend geklärt, da es diametral entgegengesetzte Ergebnisse im Zusammenhang mit der Photoperiodizität gibt. Stokkan und Sharp (1980) haben bei der Gattung *Lagopus* festgestellt, dass bei durch längere Lichttage stimmulierten Vögeln der LH-Spiegel durch das Ansteigen des Testosteron gesunken ist.

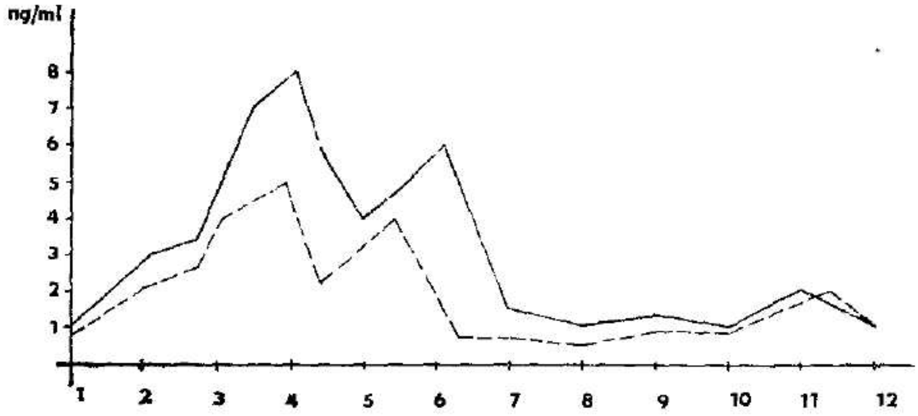

Abb. 1. *Tadorna ferruginea* Jahresverlauf LH, Männchen — volle Linie, Weibchen — unterbrochene Linie, Achse x — Monate, Achse y — Hormonspiegel.

Die Abbildung 3 zeigt am Testosteronspiegel, dass bei absinkendem Spiegel dieses Hormons der LH-Spiegel sichtbar ansteigt. Meiner Meinung nach beeinflusst nicht nur das Testosteron, aber auch das LH gemeinsam die agonistischen Verhaltensweisen der Vögel. Im Hinblick auf die Regression der Gonaden nach dem Nisten, muss das agressive Verhalten beider Elternteile zur Zeit des Führens der Jungen erhöht werden. Da offensichtlich die gonadotropen Hormone in grösserem Masse von der Photoperiodizität abhängig sind, dienen diese vorhandenen hohen Mengen von LH bei den Männchen als Ersatz für das fehlende Testosteron. An dem Jahresverlauf des Spiegels dieses Hormons sehen wir ganz klar, dass sich gerade der zweite Höhepunkt beim Männchen mit dem Schutz des brütenden Weibchens und dem Zeitpunkt des

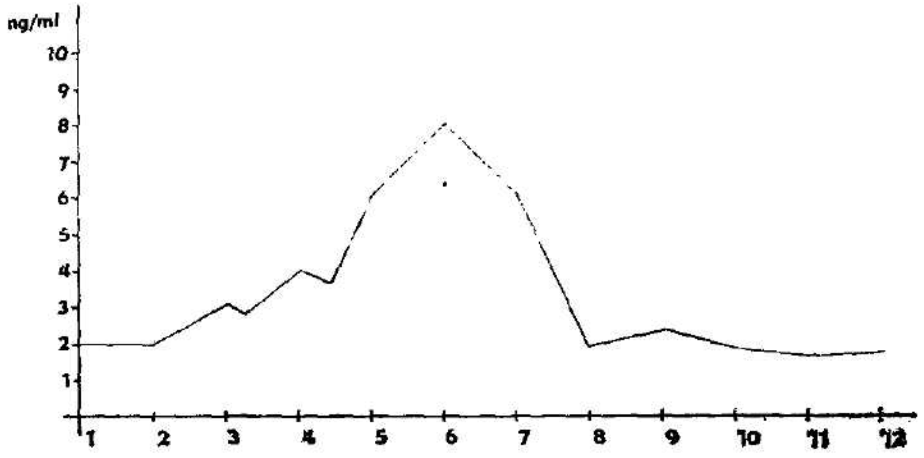

Abb. 2a. *Tadorna ferruginea* Prolaktin — Männchen, Achse x — Monate, Achse y — Hormonspiegel.

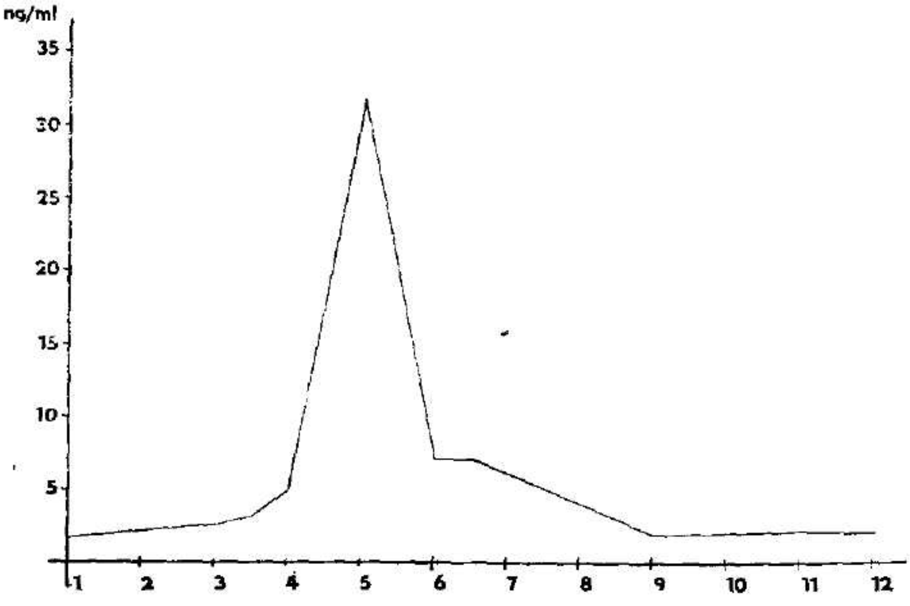

Abb. 2b. *Tadorna ferruginea* Prolaktin — Weibchen, Achse x — Monate, Achse y — Hormonspiegel.

Fuhrens der Jungen deckt. Es gibt auch eine gewisse Möglichkeit, auf welche Gwinner (1964) bei Kolkraben aufmerksam machte, dass eine durch LH verursachte bestimmte sexuale Aktivität auch für die Paare, welche beständige eheliche Bündnisse haben, notwendig ist Dies wird auch durch übereinstimmende Ergebnisse bei Rostgänsen und Streifengänsen (Dittami, 1981) bestätigt.

Es ist klar, dass das LH eine wichtige Rolle beim Beeinflusse der Gonaden spielt, aber gleichzeitig zeigt sich hier auch der Einfluss auf das antagonistische Verhalten wie zur Zeit der Verteidigung des Territoriums, so auch beim Brutverhalten. Interessant ist, dass die Paare, welche erfolgreich Junge hochgezogen haben und auch einen hohen LH-Spiegel nach der Nistung haben, sozial in den Gruppen der Vögel höhergestellt sind als Vögel, welche erfolglos genistet haben.

Das Prolaktin (LTH)

Das Prolaktin wird gleichfalls von der Adenophyse produziert. Sein Jahresspiegel beim Männchen und Weibchen wird in den Abbildungen 2a und 2b veranschaulicht. Der Verlauf ist bei beiden Geschlechtern unterschiedlich. Bei den Weibchen ist er zur Zeit der Inkubation auffällig hoch, beim Männchen dagegen steigen die Titer bereits zum Zeitpunkt der Inkubation und sinken erst beim Mausern wieder.

Beim Vergleich mit dem LH-Spiegel sehen wir, vorallem ist dies bei den Weibchen auffällig, dass es hier ein negatives Verhältnis beider Hormone gibt Den höchsten Prolaktinspiegel gibt es beim Absinken des LH. Die hohen Prolaktinwerte bei nistenden Weibchen sind im Einklang mit seinem Einfluss auf das Nisten bei Anseriformes [Goldsmith und Williams (1980)]. Nach diesen Autoren erhält sich dieser höhere Prolaktinspiegel auch nach der Inkubation der Weibchen, welche erfolgreich Junge aufgezogen haben. Wir wissen, dass das Prolaktin bei vielen Wirbeltieren für die Brutpflege verantwortlich ist. Ich persönlich erkläre mir die Verlegung des Prolaktinspiegels bei den Männchen als Adaptation auf die Verlägerung der Brutpflege und Jungenführung bis zum Mausern, wenn die Jungen voll erwachsen und selbstständig sind. Da das Weibchen die Schwungfedern etwas früher als das Männchen mausert und infolgedessen flugunfähig ist, übernimmt das Männchen eine grossere Verantwortung für den Schutz der Jungen. Ich nehme deshalb an, dass der hohe Prolaktinspiegel beim Männchen sichtlich eine biologische Begründung hat.

Das Testosteron

Bei den Männchen der Tadornini finden wir eine auffällige Erhöhung des Testosterons (Abbildung 3.) im Vorfrühling, vor allem im April, mit einem Maximum vor der Eierlegung. Dieses Maximum entspricht der Kurve der Kopulationshäufigkeit. (Abbildung 5). Danach sinkt der Testosteronspiegel und ist von Juli bis September am niedrigsten um im Herbst — im November wieder anzusteigen. Dieses Ansteigen im Herbst kann wieder biologisch erklart werden, und zwar damit, dass im Herbst in den Überwinterungsorten eine höhere Aktivitat in den Scharen entstehn, welche mit der Bildung von Paaren in Zusammenhang steht. Da offenbar bei Tadornini die ehelichen Verbindungen nicht immer beständing sind, häte dieses Erhöhen der sexualen Aktivität, welche uns bei Enten bekannt ist, biologische Bedeutung. Zwischen dem Testosteronspiegel und dem LH-Spiegel gibt es eine positive Korrelation, im Gegensatz dazu wurde eine signifikante negative Korrelation zwischen dem Testosteron und dem Prolaktin gefunden. Bei den Weibchen wurden, im Gegensatz zu den allgemeinen biologischen Angaben, *verhältmismässing hohe* Testosteronspiegelwerte in der Vornistzeit festgestellt. Ein ähnliches Erhöhen des Testosterons bei Weibchen fand Farner (1979) und Follett bei *Anas platyrhyncha* und Dittami (1981) bei *Anser indicus*. Einerseits ist sicher, dass das Testosteron für das Balzverhalten und das Sexualverhalten verantwortlich ist, das herbstliche Erhöhen spielt jedoch scheinbar eher eine soziale Rolle, denn auch *wenn sich die Paare zu der Zeit paaren, sind das eher Andeutungskopulationen*, andererseits haben mehrere Autoren z. B. Brain (1977), Wingfield und Farner (1978) und weitere auf die grosse Wichtigkeit des Testosterons fur die *Erhöhung* der *Aggressivität* hingewiesen. Die maximale Anzahl der hetzenden Äusserungen des Weibchens zum Angriff des Männchens, dessen positive Reaktion eine unmittelbare Reizung für seine Auswahl der Partnerin vorstellt, ist bei den Weibchen im März und April. Es ist deshalb kein Zufall, dass die Aggressivität der Weibchen durch den hohen Testosteronspiegel beeinflusst wird. Die Anzahl der aggressiven Äusserungen des Männchens zeigt auch zu diesem Zeitpunkt eine maximale Anzahl von Angriffen.

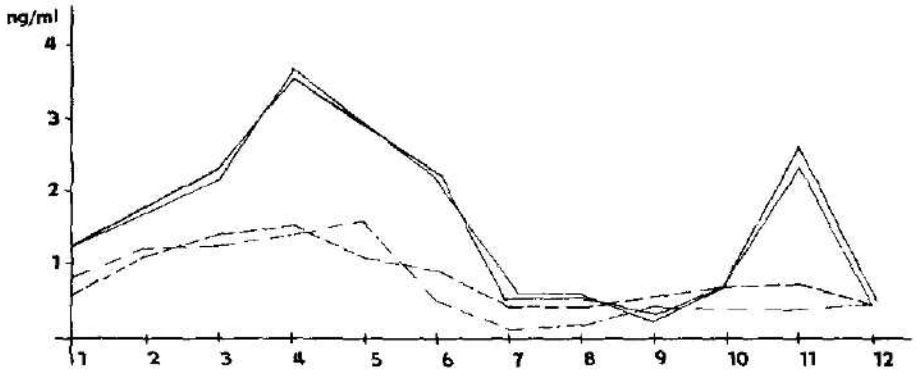

Abb 3 *Tadorna ferruginea* Testosterone, Mannchen — volle Linie, Weibchen — unterbrochene Linie, Achse x — Monate, Achse y — Hormonspiegel.

Das Oestradiol

Bei den Weibchen ist der höchste Oestradiolspiegel (Abbildung 4) im April vorhanden. Zwischen dem LH und dem Oestradiolspiegel gibt es eine signifikante positive Korrelation. Bei dem Männchen wurden nur niedrige, sichtlich unwirksame Oestradiolspiegel gefunden, das ganze Jahr hindurch völlig gleichbleibend. Ausser Testosteron wurde auch beim Oestradiol bewiesen, dass es bei dem Weibchen nicht nur auf ein erhöhtes sexuales Verhalten Einfluss hat, aber auch auf ein aggressives Verhalten. Noble (1972) zeigt dies bei *Wachteln*, Wingfield und Farner (1978) bei Singvögeln und weiteren. Im allgemeinen kann gesagt werden, dass Androgene und Oestrogene ausser der grundlegenden sexualen Rolle auch eine Aufgabe im sexualen Verhalten der Rostgans mit einem Anwachsen der Aggressivitat spielen.

Das Progesteron

Bei Männchen wie auch bei Weibchen wurde im Laufe des Jahres ein Progesteronspiegel festgelegt. Die Weibchen hatten hauptsächlich im Winter, aber auch im Vorfrühling einen erhöhten Spiegel, bei den Männchen veränderte sich der Spiegel imlaufe des Jahres überhaupt nicht. Bei den Vögeln ist über dieses Hormon nicht viel bekannt, seine Erhöhung inhibiert die Sekretion des LH, dies würde der bei den Weibchen festgestellten Situation entsprechen.

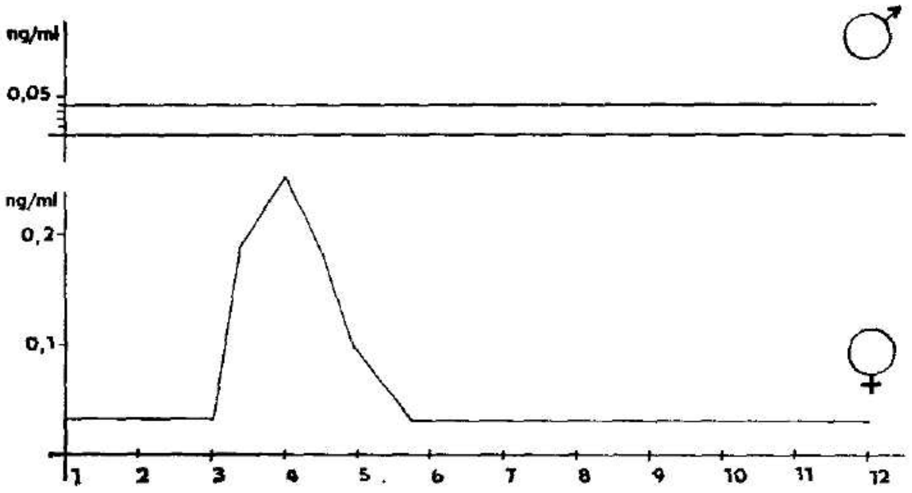

Abb. 4. *Tadorna ferruginea* Oestradiolspiegel im Laufe des Jahres, oben — Männchen, unten — Weibchen, Achse x — Monate, Achse y — Hormonspiegel.

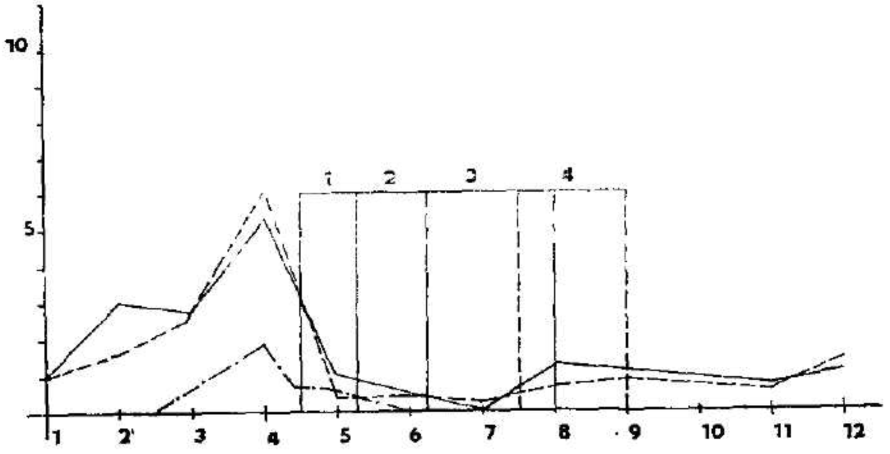

Abb. 5. *Tadorna ferruginea* Jahresverlauf des Hetzens Triumphverhalten und Kopulation. Auf der Achse y Anzahl der Äusserungen des Vogels im Laufe von 5 Stunden. Achse x — Monate Volle Linie — Hetzen. Unterbrochene Linie — Triumphverhalten. Unterbrochene Linie — Kopulation. 1. Eierlegung, 2. Brüten, 3. Jugenführung, 4. Komplette Mauser.

DISKUSSION

Diese Übersicht sollte den gegenseitigen Zusammenhang des Verhaltens und der hormonalen Induktion des Organismus zeigen. Ich bin mir dessen bewusst, wie ich dies bereits in der Einleitung betont habe, dass dies nur eine Übersicht der Mechanismen bei einer einzigen Art vorstellt. Nach der gegenwärtigen Literatur, vorallem den bereits zitierten Arbeiten Balthazarts und seiner Mitarbeiter (1983), gibt es viele Unterschiede und das nicht nur unter den einzelnen Gruppen von Lebewesen, aber auch bei einzelnen Arten im Einfluss der Hormone auf die Motivationen des Verhaltens. Es ist bekannt, dass bei Vögeln, wie in Versuchen bewiesen, z. B. der Bau des Nestes nur durch das Nervensystem geleitet werden kann, wobei bei anderen Arten auch eine hormonale Stimulation notwendig ist. Die Oestrogene rufen z. B. den Nestbau beim Wellensittich bei bereits erfahrenen Vögeln schneller hervor, als bei Weibchen die noch nicht genistet haben. Eine weitere bedeutungsvolle Erkenntnis, die ich betonen will, ist die Tatsache, dass die Hormone zwar ein Tier zu einer bestimmten Tätigkeit motivieren können, in keinem Fall können sie jedoch die Form des Verhaltens, welches nur durch das zentrale Nervensystem koordiniert wird, ändern.

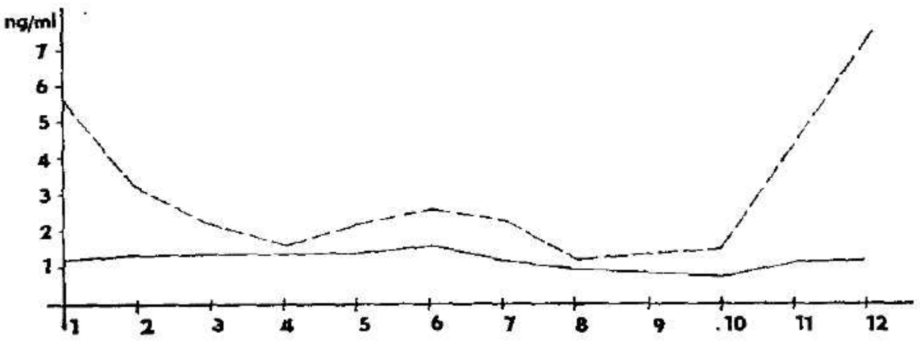

Abb. 6. *Tadorna ferruginea* Progesteronspiegel im Blut, Männchen — volle Linie, Weiochen — unterbrochene Linie, Achse x — Mnate, Achse y — Hormonspiegel.

Eine grosse Bedeutung haben Hormone im Beeinflussen der Kommunikationssignale, die Androgene bestimmen das Hochzeitskleid des Mannchens, sie kommen in den verschiedensten akustischen Signalen beider Partner zur Geltung. Der hormonale Spiegel hat jedoch auf die Rezeptoren Einfluss, bei den Vögeln das Prolaktin die Empfindlichkeit der Bauchpartien beim Berühren der Eier im Nest, was bei Anseriformes zum Ausrupfen der Nestdunen führt, mit welchen das Weibchen das Nest auslegt und die Eier zudeckt.

Eine grosse Bedeutung haben Hormone auch für das Beinflussen bestimmter Gruppen von Neuronen. Beim Nisten zum Beispiel aktivieren sich vorallem die Gebiete des Hypothalamus and zwar bei dem Weibchen sowie bei Männchen. Eine Implantation von Testosteronkristallen in die seitlichen Teile des Zwischenhirns erhölt beim Hahn die Aggressivitat, eine Implantation in das praeoptale Gebiet ruft im Gegensatz dazu eine Kopulation hervor.

Den grössten Einfluss haben Hormone bei frühen Entwicklungsstadien des Organismus, wo sie, im Gegensatz zu den Erwachsenen, Änderungen viel andauernder Charakters vorrufen können.

Hoch eine abschliessende Bemerkung zum Einfluss des Verhaltens auf die Bildung von Hormonen. Zum Beispiel ein Blick auf ein Ei oder das Berühren eines Eies bei isolierten Vögeln kann in kurzer Zeit eine höhere Produktion von Prolaktin hervorrufen. Bei Anseriformes, wo eine gemeinsame Balz verläuft, ruft dieses Verhalten auch eine bestimmte hormonale Synchronisation bei allen Tieren hervor. Die Balz hat eigentlich im Wesentlichen nicht nur in der Bildung der Paare Hauptbedeutung, aber bei Vögeln auch in der notwendigen hormonalen physiologischen Synchronisation beider Partner zum Vermehren. In zentralen Nervensystem existieren sensitive Gebiete für eingehende hormonale Informationen, im Gegensatz dazu gibt es hier auch neurohumoral wirkende Neurone, welche bei gewissen Wahrnehmungen Neurosekrete zur Beeinflussung der Tätigkeit der Drüsen mit interner Sekretion bilden.

ZUSAMMENFASSUNG

Mit Hinsicht auf die grosse Bedeutung der hormonalen Einflüsse auf das Verhalten wurden die Testosteronspiegel bei Männchen wie auch Weibchen, der Jahresspiegel des LH-Hormons, welcher, ähnlich wie beim Testosteron im Frühling kulminiert, graphisch vorgestellt. Eine ähnliche positive Korrelation zwischen dem LH-Hormon fand ich auch beim Oestradiol bei den Weibchen. Ein weiteres Hormon, dessen höchster Spiegel bei Weibchen und Männchen zur Nistzeit vorkommt, ist das Prolaktin, bei Männchen, die zur Zeit des Mausern der Weibchen die Jungen betreuen, ist der hohe Prolaktinspiegel länger vorhanden als bei Weibchen. Das letzte Hormon, dessen Jahresspiegel bestimmt wurde, war das Progesteron, wo bei Weibchen zur Winter- und Vorfrühlingszeit ein erhöhter Spiegel vorliegt. Dieses Hormon inhibiert sichtlich die Sekretion des LH. Die Hormone wurden aufgrund regelmässiger monatlicher Blutmuster festgelegt, diese Muster wurden markierten Paaren entnommen. Der Hormonspiegel korrelativ positiv mit dem festgestellten Verhalten und es zeigt sich, dass die Erkenntnis der Spiegel der einzelnen Hormone zum Verständnis der einzelnen Hormone grundlegend wichtig ist. Diese Übersicht soll gleichzeitig den gegenseitigen Zusammenhang des Verhaltens und der hormonalen Induktion der Hormone zeigen.

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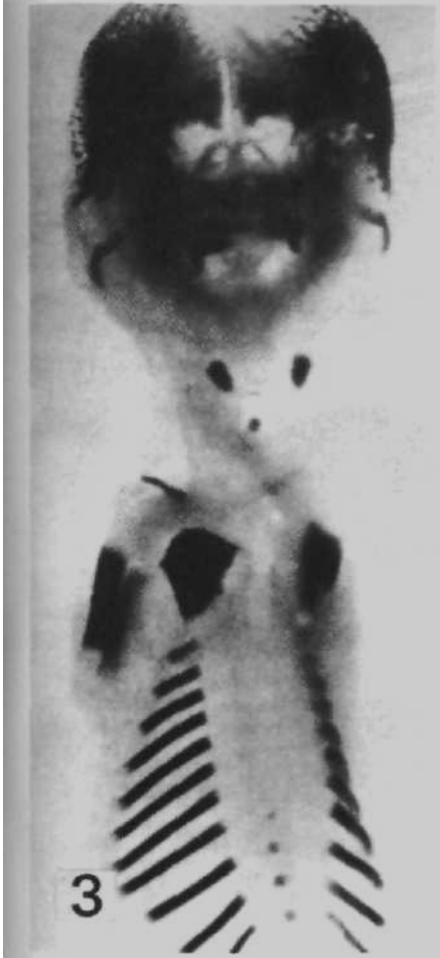

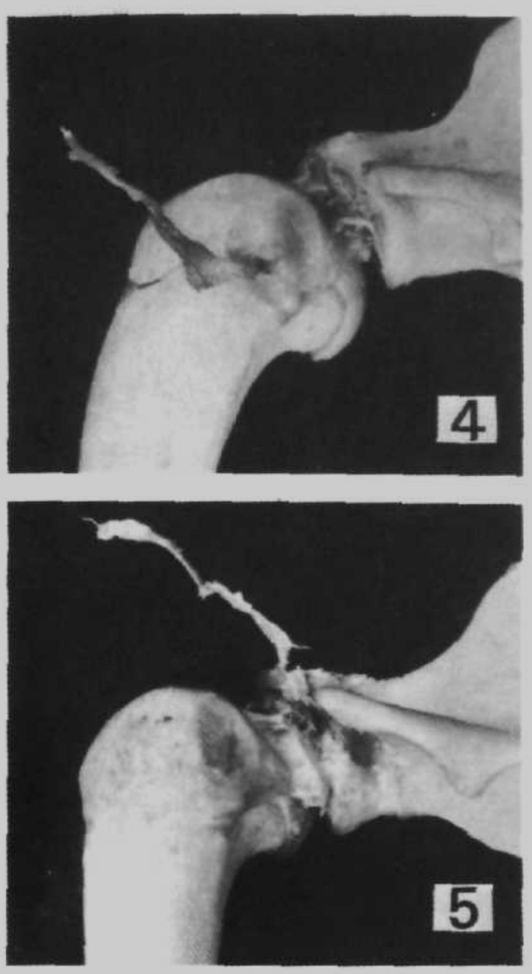

Fig. 3. Foetus of the Domestic cat *(Felis silvestris* f. *catus)* in embryonal age of about 31 days. Ossified right-side clavicle is well visible. Cleared and stained in ammoniacal alizarin-red solution after Porkert (1971). Frontal view.

Fig. 4—5. Insertion of fibrous stripe upon tuberculum majus humeri (coll. No 12050, subadult specimen, Fig. 4) and upon tuberositas supraglenoidalis scapulae (coll. No. 12033, Fig. 5). Clavicle was segregated of free end of the stripe (see text). Lateral view from the left.

Photos: M. Keil (3) and I. Heráň (4, 5)

1

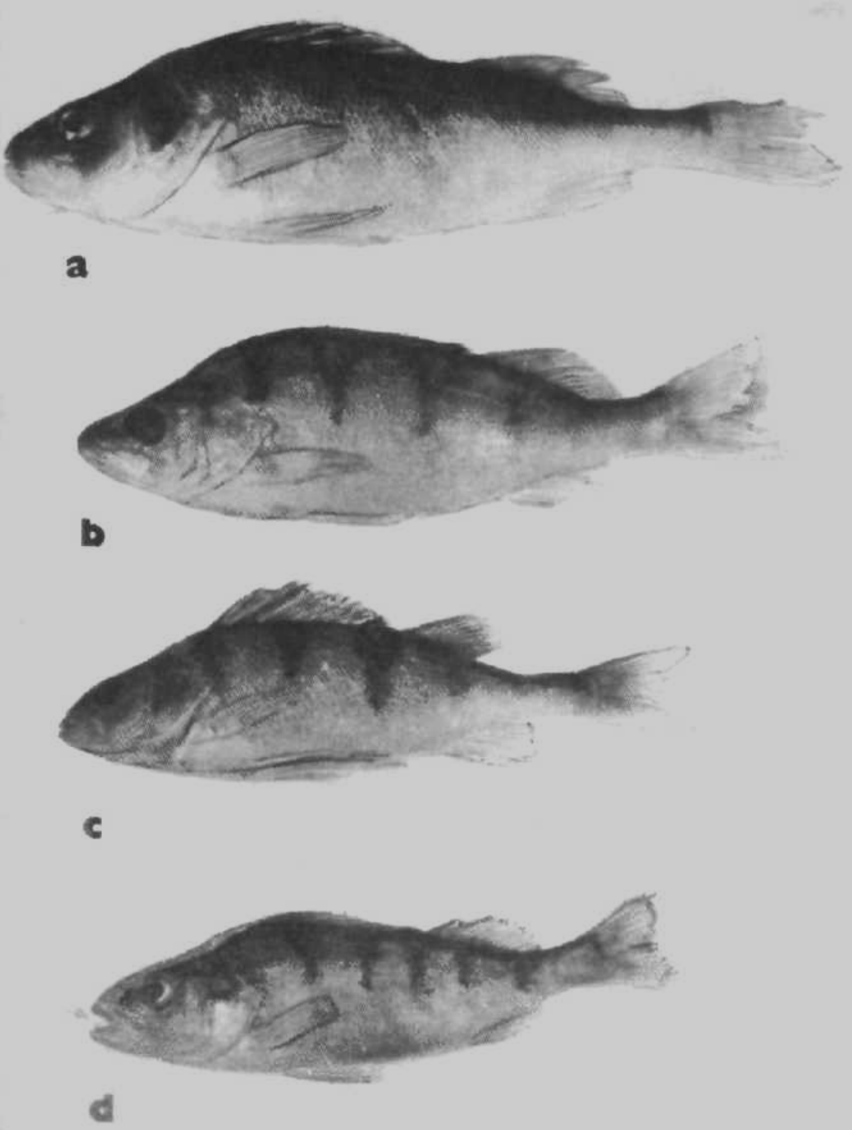

Plate 1. Specimens of the perch (*Perca fluviatilis*) caught during years 1951—57 in the reservoir Vranovská nadrž. a — No. Coll. 6592, of the depository of Dept. of Syst. Zool. Charles University. TL 217 mm, BL 186 mm, W 105 g, female, b — No. Coll. 6590, TL 180 mm, BL 153 mm, W 70 g, male, c — No. Coll. 27832. TL 160 mm, BL 140 mm, W 37 g, female, d — No. Coll. 6595, TL 155 mm, BL 121 mm, W 40 g, male.

2

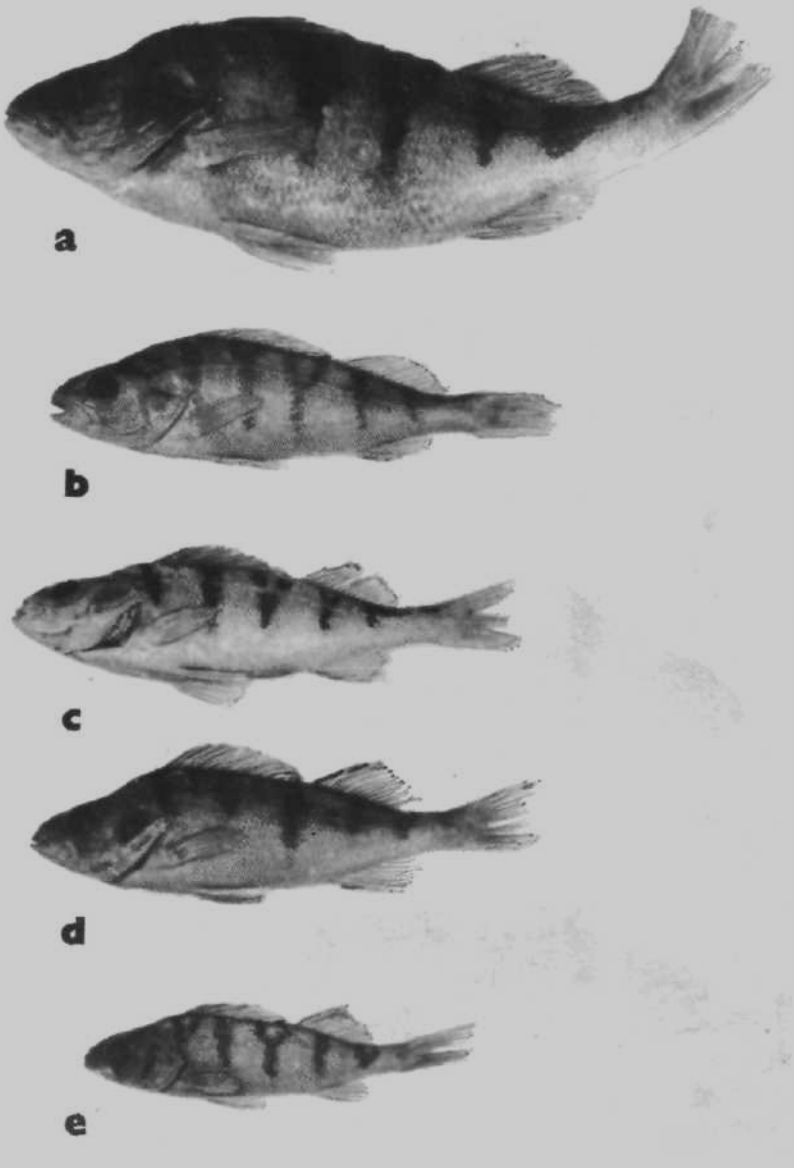

Plate 2. Specimens of the perch (*Perca fluviatilis*) caught in the river Morava near Hodonín in the year 1950; a — No. Coll. 5280, TL 203 mm, BL 180 mm, W 120 g, female, b — No. Coll. 5278, TL 131 mm, BL 111 mm, W 29 g, c — No. Coll. 5270, TL 130 mm, BL 114 mm, W 24 g, d — No. Coll. 5272, TL 131 mm, BL 114 mm, W 25 g, e — No. Coll. 5271, TL 100 mm, BL 85 mm, W 10 g.

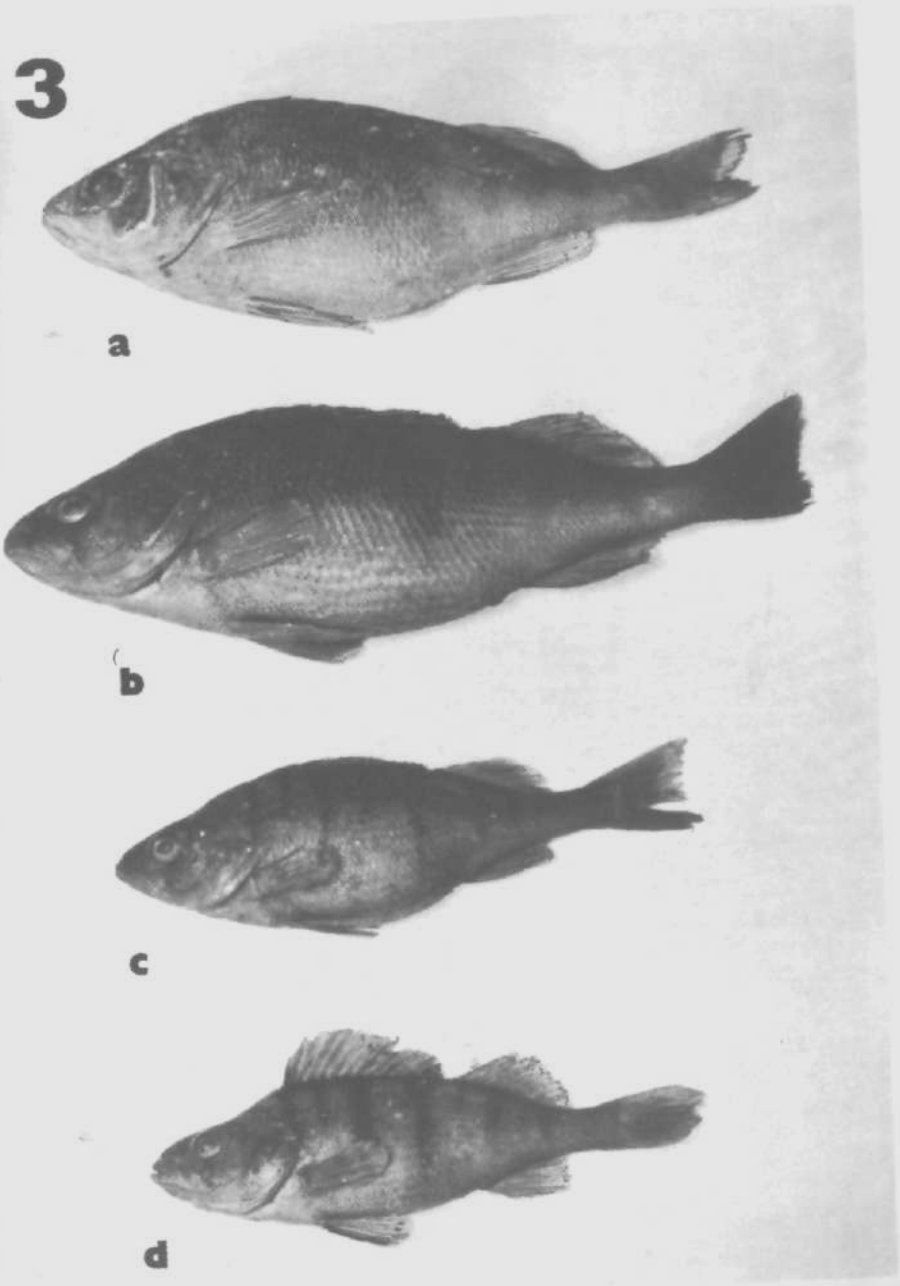

Plate 3. Specimens of the perch *(Perca fluviatilis)* caught in the river Danub
during years 1950—51; a — No. Coll. 4526, locality Čelistovo, TL 188 mm, BL 160 mn
W 110 g, female, b — No. Coll. 6442, locality Štúrovo, TL 213 mm, BL 186 mm,
147 g, female, c — No. Coll. 6444, locality Štúrovo, TL 150 mm, BL 131 mm, W 48
female, d — No. Coll. 6443, locality Štúrovo, TL 139 mm, BL 123 mm, W 37 g, femal

4

Plate 4. The perch *(Perca fluviatilis)* caught in the pond Žehuňský rybník on 9th Oct. 1951, No. Coll. 9056, TL 306 mm, BL 270 mm, W 480 g, male.

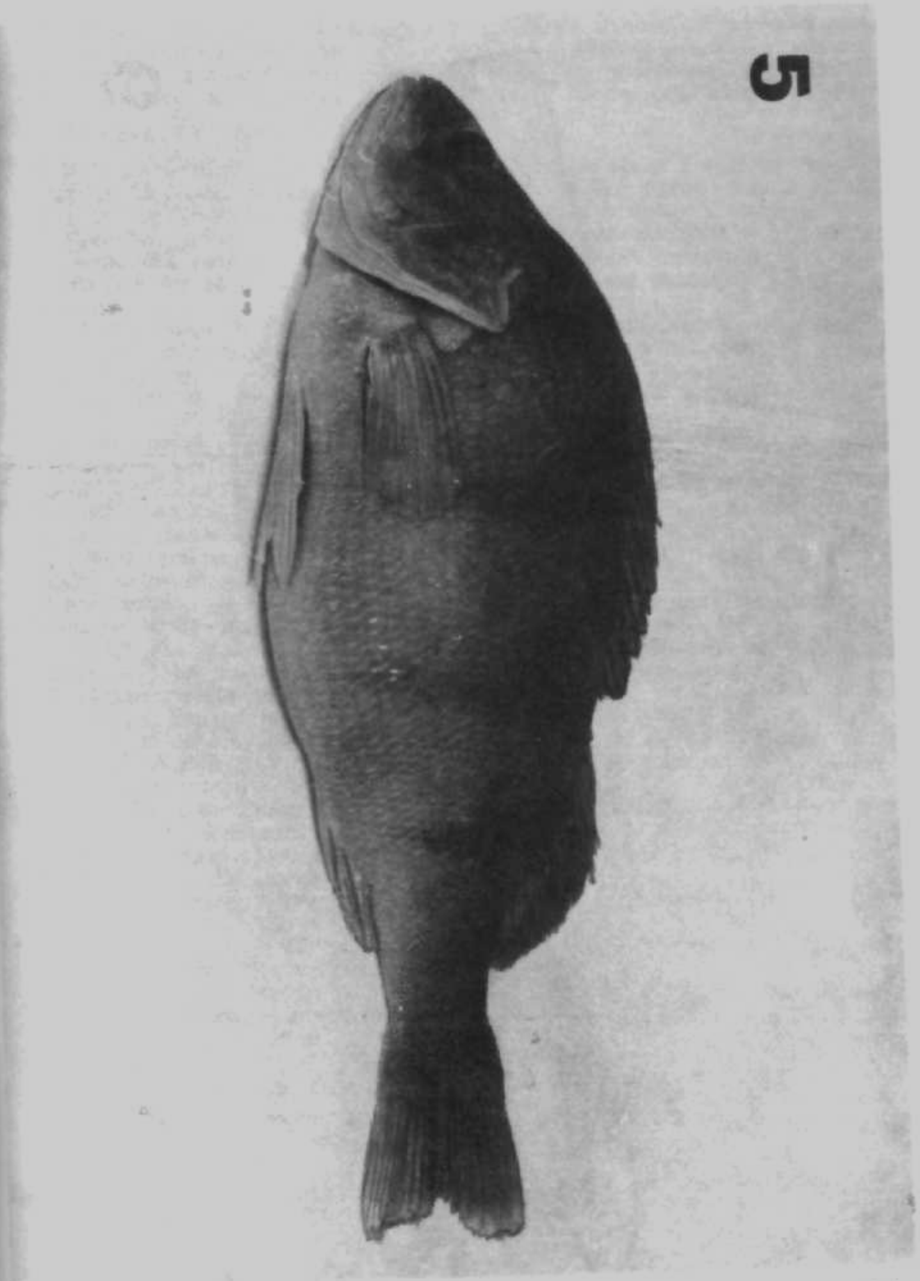

Plate 5. The perch (*Perca fluviatilis*) caught in the pond Rožmberk on Oct. 1949, No. Coll. 3507, TL 307 mm, BL 263 mm, W 500 g, female.

6

Plate 6. The perch *(Perca fluviatilis)* caught in the pond Máchovo jezero on 24th Oct. 1951, No. Coll. 9084, Tl 360 mm, BL 312 mm, W 770 g, male. All photos L. Hanel.

POKYNY PRO AUTORY

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

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

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