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Cygnus verae sp. n. (Anseriformes: Anatidae) from the Early Pliocene of Sofia (Bulgaria)

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Abstract. The site, discovered in 1995, reveals the s.c. Lozents suite, dated Early Pliocene (Ruscinian), MN 14. Three species of vertebrate (a fish, a reptile and a bird) have been established. One bone fragment (a proximal part of a left humerus, No NMNHS 1644 – holotype) belongs to an undescribed swan. A review of fossil swans and a morphological comparison of the find are presented.

Key word: Fossil birds, Anatidae, Early Pliocene, Ruscinian fauna, Bulgaria.

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I. INTRODUCTION

The site was discovered in April 1995 during the building excavation (foundation of a block) in the "Lozenets" residential district in Sofia (UTM grid GN 02) at a depth of 6,0-6,5 m, by the building engineer Raycho SHUMANOV. It is referred to the s.c. "Lozenets" suite (formation) and is dated back to the Early Pliocene (Early Ruscinian), MN 14, ca. 5 Ma (Dr. Nicolay SPASSOV – pers. comm.). The associated fauna, indicating aquatic habitat, consists of *Silurus serdicensis* TOULA, 1877-1878 and Chelonia fam. indet. (BOEV, 1996). The systematics of recent swans follows CARBONERAS (1992).

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II. SYSTEMATIC PART

The fossil record of swans

According to BRODKORB (1964) the fossil swans belong to 5 genera: *Cygnopterus* LAMBRECHT, 1931, *Cygnavus* LAMBRECHT, 1931, *Cygnanser* KRETZOI, 1957, *Olor* WAGLER, 1832, and *Cygnus* BECHSTEIN, 1803. *Cygnopterus affinis* (VAN BENEDEN, 1883) is described from the Middle Oligo-

cene in Belgium, *Cygnavus senckenbergi* LAMBRECHT, 1931, is known from the Lower Miocene in Germany, *Cygnanser csavarensis* (LAMBRECHT, 1933) is reported from the Lower Pliocene in Hungary, while the finds of *Olor hibbardi* (BRODKORB, 1958) originate from the Lower Pleistocene of Idaho. Because of the considerable age differences they may all except *C. csavarensis* be excluded from our comparison (see bellow).

Later a distinct swan was described from the Oligocene of Azerbaijan – *Guguschia nailie* ASLANOVA and BURCHAK-ABRAMOVICH, 1968 – a species dimensionally closest to the recent *Cygnus bewickii* (YARRELL, 1830) but anatomically clearly different from the genus *Cygnus* (ASLANOVA and BURCHAK-ABRAMOVICH, 1968). In addition, *Cygnavus formosus* KUROCHKIN, 1968 was described from the Lower Oligocene of Zaysan in Eastern Kazakhstan.

Five fossil species were described in the genus *Cygnus* (BRODKORB 1964): *Cygnus herrenthalsii* VAN BENEDEN, 1871 from the Upper Miocene in Belgium (phalanx), *Cygnus falconeri* (PARKER, 1865) from the Middle Pleistocene of Malta (tibiotarsus, tarsometatarsus, toe phalanx), *Cygnus lacustris* (DEVIS, 1905) from the Upper Pleistocene of Australia (coracoid, humerus, tibiotarsus, tarsometatarsus, pelvis), *Cygnus sumnerensis* (FORBES, 1889) from the Quaternary in New Zealand (coracoid, humerus) and *Cygnus paloregonus* COPE, 1878 from the Middle Pleistocene of Oregon and Idaho (tarsometatarsus, furcula, carpometacarpus, scapula, cervical vertebrae). Additionally, NORTHCOTE (1992) put *Anser equitum* (BATE, 1916) and MLIKOVSKY (1992) put *Anser atavus* LAMBRECHT, 1933 in this genus. KUROCHKIN (1971) describes *Cygnus pristinus* from the Upper Pliocene deposits from the Hung-Kure locality in Western Mongolia. Later KUROCHKIN (1976) describes additional finds of that species from other sites in Western Mongolia. Unfortunately, among the finds a distal but not proximal epiphysis is found. Besides the lack of comparative material, the taxonomical identity of *C. verae* sp. n. and *C. pristinus* KUROCHKIN (1971) could be rejected also because of the statement of the author that "*C. pristinus* stands among the largest swans by their absolute sizes." (p. 58).

In older literature the recent species *Cygnus cygnus* (LINNAEUS, 1758) and *Cygnus buccinator* RICHARDSON, 1832, together with *Cygnus columbianus* (ORD, 1815), and *Cygnus bewickii* were placed in the genus *Olor* WAGLER, 1832, but lately CARBONERAS (1992) in his general review of swans of the world regards the four taxa as species/subspecies of g. *Cygnus*.

Cygnus verae sp. n.

H o l o t y p e: humerus sin. prox. (Fig. 1 a, b, c), collections of the Fossil and Recent Birds Department of the National Museum of Natural History – Sofia, Bulgarian Academy of Sciences, NMNHS 1644. Collected in April 1985 by Mr. Raycho SHUMANOV.

L o c a l i t y: Juzhen park (South Park), Lozenets quarter in Sofia City, Sofia District, 42°39'N, 23°17'E.

H o r i z o n: rust-coloured sands and clay sands of oblique and complex inner stratification at a depth of 6,00-6,50 m.

C h r o n o l o g y: Early Pliocene; Russcinian, MN zone 14 (5,0 – 4,5 mya).

E t y m o l o g y: The name "*verae*" is given after the name of Miss Vera HRISTOVA.

M e a s u r e m e n t s: see Table 1; Fig 4.

D i a g n o s i s : An Early Pliocene swan, differing from the recent *Cygnus* species in its well developed insissura capitis, which width in the narrowest place constitutes no less than one third of the width of the caput humeri, whereas in all other Palearctic species it is less than one third.

C o l l e c t i o n a c r o n y m s: NMNHS – Natural Museum of Natural History – Sofia; ISEAK – Institute of Systematics and Evolution of Animals – Kraków.

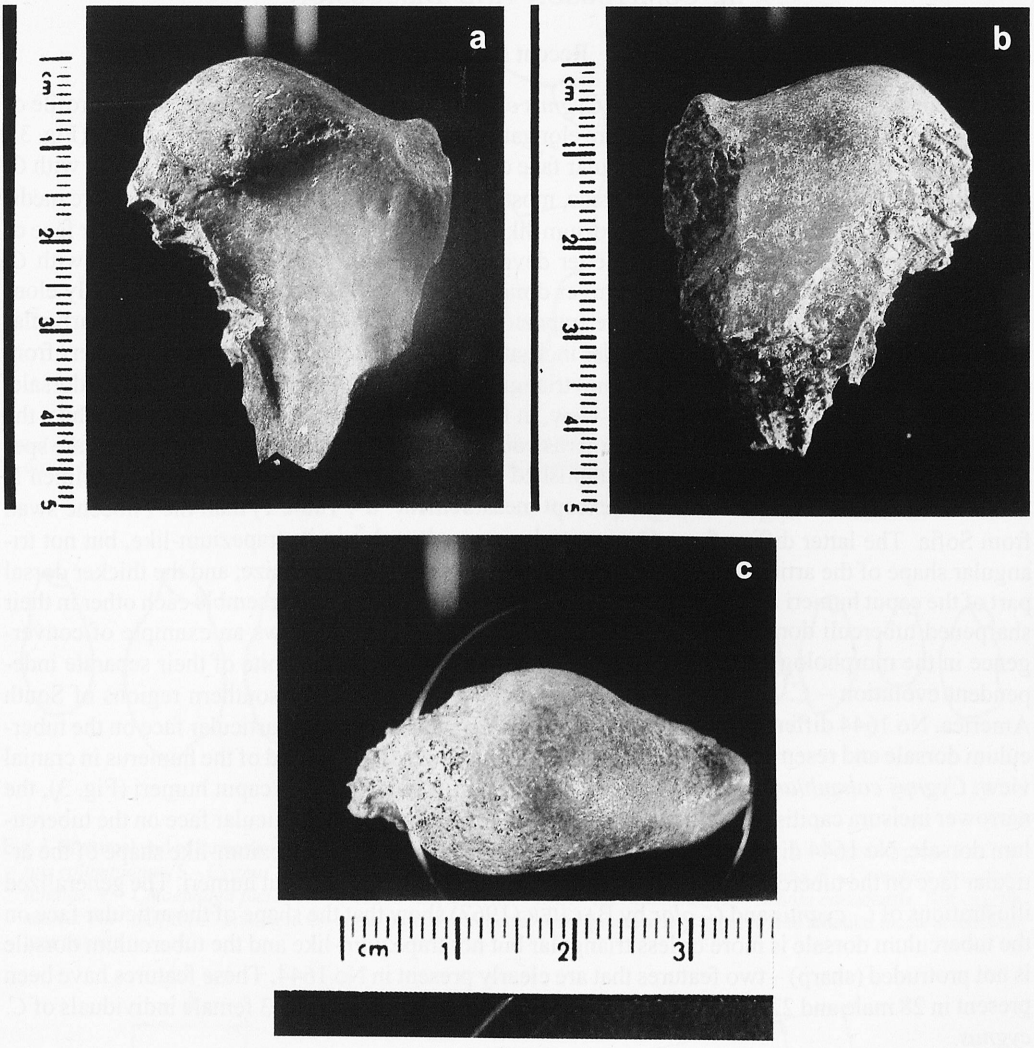

Fig. 1. *Cygnus verae* sp. n.: humerus sin. prox. (holotype), No NMNHS 1644: a – lateral view; b – medial view; c – cranial view. (Photograph: Boris Andreev).

Comparative material examined: The find was compared with analogous skeletal elements of the following species: *Cygnus cygnus* – ISEAK A-2064/69; *Cygnus olor* – NMNHS 4/1989, 5/1989, 6/1989, 7/1990, 8/1994, 9/1995, 10/1995, 12/1996, 15/1997; *Cygnus melanocoryphus* – ISEAK A-4615/89, A-4616/89; *Cygnus columbianus* – ISEAK A-4102/84, A-5002/84; *Cygnus atratus* – NMNHS 4/1992, 5/1997, ISEAK A-5145/93; *Coscoroba coscoroba* – ISEAK A-1657/66; *Chauna torquata* – *ISEAK* A-2291/70; *Chloephaga picta* – ISAEK A-2865/73; *Cereopsis novaehollandiae* – ISAEK A-5178/93; *Anser albifrons* – NMNHS 1/1989; 2/1989; 3/1989; 5/1992, ISEAK A-1651/66; *Anser erythropus* NMNHS 1/1986; 2/1989; 4/1990; *Anser anser (dom.)* NMNHS 3/1991; 4/1991; *Anser caerulescens* – ISEAK A-2573/72; *Branta canadensis* NMNHS 1/1989, ISEAK A-4942/91.

III. COMPARISON AND DISCUSSION

Recent swans

The compared specimen differs from *Cygnus columbianus* in its sharp in medial view profile of the tuberculum dorsale (Fig. 2), in the more elongated dorsally caput humeri in cranial view (Fig. 3), and the more triangular shape of the articular face of the tuberculum dorsale. In comparison with *C. olor*, the specimen No 1644 has: smaller size, most protruding part of the caput humeri, more medially positioned in cranial view, more trapezium-like, but not triangular shape of the articular face of the tuberculum dorsale, narrower and better developed incissura capitis. In comparison with *C. atratus*, the specimen under study has: larger dimensions (Table 1; Fig. 4, 5), more dorsally elongated caput humeri in cranial view, more trapezium-like, but not triangular shape of the articular face of the tuberculum dorsale, and a wider incissura capitis. The specimen from Sofia differs from *Cygnus cygnus* in its trapezium-like, but not triangular, shape of the face on the tuberculum dorsale, and its more sharpened profile in medial view, in the same way as *Cygnus columbianus.* Thus, the comparison of the proximal end of the humerus confirms that both *columbianus* and *cygnus* are species of the genus *Cygnus*, besides the established differences in comparison with the specimen N 1644. It seems that *C. cygnus* is larger (except measurement "a", Table 1) than the Pliocene swan from Sofia. The latter differs from *Cygnus melanocoryphus* also in its trapezium-like, but not triangular shape of the articular face on the tuberculum dorsale, the larger size, and the thicker dorsal part of the caput humeri in cranial view (Fig. 3). On the other hand, they resemble each other in their sharpened tuberculi dorsales. This feature is very important and it shows an example of convergence in the morphology of the proximal end of the humeral bone, in spite of their separate independent evolution – *C. melanocoryphus* being an endemic species for southern regions of South America. No 1644 differs from *Coscoroba coscoroba* in the shape of the articular face on the tuberculum dorsale and resembles it in the bottle-like shape of the proximal end of the humerus in cranial view. *Cygnus columbianus* differs from *C. cygnus* in its relatively wider caput humeri (Fig. 3), the narrower incisura capitis, and the triangular but not round shape of the articular face on the tuberculum dorsale. No 1644 differs from *C. columbianus* and *C. olor* in its trapezium-like shape of the articular face on the tuberculum dorsale and the bottle-like shape of the caput humeri. The generalized illustrations of *C. cygnus* and *C. olor* by BACHER (1967) show that the shape of the articular face on the tuberculum dorsale is more or less triangular but not trapezium-like and the tuberculum dorsale is not protruded (sharp) – two features that are clearly present in No 1644. These features have been present in 28 male and 22 female individuals of *C. olor* and 34 male and 23 female individuals of *C. cygnus*.

It must be mentioned that the correlation between the measurements "a" (width of the caput humeri) and "e" (minimum width of the incissura capitis) used in the species diagnosis is right only in the adult individuals. It is seen, in the juvenile specimen of Holarctic swans (*C. olor*, N NMNHS 8/1994 for example), that such correlation may exist in juveniles. As was mentioned above, the Sofia specimen is an adult individual, that had completely finished its growth development. We accept that the remaining species of the genus *Cygnus* (the Australian *C. atratus* and the South-American *C. melanocoryphus*) have native independent origin in the Pliocene and their morphological differences were shown above.

Fossil swans

The Upper Miocene *C. herrenthalsi* (see above) unfortunately is known only from a toe phalanx. *Cygnus falconeri* had limited flight capabilities (NORTHCOTE 1992), that must have affected the morphology of the humerus, unfortunately unknown for that species up so far. The other Maltese swan, *Cygnus equitum* BATE, 1916, was a dwarf form, the smallest known swan. The proximal extremity of its humeral bone resembles *C. cygnus*, but its body mass was estimated at barely 3,5 kg

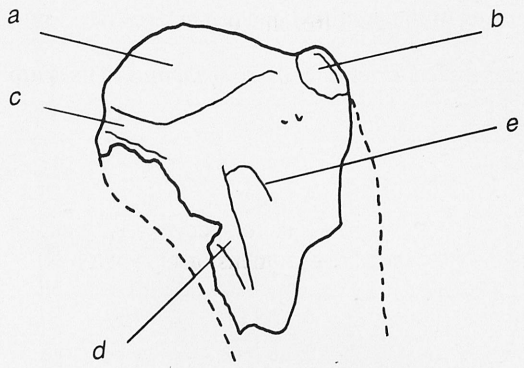

Fig. 2. The morphological features of the proximal ending of humerus in the gnus *Cygnus*: a – caput humeri; b – tuberculum dorsale; c – incissura capitis; d – longitudinal groove; e – crus dorsae fosale.

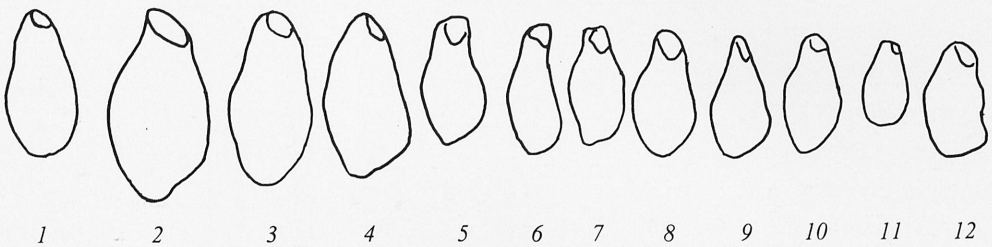

Fig. 3. Proximal end of humerus, medio-cranial view: 1 – *Cygnus verae* sp. n., 2 – *Cygnus olor*, 3 – *Cygnus cygnus*, 4 – *Cygnus columbianus*, 5 – *Cygnus atratus*, 6 – *Cygnus melanocoryphus*, 7 – *Coscoroba coscoroba*, 8 – *Cereopsis novaehollandiae*, 9 – *Chloephaga picta*, 10 – *Chauna torquata*, 11 – *Anser caerulescens*, 12 – *Branta canadensis*. Not exactly scaled. The "nail-form" ending in the upper part of silhouettes corresponds to dorsal part of the articular facete at tuberculum dorsale.

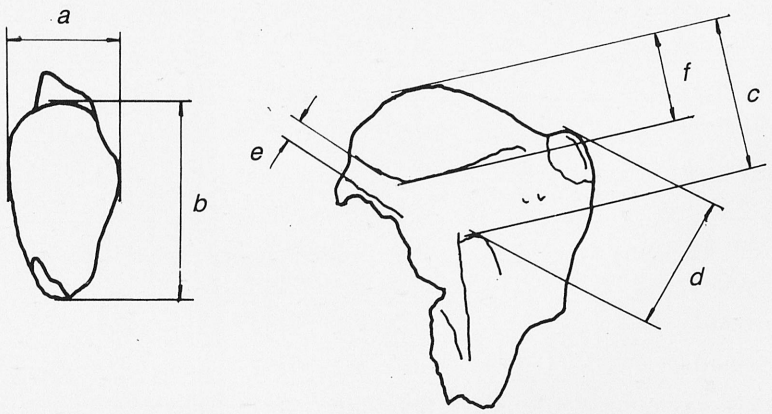

Fig. 4. The manner of measurings proximal humerus in *Cygnus*: a – tchickness of caput humeri; b – length of caput humeri; c – longitudinal distance of crus dorsae fosale; d – diagonal distance of crus dorsae fosale; e – smallest width of incissura capitis; f – height of caput humeri. The measurements "c" and "d" are barely definable in some of the individuals and they are of minor value. (Drawing: Vera HRISTOVA).

Table I

The measurements of the proximal end of humerus (see Fig. 4)

Species	a	b	c	d	e	f	a:e	b:f	f:e
Fossil									
Cygnus verae sp. n. NMNHS 1644	18.0	33.6	23.8	20.4	5.8	17.1	3.10	1.96	2.94
Recent									
Cygnus olor NMNHS 4/1989	17.0	36.6	ca. 30.0	ca. 23.0	–	–	–	–	
Cygnus olor NMNHS 5/1989	16.9	33.6	29.7	–	7.3	16.6	2.31	2.02	2.27
Cygnus olor NMNHS 6/1989 sad	15.0	31.2	31.4	–	5.8	15.7	2.58		2.70
Cygnus olor NMNHS 7/1990	18.2	36.5	24.1	25.2	–	–	–	–	
Cygnus olor NMNHS 8/1994 juv	17.7	37.5	29.3	22.9	5.7	17.7	3.10	1.65	3.10
Cygnus olor NMNHS 9/1995	18.0	35.2	27.5	ca. 23.5	6.5	19.0	2.76	1.85	2.92
Cygnus olor NMNHS 10/1995 sad.	16.0	31.3	31.3	–	5.5	16.3	2.90	1.92	2.96
Cygnus olor NMNHS 12/1996 sad.	15.0	32.0	27.0	22.5	6.0	16.5	2.50	1.93	2.75
Cygnus olor NMNHS 15/1997	18.2	38.8	30.5	20.5	6.9	18.9	2.63	2.06	2.73
Cygnus cygnus ISEAK A-2064/69	16.6	36.0	21.3	20.8	4.4	16.5	3.77	2.18	3.75
Cygnus atratus NMNHS 2/1991 ad.	13.6	26.3	16.2	16.8	3.9	13.2	3.48	1.99	3.38
Cygnus atratus NMNHS 3/1991 ad.	14.2	28.6	18.2	17.9	4.3	14.0	3.30	2.04	3.25
Cygnus atratus NMNHS 4/1992 ad.	14.8	26.5	ca. 19.8	ca. 18.8	–	–	–	–	
Cygnus atratus NMNHS 5/1997	15.2	30.3	25.5	17.9	4.8	14.8	3.16	2.04	3.08
Cygnus columbianus ISEAK A-4102/84	16.5	28.4	20.5	19.3	3.4	16.6	4.85	1.71	4.88
Cygnus melanocoryphus ISEAK A-4615/89	13.4	24.0	18.7	17.6	3.8	14.3	3.53	1.68	3.76
Cygnus melanocoryphus ISEAK A-4616/89	13.0	22.0	16.7	15.0	3.1	12.7	4.19	1.73	4.09
Coscoroba coscoroba ISEAK A-1657/66	13.6	23.7	15.6	16.3	3.6	13.3	3.78	1.78	3.69
Cereopsis novaehollandiae ISEAK A-5178/93	15.0	21.4	ca. 16.5	ca.16.2	–	15.3	–	–	–
Chloephaga picta ISEAK A-2865/73	14.9	ca. 21.0	–	–	3.2	14.6	4.65	1.44	4.56
Anser albifrons NMNHS 1/1989	10.4	21.7	18.7	12.8	–	–	–	–	–
Anser albifrons NMNHS 2/1989	11.0	22.0	20.9	–	–	–	–	–	–
Anser albifrons NMNHS 3/1989	10.8	22.0	17.4	12.0	3.8	12.2	2.84	1.80	3.21
Anser albifrons NMNHS 5/1992	11.4	21.6	18.6	–	4.3	11.7	2.65	1.84	2.72
Anser albifrons ISEAK A1651/66	11.0	19.9	–	–	2.3	11.6	4.78	1.71	5.04
Anser erythropus NMNHS 1/1986	12.5	21.3	15.5	ca.13.0	–	–	–	–	–
Anser erythropus NMNHS 2/1989	10.0	19.2	16.0	11.3	–	–	–	–	–
Anser erythropus NMNHS 4/1990	10.0	20.2	16.2	12.0	–	–	–	–	–
Anser caerulescens ISEAK A-2573/72	10.9	14.9	10.5	10.2	3.5	10.5	3.11	1.42	3.0
Anser anser domestica NMNHS 3/1991	14.5	29.8	21.0	–	–	–	–	–	–
Anser anser domestica NMNHS 4/1991	14.5	28.7	20.5	–	3.8	15.6	3.81	1.83	4.10
Branta canadensis ISEAK A 4942/91	13.2	22.3	ca. 13.8	ca. 15	3.0	14.2	4.4	1.57	4.73
Branta canadensis NMNHS 1/1989	13.0	21.5	21.2	12.3	–	–	–	–	

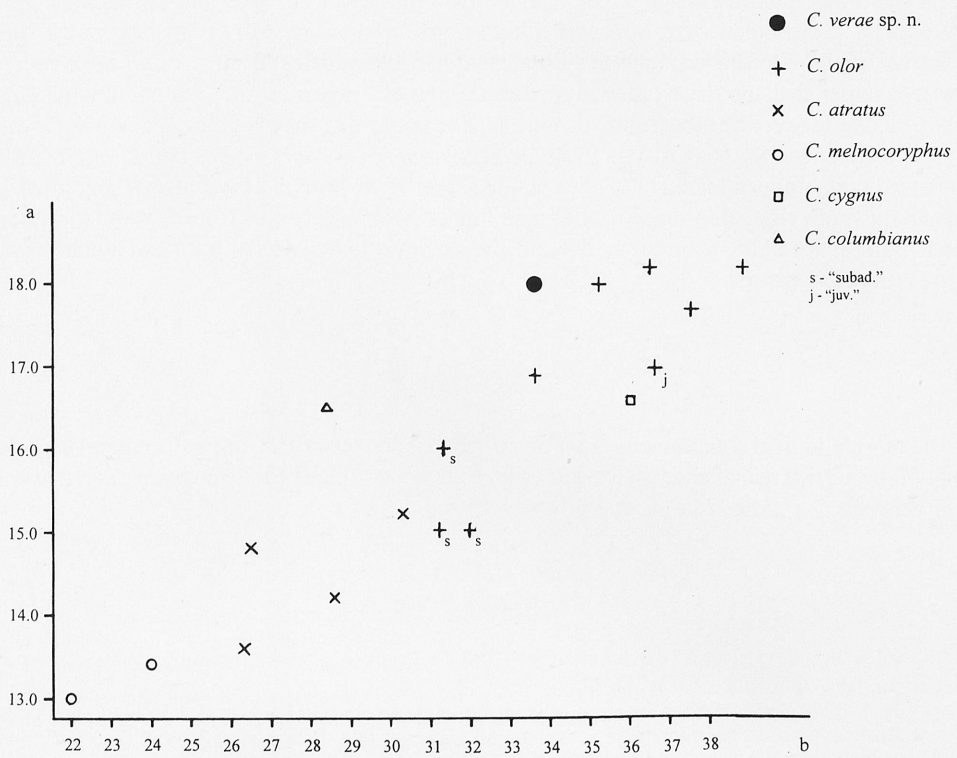

Fig. 5. Correlation between the measurements "a" and "b " in the species of g. *Cygnus*.

and with a wing span of 1,5 m (NORTHCOTE 1992). Metrical and age (Middle Pleistocene, c. 125 000 B.P.) differences allow us to exclude both Maltese swans of our comparison. *Cygnopterus affinis* (VAN BENEDEN, 1883) may be excluded owing to its older age – Middle Miocene (BRODKORB 1964). *Cygnavus senckenbergi* LAMBRECHT, 1931, *Cygnavus formosus* and *Cygnanser csakvarensis* (LAMBRECHT, 1933) are not represented by homologous bones. Therefore we exclude these fossil genera from our considerations. MLIKOVSKY (1992) proposed a new combination for *Cygnanser csakvarensis* LAMBRECHT, 1933 – *Olor csavarensis* (LAMBRECHT, 1933). This species is known from the Upper Miocene (MN 10) by the right and left carpometacarpus and phalanx 1 digiti majoris (MLIKOVSKY 1992), i.e. the Bulgarian find cannot be compared with its remains. *Cygnavus senckenbergi* LAMBRECHT, 1931 (MN 2) is known by a femur, distal tibiotarsus and pedal phalanx and also cannot be compared. *C. formosus* is known by a distal tibiotarsus, and owing to the considerable chronostratigraphical differences may also be excluded from our comparison. *Cygnus atavus* is known from the Middle/Upper Miocene (MN 7) of Germany by a femur dex. prox. (MLIKOVSKY 1992; BOCHEŃSKI 1997). This species is also incomparable because of the lack of homologous skeletal elements.

Recent geese

Cygnus verae sp. n. differs from *Branta canadensis* in its larger dimensions and more asymmetrical shape of the caput humeri in cranial view. The cranial view of the caput humeri in *Branta* is more or less rectangular, but not bottle-like (Fig. 3). As a whole the genus *Cygnus* differs from *Branta* by the spindle-shaped, but not the rectangular shape of the caput humeri. *Cygnus* does not

have a sharp tuberculum dorsale either. The metrical differences between the two genera are also very clear. The specimen from Lozenets differs from *Chloephaga picta* in its larger size, and its bottle-like (or spindle-shaped) but not abrupt caput humeri. It differs from *Cereopsis novaehollandiae* in its larger size, the sharp tuberculum dorsale, and the trapezium-like, but not the round shape of the articular face on the tuberculum dorsale and the bottle-like shape of the caput humeri. Besides metrical differences No 1644 differs from the genus *Anser* (*A. caerulescens* and *A. albifrons* were compared) in its trapezium-like, but not triangle shape of the articular face on the tuberculum dorsale and the more elongated shape of the caput humeri. The differences from *Chauna torquata* are shown in the shape of the tuberculum dorsale, the narrower dorsal part of the caput humeri, and the narrower incisura capitis.

CONCLUSION

The morphological comparison shows that the Early Pliocene find from Sofia cannot be referred to any of the known recent and fossil swans. Fig. 5 shows the intermediate position of *Cygnus verae* sp. n. between *C. cygnus, C. olor* and *C. atratus*.

REFERENCES

ASLANOVA S. M., N. I. BURCHAK-ABRAMOVICH 1968. A fossil swan from the Maykopian series of Azerbaydzhan. Acta zool. cracov., **13**(14): 325-343.

BACHER A. 1967. Vergleichend morphologische untersuchungen an Einzelknochen des postrkranialen Skeletts in Mitteleuropa vorkommmender Schwäne und Gänse. – Inst. Palaeoanat., Domestikationsforschung und Geschichte der Tiermedizin. Univ. München, 1-109.

BOCHEŃSKI Z. 1997. List of European fossil bird species. Acta zool. cracov., **40**(2): 293-33.

BOEV Z. N. 1996. Tertiary avian localities of Bulgaria. [In:] J. MLIKOVSKY (ed.) – Tertiary avian localities of Europe. Acta Universitatis Carolinae Geologica. Univerzita Karlova. Praha, **39**(1995): 541-545.

BRODKORB P. 1964. Catalogue of fossil birds. Part 2. Bull. of the Florida State Mus., Biol. Sci., Gainesville, **8**(3): 195-335.

CARBONERAS C. 1992. Family Anatidae (Ducks, Geese and Swans). [In:] J. DEL HOYO, A. ELLIOTT, J. SARGATAL (eds.) – Handbook of the Birds of the World. Vol. 1. Lynx Edicions, Barcelona. 536-628.

KUROCHKIN E. N. 1968. New Oligocene birds from Kazakhstan. Paleontological Journal, **1**: 92-101. [In Russian].

KUROCHKIN E. N. 1971. Towards the Pliocene Avifauna of Mongolia. The Fauna of the Mesosoic and Cainosoic of the Western Mongolia. Joint Soviet-Mongolian Scientific Expedition, Moscow, Nauka Publ. House, Trudy, **3**: 58-67. [In Russian].

KUROCHKIN E. N. 1976. New Data on the Birds of the Pliocene of Western Mongolia. Paleontology and Biostratigraphy of Mongolia, Moscow, Nauka Publ. House, Trudy, **3**: 51-67. [In Russian].

MLIKOVSKY J. 1992. The present state of knowledge of the Tertiary Birds of Central Europe. [In:] K. CAMPBELL (ed.) – Papers in Avian Paleontology Honoring Pierce BRODKORB. Nat. Hist. Mus. of Los Angeles County, Sci. Ser. **36**: 433-458.

NORTHCOTE M. 1992. Swans (*Cygnus*) and Cranes (*Grus*) from the Maltese Pleistocene. [In:] Campbell, K. (Ed.) – Papers in Avian Paleontology Honoring Pierce BRODKORB. Nat. Hist. Mus. of Los Angeles County, Sci. Ser., **36**: 285-291.

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Longer papers should be divided into several chapters numbered with Roman numerals. Acknowledgements should be gathered under a single heading (acapit) at the end of introduction.

Tables should be typed on separate sheets and numbered with Roman numerals.

Figures (drawings, maps, diagrams etc.) done in black ink, should be submitted as original and one copy (xero), numbered with Arabic numerals [Fig. 1., Fig. 2. ...]; figures, letters and symbols used on illustrations should be drawn so large that they will be at least 1.5 mm high after reduction in print. Photographs must be sharp and contrast; they will be treated also as figures. Every illustration should bear its own number and Author's name. All captions of illustrations should be gathered on a separate sheet (not incorporated in the figure or photograph itself).

Nomenclature. First used binominal Latin names, according to Intern. Code of Zoological Nomenclature, should be used full i.e. together with not abbreviated names of their authors and dates after coma – be careful using brackets) [e.g. *Passer domesticus* (LINNAEUS, 1758) but *Aquila pomarina* BREHM, 1831]. If repeated later on in text the names might be abbreviated [e.g. *P. domesticus, A. pomarina*].

Citation in text: VOOUS (1962) or (VOOUS 1962), (DEMENTEV & GLADKOV 1952; BROWN et al. 1988).

References. The list of references must be complete and prepared in the following method:

Journal: MACARTHUR R. H., MACARTHUR J. W. 1961. On the bird species diversity. Ecology, **42**: 594-598.

Book: VAURIE C. 1959. The birds of the Palearctic fauna. Passeriformes. Witherby, London.

Chapter: OSBORN J. W. 1978. Morphogenetic gradients: fields versus clones. In: P. M. BUTLER and K. A. JOYSEY (Eds.) – Development, function and evolution of teeth. Academic Press, London-New York-San Francisco. Pp: 171-201.

In the case of papers written in the other than Latin letters, if there is English (or German, or French) title in the summary it may be used:

TOMKOVICH P. S. 1985. Sketch of the Purple Sandpiper (*Calidris maritima*) biology on Franz Josef Land. [In Russian with English summary]. Ornitologiya, **20**: 3-17.

If there is not English summary or even title – author's name must be transcribed and title of the paper also transcribed (using anglo-american transcription) or translated into English:

DEMENTEV G. P., GLADKOV N. 1952. Ptitsy Sovetskogo Soyuza. **2**. or: [The birds of the Soviet Union (in Russian)], **2**.

Manuscripts not conforming to the requirements will be returned for revision.