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AN ANNOTATED BIBLIOGRAPHY OF THE SOVIET PALAEOICHTHYOLOGIST LEONID GLICKMAN (1929–2000)

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ABSTRACT

The paper presents a short biography and an annotated bibliography of the well-known Soviet palaeoichthyologist and evolutionary morphologist Leonid S. Glickman (1929–2000). His bibliography consists of 46 titles, including 2 monographs, 3 book chapters, 33 research papers, 4 popular papers, and 4 unpublished research reports and dissertations, devoted mainly to Cretaceous and Cenozoic elasmobranchs (principally Lamniformes). The publications cover a period of time between the years 1952 and 1998.

Key words: bibliography, biography, evolution, functional morphology, Glickman Leonid Sergeevich, sharks, skates, teeth

АННОТИРОВАННАЯ БИБЛИОГРАФИЯ СОВЕТСКОГО ПАЛЕОИХТИОЛОГА ЛЕОНИДА СЕРГЕЕВИЧА ГЛИКМАНА (1929–2000)

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РЕЗЮМЕ

В статье приводится краткая биографическая справка и аннотированная библиография известного Советского палеоихтиолога и эволюционного морфолога Леонида Сергеевича Гликмана (1929–2000). Библиография содержит 46 наименований, включая 2 монографии, 3 раздела в коллективных монографиях, 33 научных и 4 популярных статьи, а также 3 неопубликованных квалификационных работы и один отчет НИР, посвященные меловым и кайнозойским эласмобранхиям (в основном, ламнообразным акулам). Время издания публикаций охватывает период с 1952 по 1998 г.

Ключевые слова: библиография, биография, эволюция, функциональная морфология, Гликман Леонид Сергеевич, акулы, скаты, зубы

INTRODUCTION

A short biography[1]. Leonid Glickman was born on January 23rd 1929 in Leningrad in the family of a well-known chemist, Sergey Abramovich Glickman (1892–1966). Leonid's life can be subdivided to five periods, related both to his age and the cities where he worked: Leningrad, Saratov and Vladivostok (Fig. 1). In 1939 the family left Leningrad for Kiev and after the beginning of the Great Patriotic War (1941) was evacuated to Middle Asia (Tashkent, Uzbekistan). After the War (1945–1950) the Glickmans (the father and the son) lived in Saratov where Leonid finished middle school and attended a

[1] A more compete biography, with a list of elasmobranch taxa published by L.S. Glickman, is available in a separate paper: Popov and Glickman 2016.

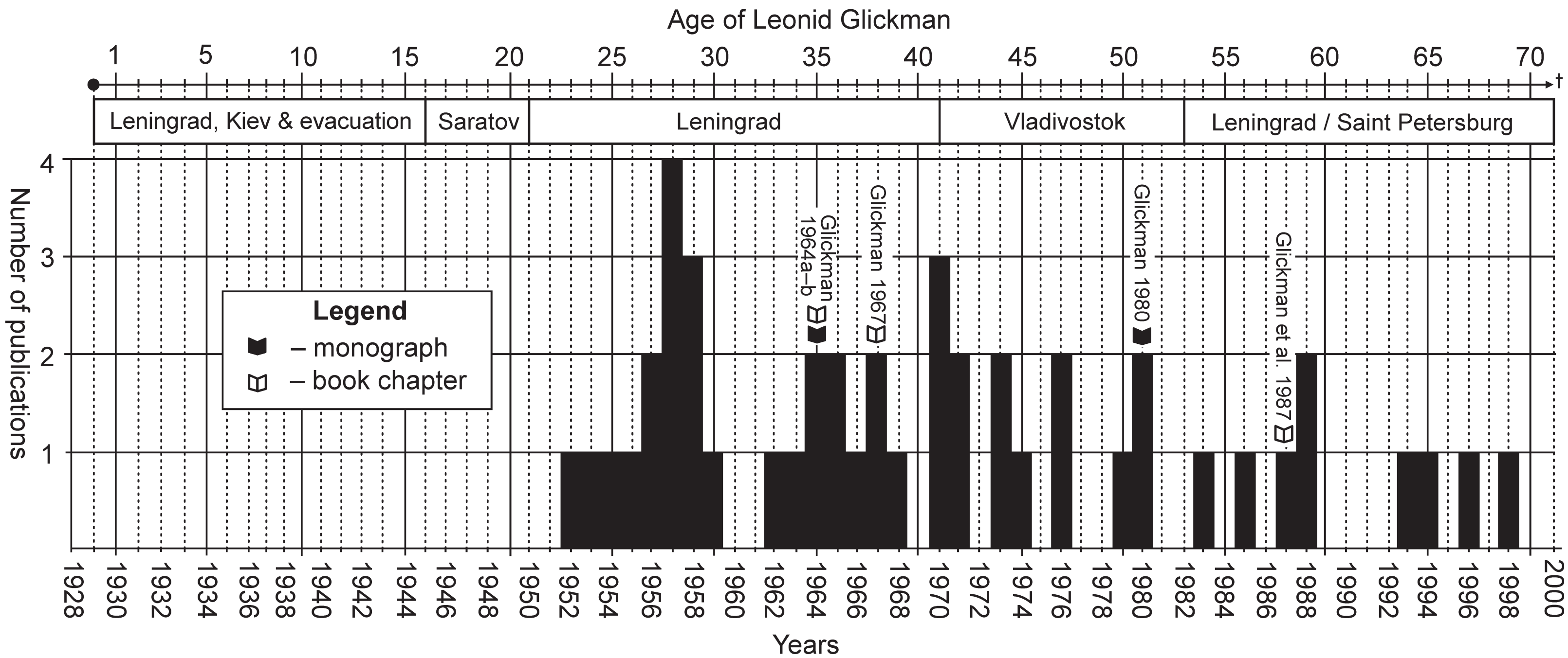

Fig. 1. A chart of publications (1952–1998) by Leonid Glickman, related with his age and life stages.

four year study course at the biological faculty of the Saratov State University. In 1945, at the age of 16, Leonid started to collect Upper Cretaceous vertebrate fossils near Saratov. In 1950 he was transferred to the Leningrad State University, finishing his University course in 1952. His first scientific paper (Glickman 1953) was based on his extensive chondrichthyan collection (ca. 10,000–40,000 specimens) from Saratov and formed his graduate thesis (Glickman 1952). His time in Leningrad (1950–1970) was his most productive, both in terms of scientific and fieldwork (see Fig. 1). Throughout that time, he was employed at the A.P. Karpinskiy Geological Museum, (1952–1963), which was later merged with the Laboratory of Precambrian Geology, USSR Academy of Sciences (=Institute of Geology and Geochronology of the Precambrian after 1967). His research was mainly focused on Cretaceous and Cenozoic lamnoid sharks (Lamniformes). At this time, Leonid carried out intensive fieldwork throughout the territory of the USSR, including European Russia, Ukraine, Crimea, western Kazakhstan and Mangyshlak Peninsula, Turkmenia, the Fergana Valley and Aral Sea region. He amassed a large collection of Cretaceous and Cenozoic shark teeth (ca. 200,000 specimens), which is deposited now in the State Darwin Museum in Moscow. In 1958, based on this collection, Glickman defended his Candidate of Biology dissertation (PhD thesis) (Glickman 1958) and then published a monograph and a book chapter (Glickman 1964a, 1964b) as well as a series of research papers. Between 1970 and 1982, Glickman was employed in the Soviet Far East (Vladivostok) where he was engaged in morphological research of the salmon of Kamchatka Peninsula at the Institute of Marine Biology of the Far East Branch of the USSR Academy of Sciences. At the end of this period, his other monograph "Evolution of the Cretaceous and Cenozoic Lamnoid sharks" (Glickman, 1980) was published based on his unfinished Doctoral Dissertation. Between 1982 and his death in January 31, 2000 Glickman lived in Leningrad (Saint Petersburg after 1991) with very limited possibilities of further research and fieldwork. His last fieldwork to western Kazakhstan was in 1999 at the age of 70.

Glickman's publications. Glickman's publications were not large in number and consist of just 46 titles, published between 1952 and 1998. These including two monographs (Glickman 1964a; 1980), three book chapters (Glickman 1964b; 1967; Glickman et al. 1987), 33 research papers in various journals, 4 popular papers, 3 unpublished theses (Graduate, Candidate and Doctoral theses) as well as one unpublished research report (Glickman 1954).

The majority of Glickman's publications (44 titles, 96%) dealt with Cretaceous and Cenozoic elasmobranchs (mainly Lamniformes), his main research interest. There are only two known publications, an abstract (Glickman 1976) and a short paper (Glickman et al. 1973) on Recent salmon, his research topic during the Far East stage of a life. Glickman wrote more than a half of his publications as a single author (25 titles; 54% of total titles), the other half were co-authored (21 titles; 46%). His principal co-authors were V.I. Zhelezko (4 co-authored papers), V.N. Dolganov (4), G.M. Belyaev (3) and A.O. Averianov (3). Only publications with the latter co-author were published in English or had a translated version, all other publications were in Russian, excepting book chapter (Glickman 1964b) translated into English in Israel in 1967 (Glickman 1967). This is one of the reasons why most of Glickman's publications were unknown to western palaeontologists and zoologists.

The aim of this publication is to provide a review of nomenclatural and research ideas of L.S. Glickman in the form of an annotated bibliography covering all his published and unpublished works. Most of his publications lack annotations (abstracts, resumés) or, where present, were short and fairly uninformative, and so structure and main ideas in each publication have been outlined below.

Glickman has preferred this English transliteration of his name instead of "Glikman" or "Glyckman" while he preferred the name Glückman for taxonomy; which is followed here. In many of his publications Latin taxa names were often misspelled or missprinted because he did not concern himself about fine details, nor properly proof read his manuscripts. Thus he, was regarded as "not a classic researcher but romantic one" by his informal supervisor Academician V.V. Menner (1905–1989). Some of these misprints have lead to nomenclatural problems, still unresolved (*Cretolamna* vs *Cretalamna*, see: Cappetta 2012: 234). Glickman made some systematic mistakes because in Soviet times, he lacked access to most western scientific publications, he had limited comparative collections and little communication with his western colleagues. Nevertheless, he made a significant impact on the study of palaeoichthyology (Cappetta 2012: 9).

For the transliteration of Russian journal titles, as well as for some local geographic names, the Universal standard has been used. There is information about number of pictures, tables, plates and references after each bibliographic description, as well as the publication language in square brackets. Unpublished works (scientific reports, graduate thesis, dissertations' thesis) are suffixed with "unpublished" after the year they were written. In each paper, where there is systematic input, any new described taxa (family, genus, species and subspecies) introduced are marked with an asterisk (*). Digital files (pdf format) of Glickman's publications are available for download via the website www.elasmodus.com.

Institutional abbreviations: IGG, Institute of Geology and Geohemistry of the Ural Branch of the Russian Academy of Sciences (Ekaterinburg, Russia); IGGP, former Institute of geology and geochronology of the Precambrian (Leningrad, USSR)[2]; IGV, Institute of Geology, Vilnius, Lithuania; SDM, State Darwin Museum (Moscow, Russia); CCMGE, Chernyshev's Central Museum of Geological Exploration (St Petersburg, Russia); PIN, Paleontological Institution of the Russian Academy of Sciences (Moscow, Russia); ZIN PC, Zoological Institute of the Russian Academy of Sciences (St Petersburg, Russia), palaeoichthyological collection.

ANNOTATED BIBLIOGRAPHY

1. Glickman L.S. 1952 (unpublished). Upper Cretaceous marine vertebrates from Saratov Volga region. Graduate thesis. Leningrad State University (Department of Vertebrate Zoology). Leningrad, 119 p. (28 plates, 5 tables, 16 references) [In Russian].

A typescript of his graduate thesis supervised by docent Lev I. Khosatzky (1913–1992) is stored in the archive of the Department of Vertebrate Zoology, Saint Petersburg State University[3]. The text consists of Introduction (6 pages), Systematic part (49), General geological characteristics of the Saratov Late Cretaceous basin (15), Conclusions (5), References (2), A list of illustrations and graphical appendix (11 original plates with fossils, 3 photo reproductions from other publications, 5 line drawings and 9 geological photographs of the localities).

The research was based on his personal collection (about 40,000 specimens) from three fossiliferous horizons at three Cenomanian localities near Saratov – in the sand quarries near the "Proletarskij poselok" and "Klinicheskij gorodok" settlments, and on Uvek Hill on the southern outskirts of the city. Some additional material was collected in other localities in Saratov as well as on west bank of the Volga River, 60 km to south of the city. The systematic part consists of descriptions of certain shark species (*Odontaspis*, *Synechodus*, *Scapanarhinchus*, *Lamna*, *Corax*, *Galeocerdo*, *Squatina*, *Cestracion*, *Hybodus*, *Acrodus*, *Ptychodus*) as well as records of chimaeroid fishes (*Ischyodus*, *Edaphodon*), bony fishes (*Pycnodus*), ichthyosaurs, plesiosaurs and pterosaurs. This section consists a discussion about shark tooth morphology, systematics and evolution. The stratigraphic part discusses fossiliferous levels with Cenomanian vertebrate remains in Saratov and paleontological and his stratigraphic observations during his southern trip from Saratov to Ahmat settlement (60 km to the south). Several tables with tooth dimensions for *Scapanorhinchus subulata* and other species, as well as the taxanomic compositions of 12 bulk samples from two stratigraphic horizons from the Saratov Cenomanian are included.

2. Glickman L.S. 1953. Upper Cretaceous vertebrates from the vicinity of Saratov. Preliminary data. *Uchenye zapiski Saratovskogo universiteta,* **38**: 51–54. (no references) [In Russian].

The paper is a collection of students' studies and includes a short review of some results from author's graduate thesis. Using material collected from several quarries in the Saratov region, he describes the stratigraphy and fauna of upper part of the Cenomanian phosphate sands. The fossiliferous levels consist of an "Upper Phosphorite Horizon", a "Lower Phosphorite Horizon" and a lowermost "White Sands" level with more autochthonous and better preserved fossils. Some differences between the preservation of the fossils from different levels and the peculiarities of stratigraphic distribution for some taxa are observed. Thus, the "Upper Phosphorite Horizon" yielded teeth of *Ptychodus* and *Cestracion* (*Heterodontus*) whereas the "Lower Phosphorite Horizon" contained teeth of *Pycnodus*. In total, a collection

[2]Material may now be deposited in the State Darwin Museum collection, Moscow.
[3]The copy of his graduate thesis lacked Latin names in the typescript.

of 10,000 shark teeth consisting of 10 genera were identified: *Lamna*, *Scapanorhinchus*, *Corax*, *Squatina*, *Hybodus*, *Acrodus*, *Synechodus*, *Odonaspis*, *Cestracion*, *Galeocerdo mullerei* Henle[4] [sic!]. Batoids [sic!] consisted of of a single genus with 3 species: *Ptychodus mammilaris* Agassiz, 1843, *P. decurrens* Agassiz, 1839, and *P. latissimus* Agassiz, 1843. Among the nearly 400 chimaeroid dental plates he collected were the genera *Ischyodus* and *Edaphodon*; the latter not previously known from the Saratov region. A number of spiral coprolites, mistakenly identified belonging to the coelacanth *Macropoma mantelli* Agassiz, 1843 were collected. Marine reptiles were represented mainly by rare ichthyosaur vertebra (*Myopterigius*) and more commonly both vertebra and isolated teeth of plesiosaurs (*Polycotylus* sp.; *P. orientalis* Bogolubov, 1911; *Elasmosaurus* sp.). In addition, two pterosaurs were recorded, including "a part of a small skeleton of a pterodactyl, about the size of a thrush" (Glickman 1953: 54).

3. Glickman L.S. 1954 (unpublished). Otchet o rabote "Verhnemelovye akuly Saratovskogo Povolzhya" [Report about research entitled "Upper Cretaceous sharks of Saratov Volga River basin"]. Collection of the Scientific Research Institute of geology and soil science of the Saratov State University, Saratov, 82 p. (4 figures, 1 table, 33 references) [In Russian].

This is an unpublished research report stored in the Zonal Scientific Library of the Saratov State University (record number 4706P). The report is both typewritten and handwritten with handwritten corrections made by (?) his research supervisor, Professor Vera G. Kamysheva-Elpatievskaya. The report consists of 5 sections: (1) The functional and morphological analysis of sharks teeth in relation to their taxonomy; (2) The stratigraphic significance of some structural features of teeth of the orders Scapanorhinchiformes, Odontaspiformes and Lamniformes; (3) The direction and pathways of evolution of the orders Scapanorhinchiformes and Odontapsiformes; (4) The classification of the Cenomanian shark orders Scaphanorhinchiformes, Odontaspiformes and Lamniformes based on the functional use of their teeth; (5) The stratigraphic significance of these sharks.

Based on a functional and morphological analysis of a large collection of shark teeth from the Cretaceous of Saratov Volga River Basin (more than 50000 specimens) he proposed the establishment of a series of new taxa of different taxonomic levels [all are *nomina nuda*]: *Scapanarhinchiformes ordo nov. (Scapanarhinchidae + Scylliorhinidae + ?Orectolobidae), *Odontaspiformes ordo. nov. (*Odontapsis* + *Paraorthacodus* + *Orthacodus*); **Paraorthacodus* gen. nov. (based on species *Synechodus recurvus* (Trautschold, 1877); *Isurus* **denticulatus* sp. nov. and *Odontaspis* **primigenius* sp. nov.[5]. Other taxa of teeth were also diagnosed: *Lamna* Cuvier, 1817; *Lamna appendiculata* (Agassiz, 1843); *Isurus* Rafinesque, 1810; *Odontaspis* Agassiz, 1838; *O. macrorhiza* Cope, 1875; *Paraorthacodus recurvus* (Trautschold, 1877); *Scapanorhynchus subulata* (Agassiz, 1843). For the latter species, tooth crown morphometric data was provided in a table, based on specimens from different levels of the Cenomanian as well from the Albian, Campanian and Paleocene deposits of the Volga River Basin[6]. The stratigraphic section consisted of a short historic review and descriptions of some sections with accompanying shark faunal lists for the localities: Pady in Balashov Province (Saratov Province now), Nizhnyaya Bannovka in the Saratov Province and Krasnyj Yar (near Miroshniki and Gordienki villages) in the Stalingrad Province (Volgograd Province now).

Details of the vertebrate and invertebrate assemblages from 7 bulk samples of 2 Cenomanian stratigraphic levels (Upper and Lower phosphorite horizons) of Saratov are presented. There are conclusions about heterochrony of Cenomanian phosphorite horizons in the region and a possibility to subdivide these horizons based on sharks teeth of the new orders Scapanorhinchiformes and Odontaspiformes because of high rate of evolutionary morphological change in these teeth from Albian to Eocene.

[4]Misprint of *Galeocerdo* Müller et Henle, 1841. Perhaps meaning the teeth of *Galeorhinus*, described later from the Cenomanian of Saratov (Popov and Lapkin 2000).

[5]This unpublished new species was based on erroneously interpreted single tooth of *Paraisurus macrorhiza*, collected from the Krasnyj Yar section (Volgograd Province now); the tooth was reinterpreted later (Glickman 1957c) and figured (Glickman 1964b: pl. 5, fig 13; 1980: pl. 10, fig. 9).

[6]It is obvious now that the morphometrically studied material consisted of a mixture of *Eostriatolamia*, *Scapanorhynchus* and *Striatolamia* teeth.

4. Glickman L.S. 1955. About age of phosphorite horizon in a top of Cenomanian stage in the vicinity of Saratov based the occurrence of fish teeth. *Uchenye zapiski Saratovskogo universiteta,* **45**: 83–84. (8 references) [In Russian].

A short note about an age of the Upper Phosphorite Horizon in a top of Cenomanian sands at Saratov, based on records of skate [sic!] genus *Ptychodus* Agassiz, 1839. The following species: *Ptychodus latissimus* Agassiz, 1843, *P. mammillaris* Agassiz, 1843, *P. decurrens* Agassiz, 1839, *P. concentricus* Agassiz, 1843 and *P. multistriatus* Woodward, 1889, were identified from this horizon. Based on a comparison of the distribution of these species in the Upper Cretaceous of France, England and Lithuania, it was concluded that the age of this horizon is "not older than the *Actinocamax plenus* zone".

5. Glickman L.S. 1956a. Position of lamnoid sharks in the system of Elasmobranchii. *Doklady Akademii Nauk SSSR*, **108**(3): 555–557. (12 references) [In Russian].

The paper consists of a morphological analysis of the jaw suspension to the skull in different groups of modern sharks and rays. These can be resolved into two basic types: (I) a strong and short hyomandibular cartilage (suspensorium) which connects the axial skull with the palatoquadrate and the Meckel's cartilage (2 variations of jaw mobility); and (II) where the hyomandibular cartilage is not involved in suspension of jaw apparatus, which is supported by the hyoid cartilage alone. The latter suspension type (II), referred to as desmostyly, is present only in lamnoid sharks (primitive character); the suspension type (I) is regarded as a true hyostyly (all other sharks and rays). Based on these characters, subclass Elasmobranchii can be subdivided into 4 superorders: Cladoselachoidei, Xenacanthoidei, as well as two new superorders – *Lamnoidei (lamnoid sharks only) and *Carcharhoidei (other sharks and rays excluding lamnoids). The true hyostyly is a major aromorphosis. The separation of lamnoid sharks as a superorder is also confirmed by a special (osteodentine) microstructure of the teeth; the lack of a mosaic teeth pattern in teeth files; the presence of long unsegmented metapterygium in the fins; a large number of vertebrae; a lack fin spines and basal plates in the dorsal fins; and other features. The Jurassic genus *Orthacodus* can be considered as an intermediate form between cladodonts and lamnoids; Carcharoidei is closely related to notidanids and the latter group may be descended from the Cladoselachii.

6. Glickman L.S. 1956b. About phylogeny of the genus *Anacorax*. *Doklady Akademii Nauk SSSR*, **109**(5): 1049–1052. (1 table, 2 figures, no references) [In Russian].

Based on a collection of teeth of the lamnoid shark *Anacorax* from the Cenomanian of Saratov Province (1077 specimens from 4 horizons at 2 localities), from the Turonain–Santonian of Uzbek SSR (154 teeth) and Campanian of Saratov Province (25 teeth) two *Anacorax* species were revised: *Anacorax falcatus* (Agassiz, 1843) and *Anacorax pristodontus* (Agassiz, 1843)[7]. Diagnoses for the two genera were given: *Anacorax* (type species – *Corax pristodontus* Agassiz, 1843) from the Turonian–Maastrichtian and a new genus **Palaeocorax* (type species – *Corax falcatus* Agassiz, 1843) from the Cenomanian. A new family *Anacoracidae was introduced and diagnosed. The functional morphology of teeth was discussed. Type specimens were not cited.

7. Glickman L.S. 1957a. Taxonomic significance of accessory cusplets of sharks of the families Lamnidae and Scapanorhynchidae. In: Trudy geologicheskogo muzeya imeni A.P. Karpinskogo. Academy of Sciences of the USSR, Moscow–Leningrad, **1**: 103–109. (2 tables, 2 figures, 7 references) [In Russian].

The paper discusses the significance of differently developed accessory cusplets on shark teeth for systematics of the group, with examples from the Recent and fossil species of genera *Lamna*, *Isurus* (= *Oxyrhina*), *Otodus* and *Scapanorynchus*. Based on a sample of 200 teeth from the Cenomanian of Saratov, a new species of shark *Isurus* **denticulatus* Glückman was described (the plate shows 17 teeth). This species differs from its decendant species, *Isurus mantelli,* by following features: 1) a relatively narrower crown; 2) less developed root lobes; 3) the presence of additional cones [cusplets] on lateral and posterior teeth; 4) a relatively thinner crown. Details of the type specimens and depository were not given. Two tables show data on the presence, size and height ratio of lateral cusplets for *Scapanarhinchus* teeth from 5 stratigraphic levels (2 levels from the Cenomanian of Saratov; from the Coniacian–Santonian of Uzbekistan; from the Eocene of Kamyshin, Volgograd Province; and from the Bukhara stage of Ambargaz,

[7]Material represents *Squalicorax* spp. including Campanian *S. kaupi.*

Tajikistan) as well as for teeth of the new species *Isurus denticulatus*. There is a general pattern in the morphological evolution of teeth of Lamnidae and Scapanorhinchidae of increasing of crown height and a reduction of the relative size of the lateral cusplets between the Cenomanian and Eocene.

8. Glickman L.S. 1957b. About the genetic link between the families Lamnidae and Odontaspididae and some new genera of Upper Cretaceous lamnids. In: Trudy geologicheskogo muzeya imeni A.P. Karpinskogo. Academy of Sciences of the USSR, Moscow–Leningrad, **1**: 110–117. (1 table, 2 figures, 11 references) [In Russian].

The paper analyses morphological features of teeth of the Upper Cretaceous lamnoid sharks. Using material from the Albian, Cenomanian and Maastrichtian[8] of the Russian platform 4 new genera were described: **Paraorthacodus* Glückman (type species *Synechodus recurvus* (Trautschold, 1877); 8 teeth are figured), **Paraisurus* Glückman (type species *Oxyrhina macrorhiza* Pictet & Campriche, 1858; two teeth are figured[9]), **Pseudoisurus* Glückman (type species is introduced here new species *Pseudoisurus *tomosus* Glückman, based on 10 teeth, 4 of which are figured), **Euchlaodus* Glückman (type species *Oxyrhina lundgreni* Davis, 1890; one tooth is figured[10]). A species of *Hybodus dispar* Reuss, 1846 (= *Synechodus nitidus* Woodward, 1911) is reassigned to the genus *Synechodus* Woodward, 1911 (5 teeth are figured). Information about the species types, depository, both type stratum and localities was not provided. The genera *Lamna, Paraisurus* and *Isurus* were classified as Lamnidae whereas *Odontaspis* and *Pseudoisurus* were classified as Odontaspididae. The family Lamnidae was subdivided into two subfamilies Lamnidae [sic! misprint] and Isurinae. The Orthacodidae (*Orthacodus, Paraorthacodus, Euchlaodus*) was regarded as ancestral to both families (Lamnidae and Odontaspididae).

9. Glickman L.S. 1957c. About age of the lower phosphatic horizon in vicinity of Krasnyj Yar settlement, Stalingrad region. In: Trudy geologicheskogo muzeya imeni A.P. Karpinskogo. Academy of Sciences of the USSR, Moscow–Leningrad, **1**: 118–120. (1 table, 1 figure, 6 references) [In Russian].

In a short note the author demonstrated that the record of a single tooth of *Isurus macrorhiza* (Pictet & Campiche, 1858) amongst the sharks collected from the Lower Phosphorite Horizon in supposed Cenomanian deposits near Miroshniki and Gordienki villages (neighbor of Krasnyy Yar settlement in the Stalingrad Province)[11] indicated an Albian age for this layer and the underlying sandy sequence (about 38 m in thick). Other sharks' teeth from this level included (N=100): *Acanthias* sp. [=*Squalus*], *Scapanorynchus raphiodon* (Agassiz, 1843), *Synechodus nitidus* Woodward, 1911 and *Squatina* sp.[12]. The composition and morphology of Lamnoid teeth from this assemblage were compared in with Albian teeth from the Lithuania and the Ukraine (Kanev) that he had studied personally. The Albian species *Otodus monstrosus* Rogovich, 1860, from the Ukraine, was regarded as a junior synonym of *Oxyrhina macrorhiza*.

10. Glickman L.S. 1957d. Teeth of Turonian fishes from the Tajik SSR. In: Trudy geologicheskogo muzeya imeni A.P. Karpinskogo. Academy of Sciences of the USSR, Moscow–Leningrad, **1**: 121–122. (3 references) [In Russian].

In a short paper, a small fish tooth collection from the Turonian of Kulyab (near Stalinabad town, south-western Darwaz, Tajik SSR) was described. The collection consisted of shark teeth: *Odontaspis divaricatus* (Leidy, 1872), *Leptostyrax* Williston, 1900, *Ptychodus deccurrens* Agassiz, 1839, *Anacorax falcatus* (Agassiz, 1843), *Scapanorhynchus raphiodon* (Agassiz, 1843) Woodward and two genus of bony fishes of the family Pycnodontidae: *Coelodus* Haeckel, 1854 and (?)*Mesodon*. It was concluded that the assemblage is identical with those from North American (Leidy 1873; Cope 1875; Williston 1900) but less diverse than those from Western Europe.

11. Glickman L.S. 1958a. Diagnostic significance of some characters of elasmobranchian teeth. In: Sbornik statej molodyh nauchnyh sotrudnikov

[8]The age of the deposits were later reinterpreted as Danian (see Glickman 1962; Averianov and Glickman 1996).

[9]One of the referred and figured tooth (fig. 15) was attributed to this species erroneously; EVP observation.

[10]This tooth come from the Danian deposits near Lysye Gory settlement in Saratov Province, see Averianov and Glickman 1996.

[11]During field prospecting of last two decades localization of both section and regional layer with this shark complex were unsuccessful despite a presence of the notes and outline provided us by Glickman; EVP pers. observation.

[12]This sample is stored in SDM collection, Moscow; EVP pers. observation, 2015.

Leningradskih geologicheskih uchrezhdenij AN SSSR. Academy of Sciences of the USSR, Moscow–Leningrad, **1**: 163–171. (8 references) [In Russian].

The paper develops the ideas of E. Casier (1943) about the low systematic value of vestigial characters in a taxonomic group. This idea is discussed using the development of lateral cusplets in shark teeth of the following families: Ctenacanthidae, Xenacanthidae, Cladoselachidae, Orthacodidae, Hybodontidae, Paraorthacodontidae, Odontaspididae, Lamnidae/Scapanorhynchidae, Chlamydoselachidae, Notidanidae, Cestracionidae, Scylliorhinidae/Triakidae/Orectolobidae, Squalidae/Echinorhinidae, Carcharhinidae/Sphyrnidae and Squatinidae/Pristiophoridae. It was concluded that (1) additional cusplets inhibit an evolutionary development of the main crown; (2) a height of the crown and a size of lateral cusplets are interrelated; (3) lateral cusplets may be generic characters if the cusplets are only numerous and large (in lamnoid sharks as well as in the most Orthacodidae the presence/absence of lateral cusplets cannot be a character of the both generic and species value); (4) a relative role of additional cusplets is different in the teeth of different functional purposes: in cutting and crushing teeth additional cusplets cannot be considered as an important systematic character, whereas awl–shaped teeth and (rarely) conical ones can be of systematic value as a species character; (5) during the evolutionary reduction of lateral cusplets, their presence/absence cannot be a systematic feature, whereas a trend towards the reduction can be regarded as a familial character (Lamnidae). In a case of the early evolutionarily loss of the lateral cusplets, an absence of the latter is a distinct character (Squatinidae, Sphyrnidae, etc.); (6) all elasmobranchs show a trend toward a reduction of lateral cusplets and this can be an example of an "oligomerization" process (*sensu* Dogel 1954) in a morphological evolution of the group. The diagnostic value of some other tooth characters (s-shaped bend of the crown of anterior teeth, crown serration, convexity of the crown) depending of tooth position was also briefly discussed.

12. Glickman L.S. 1958b. Rates of evolution in Lamnoid sharks. *Doklady Akademii Nauk SSSR*, **123**: 668–672. [In Russian].

The paper discusses rates of evolution of lamnoid sharks based on the study of dentitions (including dental formula parameters). The Cretaceous species *Oxyrhina mantelli* was separated from the Lamnidae family as a new genus **Cretoxyrhina* of a new family *Cretoxyrhinidae. Both new taxa are diagnosed. *Cretoxyrhina* includes two species: *Isurus denticulatus* Glückman, 1957a and *Oxyrhina mantelli* (type species); the new family includes genera *Cretoxyrhina* and *Paraisurus*. It was suggested that the species *Paraisurus macrorhiza* is an ancestral form for the family and the origin of the latter is derived from the family Orthacodidae. A new genus **Cretalamna* [sic!][13] with the type species *Lamna appendiculata* Agassiz, 1843 (based on material from the Cenomanian of Saratov) was also briefly diagnosed. This genus was presumably attributed to the family Odonaspididae. Information about nomenclatural types, type strata and localities was not given. Changes in the morphology of teeth and dental formula of lamnoid sharks indicated a rapid rate of evolution in the group.

13. Glickman L.S. 1958c (unpublished). About classification of sharks. Abstract of PhD thesis (Candidate of biology). Leningrad, 20 p. (2 tables) [In Russian].

Abstract of his candidate of biology (PhD) thesis: Introduction and a brief historical review; Chapter 1. Overview of elasmobranchs; Chapter 2. Principles of systematics of the sharks (a: Evolutionary and functional significance of the morphological characters of elasmobranchs; b: Methods of studying the teeth of fossil sharks: b1: A description of the tooth crown as an instrument bearing a specific function; b2: Functional types of teeth; b3: Root features and their significance; b4: Microstructure; b5: Tooth position in the jaws; b6: A comparison of sharks teeth from different horizons; c: Diagnostic significance of certain minor characters of dentition; Chapter 3. The systematics of the elasmobranchs; Analysis of the systematic characters of modern families; Conclusions; followed by a list of author's publications (4 published works and 3 publications in press).

The dissertation maintains that: (1) sharks are one of the most advanced living groups of vertebrates; (2) two independent, and separate lineages of sharks (subclasses Carharia and Lamnia) range from the Devonian to the Recent; these lineages are convergent; (3) The main difference between these two branches is histological structure of teeth: orthodentine (Carcharia) or osteodentine without pulp cavity (Lamnia); (4) During the Mesozoic and Ce-

[13]See discussion in Cappetta (2012: 234).

nozoic both branches give rise to forms with a mobile jaw suspension; but the similarities are superficial because of desmostylic suspension type (lamnoid sharks) is morphologically distinct from the hyostyly (carcharhinid sharks); (5) Both notidanids and batoids are anatomically related by gradual transitions from other carharinid sharks; (6) a description of genera and species is recommended only after an overall assessment of leading features in phylogeny, in order to avoid errors caused by this morphological convergence; (7) in a description of teeth at any taxonomic level, it should be remembered that the shape of the crown determines the details of its morphology, but the crown is also dependant of the root structure, modes of tooth articulation and dental histology.

14. Glickman L.S. 1959. Directions of evolutionary development and ecology of some groups of the Cretaceous elasmobranchians. In: Trudy Vtoroy sessii Vsesoyuznogo paleontologicheskogo obshchestva, Moscow: 52–62. (6 figures, 11 references). [In Russian].

The paper concerns the functional and evolutionary morphology of sharks' teeth. The total volume of the author's collection was estimated ca. 200,000 specimens[14]. Frequently, the evolution of organisms are dependant on the evolution of their dentition, and peculiarities of the latter (and structure of individual teeth as well) can be reflected in characters of different taxonomic value. Four evolutionary tooth morphologies were identified: a percussive cone (canine), an awl, flat crushing tooth and cutting plate (knife). Each morphology corresponds to a particular type of food. A percussive-prehensile cone is a most primitive morphology, but at the same time, this type is versitile one, having the maximum evolutionary flexibility. The cutting type is the most advanced one. Differences of microstructure of the osteodont and orthodont teeth and their relationship with functional types of teeth were briefly discussed. Structural features of the tooth roots and the evolutionary trend toward an increasingly arched construction was discussed. The arched construction of the root was considered to be one of the aromorphoses of sharks. During the evolution of teeth in most shark groups there is an increase in size followed by a reduction in number in the jaws ("oligomerization" *sensu* Dogel 1957); the whole body begins to change, which can lead to further aromorphosis or extinction.

15. Glickman L.S. 1962. Evolution of elasmobranchs in transgressive and regressive epochs. In: Trudy V i VI sessij Vsesoyuznogo paleontologicheskogo obshchestva: 226–234. (2 plates, 13 references) [In Russian].

The paper discusses the relationship of evolutionary diversity of the sharks with transgressive-regressive cycles. Historically, radiations of the oceanic sharks correspond to the periods of maximum transgression, whereas the short-term regressions (e.g. episodes in the Late Cretaceous and Paleogene) do not result in the creation of freshwater forms but instead a reduction in abundance and diversity. The Late Cretaceous explosion in shark diversity is discussed in general, based on data from the Volga River Basin. The diversity dynamics of some shark groups (including Squalidae and Anacoracidae) from the Albian to Danian, as well as an appearance in the Danian of relict "Jurassic forms" (*Euchlaodus* Glückman, 1957b) are also discussed. The almost complete absence of Squalidae in the Cenomanian deposits was explained by their displacement by small anacoracid sharks (*Palaeocorax falcatus*) with similar tooth morphology and function. Further evolution of the Anacoracidae drove them to become large pelagic predators (*Anacorax*) whereas Squalidae left their "hiding places" and filled vacent (in Maastrichthian) ecological niches during the Danian regression. Based on the occurrence of a single tooth of *Euchlaodus lundgreni* (Davis, 1890) and partially serrated teeth of *Squalus appendiculatus* (Agassiz, 1843) collected from the quartz sands of the Lysye Gory settlement (Saratov Province), the deposits were dated as Danian (the dating was given as a footnote). In addition, the morphological evolution of a Paleogene phylogenetic lineage was discussed: *Odontaspis striatus – O. macrota – O. rossica* and that of *Jaekelotodus trigonalis*. It was concluded that (1) a marine regression is associated with abrupt changes in the marine environment; after a period of regression, new pelagic groups evolve from the shallow water groups; (2) the regression revitalise relict groups; (3) the abundance of pelagic sharks are not linked to the size of transgressions, but more related with their duration; (4) pelagic sharks are always more conservative than coastal ones. From these discussions and based on data about sharks, the Albian stage must start the Late Cretaceous epoch and the

[14] This number at that time (1959) may be exaggerated; EVP pers. observation.

Maastrichtian must start the Paleocene epoch. A question about possible heterochrony of the similar shark assemblages from other basins was discussed. This can result in some biostratigraphical problems which can be solved by studying large numbers of shark teeth of rapidly evolving groups collected from successive stratigraphic horizons.

16. Glickman L.S. 1963. Sharks. Origin and evolution. *Priroda*, **12**: 58–62. (6 figures, 2 references) [In Russian].

A scientific paper in a popular monthly journal of natural sciences of the Academy of Sciences of the USSR. The paper discusses sharks, their lifestyles, anatomy, origins and evolution.

17. Glickman L.S. 1964a. Sharks of Paleogene and their stratigraphic significance. Nauka, Moscow, 229 p. (76 figures, 12 tables, 31 plates, 154 references) [In Russian].

This monograph consists of six chapters entitled: (I) The principles of systematics of sharks; (II) Methods of studying of teeth; (III) The system of elasmobranchs; (IV) Basic principles of studying of the Paleogene sharks; (V) Main Paleogene sharks assemblages; (VI) The diagnoses of Paleogene shark species.

The Introduction (5 pages) consists of a brief historical review of fossil shark studies in the World, the basic characteristics of the group and their biological and geological significance and Acknowledgements. It was stated that the collection was stored at the Department of Monographic Collection[15] under the number 2901; a first figure of each new species in the plates was the holotype.

Chapter I (34 pages) discusses the features of elasmobranchs as a separate subclass of vertebrates and offers a new classification system for the group (Appendix 1). Taxonomic characters of the skull, skeleton and dentition were discussed and analyzed; the independence of the infraclass Osteodonti was justified. There was a discussion on the taxonomic distance between squaloid sharks and batoids (the latter being regarded as a benthic life form of sharks).

Chapter II (43 pages) describes the methodology in the study of sharks. In addition to historical information and a brief review of the evolution of lamnoid dentitions, functional types of teeth, their differences and peculiarities in different groups of orthodont and osteodont as well as diagnostic features of the teeth (serration, enameloid striation, vascularization etc.) are discussed. The question of the relationships of lamnoid and carcharhinid sharks was discussed.

Chapter III (23 pages) contains a criticism of the existing taxonomy of the Elasmobranchii and the new system proposed by the author (see Appendix 1). The main innovations were the following: subclass Elasmobranchii consists of two infraclasses Osteodonta and Orthodonta; Orthodonta includes five superorders: Cladoselachii, Xenacanthi, Polyacrodonti, Chlamydoselachii, Carcharini; whereas Osteodonti includes 3 superorder: Ctenacanthi, Hybodonti and Lamnae. A diagram with the phylogeny of the orders Hexanchida, Squatinida and superorder Lamnae is given. New families (subfamilies) *Jaekelotodontidae, *Otodontidae, *Lamiostomatidae, *Lamiostomatinae and genera **Striatolamia* Glückman, 1964a, **Palaeohypotodus*, **Megaselachus*, **Cosmopolitodus*, **Lamiostoma*[16] and **Macrorhizodus* are briefly diagnosed.

Chapter IV (30 pages) comprises a critical review of the works of L. Agassiz (1837–43) and, in part, by M. Leriche (1902–1951). It also discusses the methodology of studying sharks dentitions and the general principles of morphological evolution of lamnoid shark teeth in several lineages: *Striatolamia* (Thanetian–Oligocene), *Macrorhizodus* (lower Upper Eocene – middle Oligocene), *Otodus* (Thanetian – Middle Oligocene), *Palaeohypotodus* (Thanetian) and *Jaekelotodus* (Paleocene – Lower Eocene). As a part of the proposed phylogenetic lineages, new species or combinations: *Macrorhizodus *gigas* Glückman, 1964a, *Palaeohypotodus *lerichei* Glückman, 1964a, *Jaekelotodus *boristenicus* Glückman, 1964a and *Palaeohypotodus *rutoti* Winkler, 1874 were diagnosed. Additionally, the chapter introduced several species and subspecies without separate formal descriptions: *Lamiostoma *belyaevi* Glückman, *Striatolamia *chelkarnurensis* Glückman, *S. rossica* (Jaekel, 1895) **usakensis* Glückman, *S. rossica* (Jaekel, 1985) **prima* Glückman. The status of some varieties of earlier authors were elevated to

[15]The working place of L.S. Glickman at that time was the Laboratory of the Precambrian Geology, Academy of Sciences of the USSR, Leningrad (= IGGP, Leningrad after 1967), now collection is mainly stored in the SDM, Moscow.

[16]Validity of both genus and species *Lamiostoma belyaevi* was criticized later by Pinchuk (1983) (=*Isurus oxyrhinchus* or *Isurus ?paucus*).

species level, e.g.: *Odontaspis macrota* Agassiz, 1843 var. *rossica* Jaekel, 1895 was elevated to *Striatolamia rossica* (Jaekel, 1985), and *Carcharodon turgidus* var. *sokolowi* Jaekel, 1895 elevated to *Otodus sokolowi* (Jaekel, 1895).

Chapter V (19 pages) discusses elasmobranch assemblages from the Paleogene of Western Europe with an analysis of some European publications, mostly by M. Leriche (1902–1951). Based on material from the Soviet Union, a series of shark zones was introduced: for Paleocene – Zone 1 (*Palaeohypotodus rutoti – Otodus minor mediavus*) and Zone 2 (*Palaeohypotodus lerichei – Otodus minor minor*); for the Lower–Middle Eocene: Zone 3 (*Otodus obliquus*) and Zone 4 (*Otodus auriculatus*); for the Upper Eocene: Zone 5 (*Striatolamia rossica prima – Macrorhizodus praecursor*) and Zone 6 (*Striatolamia rossica usakensis – Macrorhizodus americanus*); for the Upper Eocene and Lower and Middle Oligocene: Zone 8 (*Otodus turgidus*) and 9 (*Lamiostoma gracilis*); for the Upper Oligocene – Middle Miocene: Zone 10 (*Odontaspis praecrassidens*), zone 11 (*Odontapsis molassica*) and 12 (*Odontaspis crassidens*). These zones were correlated with Western Europe and the United States (in part).

In chapter VI (14 pages) Glickman diagnosed another 41 species of shark and batoid, including 10 new species, one subspecies and one new genus: *Notidanus microdon* Agassiz, 1835; *N. serratissimus* Agassiz, 1844; *N. primigenius* Agassiz, 1843; *Gyropleurodus orientalis* Sinzow, 1899; *G. lerichei* Casier, 1947; *Rhinoptera raeburni* White, 1935; *R. daviesi* Woodward, 1889; *R. studeri* Agassiz, 1837; *Myliobatis *arambourgi* Glückman, 1964a; *M. toliapicus* Agassiz, 1843; *M. striatus* Buckland, 1837; *M. dixoni* Agassiz, 1843; *Echinorhinus *caspius* Glückman, 1964a; *Squalus orpiensis* Winkler, 1874; *S. minor* Daimeries, 1888; *Isistius trituratus* Winkler, 1874; *Dalatias *turkmenicus* Glückman, 1964a; *Ginglimostoma cf. africanum* Leriche, 1927; *G. thielensi* Winkler, 1873; *Squatirhina* sp, *Squatina prima* Winkler, 1874; *S. helophorus* Rogovic, 1860; *Scyliorhinus minutissimus* Winkler, 1873; *Physodon tertius* Winkler, 1874; *P. secundus* Winkler, 1874; *Galeorhinus gomphorhiza* Arambourg, 1952; *G. minor* Agassiz, 1843; *G. latus* Storms, 1894; *Galeocerdo latidens* Agassiz, 1843; *G. *cheganicus* Glückman, 1964a; *Paraorthacodus *turgaicus* Glückman, 1964a; *Odontaspis whitei* Arambourg, 1952; *O. whitei *gigas* (Arambourg) Glückman, 1964a; *O. denticulate* Agassiz, 1844; *O. *praecrassidens* Glückman, 1964a; *O. crassidens* Agassiz, 1843; *O. *tamdensis* Glückman, 1964a; *O. *baigubeki* Glückman, 1964a; *O. molassica* (Probst, 1879); **Araloselachus* Glückman, 1964a; *A. *agespensis* Glückman, 1964a; *Jaekelotodus *karagiensis* Glückman, 1964a. Information about the types was not given.

Summary (4 pages) consisted of tables with information about the distribution of shark species in the Paleogene and Miocene of the USSR as well as the ecological differentiation of shark species (coastal or open sea) for all zones. There is Latin names index. Thirty-one plates consisting of 686 photographs of the teeth of Jurassic, Cretaceous and Cenozoic elasmobranchs from the territory of the USSR.

18. Glickman L.S. 1964b. Subclass Elasmobranchii. Selachian fishes. In: D.V. Obruchev (Ed.) Fundamentals of Paleonotology, Vol. 11 (Agnata and fishes). Nauka Publishers, Moscow: 196–237. (39 figures, 6 plates, 172 references) [In Russian].

The chapter provides a review of the Elasmobranchii in a special volume of the "Fundamentals of Paleontology". The general part includes sections on the history of the shark study, morphology, principles of systematics, evolution, ecology and taphonomy, biological and geological significance, as well as the method of study of fossil material. The systematic part includes fossil and modern (but having fossil members of the group) taxa classified in two infraclasses: Orthodonti and Osteodonti (see Appendix 1). A brief diagnoses for 2 infraclasses, 8 superorders, 20 orders, 7 suborders, 9 superfamilies, 60 families, 4 subfamilies and 141 genera (of totally indexed 142[17] genera) was provided. Two new taxa: the family *Polyacrodontidae Glückman and the genus **Palaeohypotodus* Glückman were introduced. For all genera diagnosed, a type species and a both stratigraphic and geographic distribution were recorded. The 99 figures of six paleontological tables show teeth and other remains of 66 species, as well as the microstructure of teeth for 7 genera and species.

19. Glickman L.S. 1965. Sharks and stratigraphy of Tertiary deposits. In: V.V. Menner (Ed.). Problemy stratigrafii kaynozoya. Doklady sovetskikh geologov na XXII sessii Mezhdunarodnogo geologicheskogo kongressa (1964). Nedra, Moscow: 30–36. (1 table, 19 references) [In Russian with an English abstract].

[17]Excluding diagnosis for *Rhinchobatus*.

[Original abstract]: Despite an abundance of shark remains in Cenozoic deposits, the teeth of selachians are virtually unused for wide correlations. And yet the data published by M. Leriche, E. Casier and a number of other authors leave no doubts of a rapid variability of this group in time. This fact induced the author, who accumulated extensive collections from Paleogene deposits, to try and use the teeth of sharks for the compilation of a zonation of Paleogene deposits. As a result of this work, 9 zones have been established in the interval from the Upper Paleocene to Lower Oligocene. These zones are characterized by tooth associations and can be traced not only in a number of countries of the world but even on different continents: Paleocene: Zone I – *Otodus minor mediavus*; Zone II – *Otodus minor minor*, Lower Eocene: Zone III – *Otodus obliquus*; Middle Eocene: zone IV – *Otodus auriculatus*; Upper Eocene: Zone V – *Isurus praecursor*, Zone VI – *Isurus americanus*; Zone VII – *Isurus falcatus*; Oligocene: Zone VIII – *Otodus turgidus*; Zone IX – *Isurus gracilis*.

Taking into account the exceptionally wide distribution of Recent shark species in the oceans and a rapid variability in time of the teeth of even those species of sharks, which existed for a long time, one can assume that the remains of this particular group will serve in future as a basis for a global stratigraphic scale of Cenozoic deposits, which has been impossible to compile until now using any other group of organisms.

20. Belyaev G.M. and Glickman L.S. 1965. On mass accumulations of the teeth of sharks on the floor of the Pacific and Indian Oceans. In: V.V. Menner (Ed.). Problemy stratigrafii kaynozoya. Doklady sovetskih geologov na XXII sessii Mezhdunarodnogo geologicheskogo kongressa (1964). Nedra, Moscow: 74–79. (10 references) [In Russian with an English abstract].

[Original abstract]: During the voyages of e/s "Vitiaz" of the Institute of Oceanology of the Academy of Sciences of the USSR mass accumulations of shark teeth have been found on the floor of vast abyssal basins in the central parts of the Pacific and Indian oceans. The number of teeth exceeding 0,5 cm can be over 1,500 in one trawler catch. Judging by bottom samples, the total number of teeth (including small teeth of deep-sea sharks of the family Dalatiidae) can come to 1,000 for 1 square metre of the ocean floor. Mass accumulations of teeth have only been found at depths over 4 km and in the majority of cases of over 4,500 m. These tooth accumulations usually coincide with the places where ferro-manganese concretions occur on the ocean floor.

In such mass accumulations, there are together teeth of living sharks and extinct Tertiary species. Teeth of 22 species of sharks have been identified. The degree of fossilization of the different species corresponds to the geological age of these species. Three main types have been recognized: 1) most intensely fossilized teeth of Upper Miocene or Lower Pliocene species; 2) less fossilized teeth of species known from the period from the Pliocene and up to Recent times; 3) teeth without any signs of fossilization (except the dissolution of dentine) belonging to Recent species. These accumulations correspond to species typical of the Upper Miocene, Pliocene and Quaternary deposits in shelf seas.

The presence in the Pacific and Indian Oceans of tooth associations of similar specific composition but of different ages suggest that there is a possibility of using them for long-range stratigraphic correlations.

21. Glickman L.S. and Stolyarov A.S. 1966. Stratigraphy of the Upper Eocene of the Mangyshlak Peninsula based on paleoichthyological data. *Izvestiya Akademii Nauk SSSR. Seriya geologicheskaya*, **11**: 130–138. (2 figures, 9 references) [In Russian].

The paper deals with the Upper Eocene stratigraphy of the Mangyshlak peninsula (Amankizilit, Shorym and Aday formations) based on elasmobranch teeth. For all three formations, lithological characteristics and the composition of elasmobranch assemblages are given. From this information, a correlation of 11 key sections of Upper Eocene deposits, including the localities Ungaza, Usak, Kendyrly, Sullu-Kapy, Burlyu and others are made. Lithological descriptions of two cross-sections of the Amankizilit formation: Bokty and Sullu-Kapy are presented. A shark assemblage from the Middle Eocene Chat formation including species *Otodus auriculatus* (Blainville, 1818), *Striatolamia macrota* (Agassiz, 1843) and *Xyphodolamia eocaena* (Woodward, 1889) was briefly described. Different facies within the Amankizilit Formation are characterized by shark faunas containing both coastal waters and the open sea. They are referred to *Striatolamia rossica prima – Macrorhizodus praecursor* (*sensu* Glickman 1964a) shark zone. The Shorym Formation consists of shark teeth *Striatolamia rossica usakensis* Glückman, 1964a *Jaekelotodus trigonalis* (Jaekel, 1895) *medius* Glückman, 1964a, *Macrorhizodus americanus*

(Leriche, 1942), *Otodus angustidens* (Agassiz, 1843), *Alopias exiqua* (Probst, 1879), *A. latidens* (Leriche, 1909), *Notidanus primigenius* Agassiz, 1843. Chalk-like marl of Aday formation consists of the complex of *Otodus sokolowi* shark zone: *Jaekelotodus trigonalis trigonalis* (Jaekel, 1895), *Striatolamia rossica rossica* (Jaekel, 1895), *Macrorhizodus falcatus* (Rogovich, 1860), *Otodus sokolowi* (Jaekel, 1895). An analysis of changes in regional shark faunas from the middle Eocene to Oligocene, based both on the appearance / disappearance of species and the quantitative ratio of taxa was presented. In particular, the regional fauna during the Late Eocene showed a change of dominance: *Macrorhizodus* spp. displaced both *Striatolamia rossica* and *Jaekelotodus*; and at the end of the Aday times, Oligocene taxa *Odontaspis dubia* Agassiz, 1843, *O. denticulata* Agassiz, 1843 (*Macrorhizodus falcatus* zone) appeared.

22. Glickman L.S. 1967. Subclass Elasmobranchii (sharks). In: D.V. Obruchev (Ed.). Fundamentals of paleontology. Israel Program for Scientific Translations, Jerusalem, **2**: 292–352.

Translation without changes of other publication by the author (see Glickman 1964b).

23. Glickman L.S. and Ischenko V.V. 1967. Marine Miocene deposits in the Middle Asia. *Doklady Akademii Nauk SSSR. Seriya geologicheskaya*, **177**(3): 662–665. (1 figure, 12 references) [In Russian].

The paper provides a brief overview of the Tertiary stratigraphy of the Fergana Valley and Tajik Depression, with ideas about an age of the individual formations. Shark teeth from the Sumsar beds of different regions of Central Asia were identified and partly figured: *Odontaspis molassica* Probst, 1879, *Araloselachus agespensis* Glückman, 1964a, *Odontaspis vorax* Le Hon, 1871, *Odontaspis* sp., *Notidanus primigenius* Agassiz, 1843, *Scoliodon taxandriae* Leriche, 1940, *Scoliodon kraussi* Probst, 1878, *Scoliodon* sp., *Galeocerdo aduncus* Agassiz, 1843, *Galeocerdo praecursor* Dartvelle & Casier, 1959, *Squatina* sp., *Actobatis arcuatus* Agassiz, 1843 and *Myliobatis meridionalis* Gervais, 1852. According to this assemblage, the age of Sumsar beds was Lower Miocene (*Odontaspis molassica* shark zone). The Oligocene and Miocene stratigraphy and paleogeography of the region, as well as that of adjacent areas of northern Afghanistan and central Iran was discussed.

24. Glickman L.S. 1968. Are you familiar with a shark? (Foreword and the Notes to the book). In: McCormick H.W., Allen T., Young W.E. Shadows in the sea. The sharks, skates and rays. Translated from English by G.A. Ostrovsky. Gidrometeoizdat, Leningrad: 6–8 and 223–228. [In Russian].

A short foreword to the Russian edition of well-known popular book. It briefly talks about the biology of sharks, their diversity, geological history and a modern commercial value. It mentions that fossil shark teeth can be collected in different regions of the USSR and their remains are abundant at some horizons (e.g. in vicinity of Saratov city and Kamyshin town in the Volga River Basin), virtually "shark cemeteries". At the end of the book (Notes), Glickman lists 57 references with term descriptions and comments.

25. Glickman L.S., Zhelezko V.I., Lazur O.G. and Segedin R.A. 1970. New data about the age of Upper Cretaceous phosphorite-bearing deposits in a region of upper reaches of Ilek and Temir rivers in the Western Kazakhstan. *Byulleten' Moskovskogo obshchestva ispytatelej prirody. Otdel geologicheskij*, **14**(6): 73–80. (3 figures, 10 references) [In Russian].

The paper concerns the biostratigraphy of the Santonian–Campanian phosphorite-bearing deposits of upper reaches of the Ilek and Temir rivers in the western Kazakhstan (now Aktobe Province). The history of their study is briefly described. Based on belemnites and shark teeth, it was concluded that these phosphorite-bearing deposits were Campanian in age excepting the lowermost part of the section (member A) which is Upper Santonian borne out by the presence of teeth *Ptychodus rugosus* Dixon, 1850. The phosphorite-bearing deposits are subdivided into two lithological complexes: Kubley Beds (lower complex) and Zhurun Beds (upper complex). The Kubley beds consists of interbedded clays, silts and sands with several phosphorite layers containing belemnites and shark teeth *Anacorax kaupi* (Agassiz, 1843), *A. yangaensis* Dartvelle & Casier, 1943, *Odontaspis venusta* (Leriche, 1906). The Zhurun beds consists of silts with three phosphorite layers with shark teeth *Anacorax kaupi*. In the western part of the area, the phosphorite layers combine to form a single phosphate member. Prior to this study, these deposits were dated as the Lower and Upper Santonian. A correlation scheme for 12 cross-sections was presented, as well as a list of shark taxa collected from the different members of the phosphorite deposits but with no detailed distribution: *Anacorax falcatus* (Agassiz, 1843), *Anacorax santonicus* Glückman [*nomen nudum*], *Meristodon* sp, *Orthacoides* sp., *Pseudocorax laevis* (Leriche, 1906), *Odontaspis macrorhiza* (Cope, 1875), *Cretoxyrhina mantelli* (Agassiz, 1843), *Cretolamna appendiculata* (Agassiz, 1843), *Ptychocorax* sp., *Synechodus* sp., *Squatina* sp. and others.

26. Belyaev G.M. and Glickman L.S. 1970a. The teeth of sharks on the floor of the Pacific Ocean. *Trudy instituta okeanologii imeni P.P. Shirshova, Academy of Sciences USSR*, **88**: 236–251. (4 figures, 2 tables, 2 text appendixes, 2 plates, 61 references) [In Russian].

[Original abstract]: During the cruises of R/V "Vityaz" mass accumulations of shark teeth have been found on the floor of vast abyssal basins (deeper than 4–4.5 km) in the central part of the Pacific Ocean. The number of teeth larger than 0.5 cm can be over 1,500 in one trawl catch and judging by bottom-sampler samples up to 60 specimens per one square meter of the ocean floor. The regions of teeth accumulations are characterized by very low biological productivity, very low rate of sedimentation, by sediments of red clays type, and by abundance of ferro-manganese nodules on the surface of the ocean floor. There are teeth of living sharks along with teeth of extinct Tertiary species in such mass accumulations. Teeth of 26 species of sharks have been identified. Three main types have been recognized on the basis of systematic composition and the extent of the fossilization of teeth: 1) most intensely fossilized teeth of Upper Miocene or Lower Pliocene species; 2) less fossilized teeth of species known from the period from the Pliocene and up to Recent times; 3) teeth without any signs of fossilization (except the dissolution of dentine) belonging to Recent species. A table of the quantitative distribution of shark teeth on the floor of the Pacific Ocean is constructed. The questions of the mosaic distribution of the outcrops of the Tertiary sediments on the ocean floor and of the unevenness of the sedimentation and its rate are discussed.

27. Belyaev G.M. and Glickman L.S. 1970b. On the geologic age of the teeth of shark *Megaselachus megalodon* (Agassiz). *Trudy instituta okeanologii imeni P.P. Shirshova, Academy of Sciences USSR*, **88**: 277–280. (1 plate, 12 references) [In Russian].

[Original abstract]: Numerous shark teeth including teeth of giant extinct shark *Megaselachus megalodon* (Agassiz, 1837) have been found on the floor of the vast central regions of the Pacific and Indian oceans. The teeth of this shark are characteristic of Upper Miocene and Lower Pliocene deposits of the platform seas of all the continents but are not found in the Quaternary ones. Two attempts to determine *M. megalodon*'s age on the basis of thickness of the ferro-manganese crust on the teeth from the ocean floor were made. It was suggested that this shark disappeared in Holocene only some thousand years ago (Tschernezky 1959; Gipp and Kuznetzov 1961). This data was discussed. Based on the examination of the various types of ferro-manganese deposits on the numerous sharks' teeth, the supposition that *M. megalodon* disappeared in the post-Pliocene time is shown to be wrong.

28. Glickman L.S. and Shvazhaite R.A. 1971. Sharks of the family Anacoracidae from Cenomanian and Turonian of Lithuania, Pre-Volga's region and Middle Asia. In: Paleontologiya i stratigrafiya Pribaltiki i Belorussii. Mintis, Vilnius, **3**: 185–193. (1 plate, 7 references) [In Russian with English summary].

The paper discuses the biostratigraphic significance of the lamnoid shark family Anacoracidae. The type section of the Jiesia formation near the village of Vareikia (Sventoji River) in Lithuania is briefly described. The age of the formation was determined to be Cenomanian (probably, earliest Cenomanian) based on the presence of the teeth of *Scapanorhinchus subulatus* Agassiz, 1843 and *Gyropleurodus canaliculatus* (Egerton in Dixon, 1850). Layer 3 in the section is a type stratum for a new genus and species *Eoanacorax dalinkevichiusi* Glückman & Shvazhaite, 1971 (holotype IGV №14/1134)[18]. The species *E. dalinkevichiusi* is supposed to be intermediate form between families Odontaspididae and Anacoracidae. A replacement name *Palaeoanacorax* Glückman in Glickman & Shvazhaite, 1971 is introduced instead of the preoccupied name *Palaeocorax* Glückman, 1956b. Based on material from the Volga River Basin and Central Asia, a species *Palaeoanacorax obliquus* (Reuss, 1845) is redescribed as well as three new species: *Palaeoanacorax volgensis* Glückman in Glickman & Shvazhaite, 1971 (holotype IGGP 2936/181; from the Lower Cenomanian of Nizhnyaya Bannovka settlement, Saratov Province[19]), *Palaeoanacorax pamiricus* Glückman in Glickman & Shvazhaite,

[18]The figured paratypes (figs. 2–3) are housed in the SDM collection, specimens 8057/67 and 8057/68.

[19]Later figured holotype of *Palaeoanacorax volgensis* (Glickman 1980: pl. 13, fig. 18) and indexed as well as lectotype in the SDM collection (8057/5) come from another locality (probably locality in Saratov no longer exposed) based on

1971 (holotype IGGP 2936/270; from the Lower Turonian, area of Kulyab town, Tajik SSR) and *P. intermedius* Glückman in Glickman & Shvazhaite, 1971 (holotype IGGP 2936/56; basal layer of the Upper Turonian, area of Aksyrtau town, Mangyshlak Peninsula). Based on the evolution of the two anacoracid genera biostratigraphic zones (conditionally correlated with zones for orthostratigraphic invertebrates) were erected: *Eoanacorax dalinkevichiusi* (basal of the Lower Cenomanian), *Palaeoanacorax volgensis* (Lower Cenomanian), *P. obliquus* (Upper Cenomanian), *P. pamiricus* (Lower Turonian), *P. intermedius* (Upper Turonian).

29. Zhelezko V.I. and Glickman L.S. 1971. About Cenomanian deposits of Western Kazakhstan and some Cretaceous sclerophagous sharks. In: Problemy geologii Zapadnogo Kazahstana (k 60-letiyu akademika Aleksandra Leonidovicha Yanshina). Nauka Kazakh SSR Publishers: 179–188. (2 tables, 2 figures, 17 references) [In Russian].

The paper starts with a brief review of history of the biostratigraphic use of sharks' teeth in the World and in the USSR. Based on shark teeth, the stratigraphy, stage and substage correlation of the Cenomanian from the Russian Plate (sections near Saratov and Nizhnyaya Bannovka settlement in the Saratov Province, Volga River basin; Nogajty River and Taskuduk section in the Precaspian depression, Sagiz River basin) and from the Mangyshlak Peninsula (Sullukapy, Aksyirtau and Besokty sections) is discussed and figured. There are defined three biostratigraphic shark zones from the Cenomanian of western Kazakhstan (oldest first): (I) *Palaeoanacorax volgensis* zone, (II) *Palaeoanacorax subserratus* zone and (III) *P. obliquus* zone. Several *nomina nuda* were introduced in the paper: *Eostriatolamiidae, *Eostriatolamia* **acutidens* Glückman, *E.* **archangelskii* Glückman and *Palaeoanacorax* **subserratus* Glückman. The second part of the paper is devoted to a description of the hybodontid shark species from the Upper Cretaceous of western Kazakhstan. A new genus of hybodontid sharks **Pseudoheterodontus* Glückman & Zhelezko, 1971 with the type species *P. rugosus* (Agassiz, 1843) (from the Campanian–Maastrichtian) and *P. polydictios* (Reuss, 1846) (from the Albian–Cenomanian) were described. Other taxa were described and figured: *Acrodus levis* Woodward, 1887 (from the Albian–Cenomanian); *Polyacrodus illingworthi* Dixon, 1850 (from the Cenomanian); *P. brabanticus* Leriche, 1930 (from the Campanian). It was assumed that an absence of sclerophagous (duraphagous) hybodontids in the Turonian–Santonian of western Europe, the Volga River basin and western Kazakhstan was a result of their replacement by Ptychodontidae sharks (*Ptychodus* spp.).

30. Glikman L.S. Konovalov S.M. and Rassadnikov O.A. 1973. The direction of evolutional development of chondrocranium of the salmons of the genera *Salvelinus*, *Salmo* and *Oncorhynchus*. *Doklady Akademii Nauk SSSR*, **211**(6): 1472–1474. (1 figure, 7 references) [In Russian].

Chondrocrania of the recent salmonid fishes from an area of the Abadzekh Lake, Kamchatka Peninsula were studied. A new salmon genus *Paraoncorhynchus* Glickman et al., 1973 was diagnosed based on the features of chondrocranium, mainly by the absence of frontal fontanels. The new genus consisted of three species: Chinook salmon (chavycha) *Salmo tschawytsha* Walbaum, 1792 (type species), Chum salmon (keta) *Oncorhynchus keta* Walbaum, 1792 and Coho salmon (kizhuch) *O. kisutsch* (Walbaum, 1792). It has been suggested that the new genus is most specialized and advanced in a series of genera: *Salvelinus – Salmo – Onchorhynchus – Paraoncorhynchus*, and morphological evolution of the genus *Onchorhynchus* to *Paraoncorhynchus* went through anaboly of cartilage and bone in the skull, resulting in a heavily protected brain (by the elimination of the rudimentary dorsal fontanels, narrowing of the cranial nerves openings, etc.).

31. Sochava A.V. and Glickman L.S. 1973. Cyclic variations of free oxygen content in the atmosphere and their bearing on evolution. In: Materialy evolyutsionnogo seminara. Vladivostok, **1**: 68–87. (1 table, 4 figures, 21 references) [In Russian with English abstract].

This paper consists of eight sections, two of which were written by L.S. Glickman and dedicated to sharks (section 5) and euryoxybiothic invertebrates (section 6). The research develops the ideas of Berkner and Marshall (1966)[20] and McAlester (1970) on cyclic changes of free oxygen in the atmo-

the particular preservation of the type which is differs greatly of material from both type stratum and locality. The actual depository of original types is currently unknown. EVP pers. observation, 2015.

[20]This is translated version of the paper published in Russian

sphere during the Phanerozoic. These changes have had a significant impact on the evolution of both lithogenesis and the biosphere. Data on terrestrial lithogenesis was prepared by the first author are used as an example. Increasing of areas with red beds were not only related to climate changes (aridity), but also with the stages of increasing of atmospheric oxygen content. The global distribution of this process is illustrated in the table 1 by the ratio of red and coal-bearing Jurassic and Cretaceous formations from Middle and Central Asia and North America. The time of the greatest proliferation of red continental beds was during the Late Jurassic, Late Albian–Cenomanian and the Senonian. The minimum atmospheric oxygen, in contrast, existed in times of intensive coal formation in Rhaetian, Early and Middle Jurassic, Early Aptian–Albian, at the end of Senonian and in the Early Paleogene. The cyclic oxygen content was reflected in the evolution of reptiles, mammals in the fig. 3, and terrestrial plants (with a time shift). A hypothetical curve of the change of free atmospheric oxygen content from the Late Triassic to present is shown in the fig. 4. An increase in the atmospheric oxygen content creates favors highly active groups of organisms, whereas a significant decline of oxygen leads to their extinction.

Data on the evolution of sharks (section 5) is placed into the context of this hypothesis, based on collection of L.S. Glickman[21]. Table 2 shows the stratigraphic distribution of the most important genera and families of sharks from the Late Triassic to present, with an indication of their relative diversity and "degree of specialization/progressivity". The origin of new shark groups coincides with the beginning of the following intervals: Late Jurassic, Late Albian, Late Santonian[22], Danian, Early Eocene, Early Oligocene, Miocene and Quaternary. These changes in dominant groups was accompanied by the extinction of large pelagic predators or large sclerophagus sharks at beginning of the following stages: Aptian, Late Campanian, Danian (Montian), Early Eocene, Early Oligocene and late Pliocene. The origin of new groups coincides with lithological data on increasing of oxygen content in Danian (Montian), Early–middle Eocene, Early–Middle Oligocene, Early–Middle Miocene and the Quaternary. Origin of "recurrentis forms" [=temporary drived back taxa; =? Lazarus taxa] by two types: primitive relict group of pelagic predators (Hexanchidae, Squalidae, Orthacodontidae) or progressive coastal/small benthic predators (batoids, Scyliorhinidae) were related to oxygen cyclicity. In times of low atmospheric oxygen, these groups are reduced in diversity and are driven back to refugia.

32. Glickman L.S. 1974 (unpublished). Patterns of evolution of the Cretaceous and Cenozoic Lamnoid sharks. Abstract of the Doctor of Biological Sciences thesis. Moscow, 49 p. (2 tables) [In Russian].

An unpublished abstract of unfinished Doctoral dissertation in Biology (highest scientific degree in biology). A structure of the text: Introduction; Chapter 1. Comparative morphology of orthodont and osteodont sharks; Chapter 2. Morphological features of shark teeth; Chapter 3. Description of the species; Chapter 4. Evolutionary pattern of lamnoid sharks; Chapter 5. Paleozoogeography of the sharks; Chapter 6. Stratigraphic significance of sharks; Conclusion; A list of the author's publications on the subject of the thesis (24 references).

33. Glikman L.S. 1976. Peculiarities of the cranium texture in Far East salmon and the other Salmonidae. In: Lososevye ryby (morfologiya, sistematika i ekologiya). Zoological Institute of the Academy of Sciences of the USSR, Leningrad: 19. [In Russian].

Abstract of the report: The ontogenetic stages identified in the development of the chondrocranium of the Far Eastern salmon are described (three stages were erected). The development shows strong heterochrony and remodeling of cartilage and bone. In general, the chondrocranium of the Salmonidae is more evolutionarily advanced than that of Clupeiformes, Cypriniformes and Perciformes.

34. Zharkov M.P., Glickman L.S., Kaplan A.A., Krasnov S.G. and Strelnykova N.I. 1976. On the age of the Paleogene of Kaliningrad region. *Izvestiya Akademii Nauk SSSR. Seriya geologicheskaya,* **1**: 132–135. (9 references) [In Russain].

This short paper dealt with an age determination of the Paleogene stratigraphic units of the Samland Peninsula (Kaliningrad Province of the USSR) based on algal remains and shark teeth. Based on remains of diatoms and silicoflagellates from clay and silty-clay sediments of the Sambia formation (bore hole "2–Pionersk"), the age of this formation was determined

[21]The volume of collection was estimated by the author as more than 200,000 specimens.

[22]This interval was indicated in the table 2 only.

as Early Eocene. The shark teeth obtained from 79 bore holes as well as from several natural sections were analyzed taking into account the peculiarities of their burial and re-deposition. Numerous shark teeth from the both of autochthonous intervals as well as from a series of erosional levels in the upper part of Alk Formation (underlying amber-bearing Prussian Formation) were identified as the following: *Notidanus primigenius* Agassiz, 1843, *N. serratissimus* Agassiz, 1843, *Squatina prima* (Winkler, 1876), *Physodon tertius* (Winkler, 1874), *Galeorhinus loangoensis* Dartvelle & Casier, 1943 *Anomotodon biflexus* (Rogovich, 1860), *Procarcharodon auriticulatus* (Blainville, 1818), *Lamiostoma vincenti* (Winkler, 1876), *Jaekelotodus trigonalis* (Jaekel, 1895), *Odontaspis winkleri* Leriche, 1905, *Hypotodus africanus* (Arambourg, 1952), *Macrorhizodus praecursor* (Leriche, 1905) and *Striatolamia rossica* (Jaekel, 1895). This assemblage was correlated with uppermost part of the Alk Formation, lower Upper Eocene and represents coastal or shallow areas of open sea. The "green wall" deposits overlying Prussian Formation were dated as Oligocene based on shark teeth (*Notidanus primigenius*, *Procarcharodon* sp., *Odontaspis dubia* Agassiz, 1843). With additional absolute age data about from glauconite, the age of these deposits were dated as Lower Oligocene.

35. Glickman L.S. and Zhelezko V.I. 1979. Sharks. In: Granica santona i kampana na Vostochno-Evropejskoj platforme (Sbornik nauchnykh statey po materialam polevogo simpoziuma, 1974). Uralian Scientific Center of the AS USSR, Sverdlovsk: 90–105. (1 table, 1 plate) [In Russian].

The paper describes shark assemblages from the Santonian and Campanian deposits of the upper reaches of Ilek and Temir Rivers (Aktubinsk Province; now Aktobe region of Kazakhstan); These shark assemblages are defined layer by layer and linked with the cross-sections described in another article in this book (Zhelezko et al. 1979). Five genera and 8 species of lamnoid sharks, including 4 new genera and 5 new species, are diagnosed and/or described: *Anacorax* White & Moy Thomas, 1940; *Anacorax kaupi* (Agassiz, 1843); *Anacorax lindstromi* (Davis, 1890); *Anacorax santonicus* Glückman & Zhelezko, 1979 (holotype IGGP 2936/109, from the base of phosphorite horizon of the Lower Santonian, the upper reaches of Sagursay River near the Tavricheskij settlement in the Aktjubinsk Province); *Paraanacorax* Glückman in Glickman & Zhelezko, 1979 (type species *Corax bassanii* Gemmellaro, 1920); *P. obruchevi* Glückman in Glickman & Zhelezko, 1979 (holotype IGGP 2936/2697, from the Alym-Tau mountains near Tashkent, southern Kazakhstan); *Ptychocorax* Glückman, 1979 (type species *Acrodus (Palaeobates) dolloi* Leriche, 1929); *Microanacorax* Glückman in Glickman & Zhelezko, 1979 (type species *Corax yangaensis* Dartvelle & Casier, 1949); *M. praeyangaensis* Glückman in Glickman & Zhelezko, 1979 (holotype IGGP 2936/150, from the Upper Santonian of Kublei Creek); *Eostriatolamia* Glückman in Glickman & Zhelezko, 1979 (type species *Lamna venusta* Leriche, 1906); *E. segedini* Glückman & Zhelezko, 1979 (holotype IGGP № 2936/165, from the Lower Santonian of Tykbutak Creek, western Mugodzhary); *E. venusta* (Leriche, 1906); *E. lerichei* Glückman & Zhelezko, 1979 (holotype IGGP 2936/166, from the Lower Campanian (beds with *Belemnitella mucronatiformes* Jel.) of the Shijli Creek, Emba River basin, western Mugodzhary). A stratigraphic distribution of 25 species of elasmobranchs from the Santonian and Campanian of Aktobe-Mugodzhary region is shown in the table. On the basis of this data 4 biostratigraphic shark zones are proposed: *Anacorax santonicus* (Lower Santonian), *A. kaupi* (Upper Santonian), *A. lindstromi* (Lower Campanian), *A. plicatus* (Upper Campanian). The zones show a wide distribution in the USSR (Mangyshlak, Central Asia, Eastern European platform), and some taxa of the zonal assemblages are also present abroad (North America, France, Belgium, Sweden, Madagascar).

36. Glickman L.S. 1980. Evolution of Cretaceous and Cenozoic Lamnoid sharks. Nauka, Moscow, 248 p. (24 figures, 6 tables, 33 plates, 545 references) [In Russian].

The monograph consists of following parts: Introduction (4 pages), Conclusion (3 pages) and 7 unnumbered chapters: (1) A brief review of the literature (4 pages); (2) Comparative morphology of osteodonts and orthodonts (40 pages); (3) Morphological features of the teeth of lamnoid sharks (44 pages); (4) Description of the species (26 pages); (5) Evolutionary patterns of lamnoid sharks (23 pages); (6) Paleozoogeography of sharks (34 pages), and (7) Stratigraphic significance of sharks (5 pages).

The section (2) discusses advanced characters of the sharks. A brief description of anatomy of lamnoid sharks is examined with an emphasis on chondrocranium of *Lamna ditropis* Hubbs & Follett, 1947. Structural features of lamnoid skulls compared with orthodont skulls (50 characters) as well as cranial characters of modern orthodonts (51 characters) are discussed. The anatomical ideas by Holmgren (1941) about batoids as a separate group of elasmobranchs was critically discussed. Anatomical features of xenacantids are described and a "transitional form to the orthodonts" – a monotypic family *Xenosynechodontidae with a new genus and species **Xenosynechodus* **egloni* Glückman (holotype PIN 157/501) from the Upper Permian of Isheevo locality, European Russia are described as well. Other morphological characters of lamnoid sharks (axial skeleton, fins, fin spines, circulatory system and dentition) are also discussed.

The section (3) discusses following questions: a macrostructure of teeth of lamnoid sharks (lateral cusplets, the main part of the crown and the root; tooth neck); subordination of morphological characters (38 points) and their evolutionary changes (38 points); parallel evolution of the characters in different phylogenetic lineages; structural polymorphism of the teeth. The taxonomic value of the tooth characters and their variability was discussed and a morphometric method for tooth description and a plan of tooth description was introduced.

The descriptive section (4) focuses on the Anacoracidae. There are diagnoses of 12 genera and 11 species and two subspecies, including 8 new genera, 10 new species and 1 subspecies[23]: *Eoanacorax* Glückman & Schwajeaite, 1971; *E. dalinkevicius* Glückman & Schwajeaite; *Palaeoanacorax* Glückman, 1971; *P. volgensis* Glückman, 1971; *P. obliquus* (Reuss, 1845), *P. obliquus obliquus* (Reuss, 1845); *P. obliquus* (Reuss, 1845) **subserrarus* Glückman, 1980; *P. pamiricus* Glückman, 1971; *P. intermedius* Glückman, 1971; **Paraanacorax* Glückman, 1980; *P. bassanii* (Gemmellaro, 1920); *P.* **obruchevi* Glückman, 1980; **Ptychocorax* Glückman & Istchenko, 1980[24]; *P.* **aulaticus* Glückman & Istchenko, 1980; *P.* **hybodontoides* Glückman, 1980; **Praeptychocorax* Glückman, 1980; *P. curvatus* (Williston, 1900); *Squalicorax* Whitley, 1939; *S.* **sagisicus* Glückman, 1980; *S. falcatus* (Agassiz, 1843); *Anacorax* White & Moy-Thomas, 1940; *A.* **santonicus* Glückman & Zhelezko, 1980; *A. kaupi* (Agassiz, 1843); *A. lindstromi* (Davis, 1890); *A. plicatus* (Priem, 1898); *A. pristodontus* (Agassiz, 1843); **Microanacorax* Glückman, 1980; *M.* **praeyangaensis* Glückman, 1980. Several other lamnoid taxa are described: **Protoscapanorhynchus* Glückman, 1980; *P.* **eorhaphiodon* Glückman, 1980; *Scapanorhynchus* **darvasicus* Glückman, 1980; *S.* **armenicus* Glückman, 1980; **Rhaphiodus* Glückman, 1980 (type species – *Lamna texana* Roemer, 1852); **Eostriatolamia* Glückman, 1980 (type species – *Lamna venusta* Leriche, 1906); **Eoxyphodolamia* Glückman, 1980; *E.* **mangislakensis* Glückman, 1980. Information about nomenclature types was listed.

The evolutionary section (5) analyzes the evolution and phylogeny of the family Anacoracidae. The evolution of the Scapanorhynchidae and Odontapsididae was also discussed. "Paleogenetic data" are briefly discussed, e.g. "fen" (individual variation in population) the existance of "*Eostriatolamia angustidens*" (teeth without lateral cusplets) within material of *E. subulata* species during the Cenomanian and an evolution of a separate species based on individual variations of this kind in the Turonian.

Section on paleogeography (6) critically analyzes the data by Engelhardt (1913); discusses bionomy of elasmobranchs; analyzes the global distribution of the Recent, Neogene and Paleogene elasmobranchs. Localities of fossil sharks in the Soviet Union, their distribution pattern during the Cretaceous period are based on collections from this territory for following ages: Pre-Albian, Albian, Early and Late Cenomanian, Turonian, Coniacian, Early and Late Santonian, Early and Late Campanian, Maastrichtian and Danian. Table 6 shows the percentage of different taxa in 83 bulk samples (N = 59,794 specimens) from the Valanginian to Turonian of different regions of the USSR.

The brief stratigraphic section (7) discusses the problem of Danian and Montian stages, and summarizes data about distribution of sharks during the Cretaceous.

There are 33 plates showing the skull of modern sharks *Isurus oxyrinchus* (Müller & Henle, 1839) and *Carcharhinus longimanus* (Poey, 1861) (plates 1–5), teeth microstructure (plate 6 with 8 figures) as well as other plates with 195 photographs and 299 line-drawings of sharks and rays teeth from the Cretaceous to the Recent.

[23]Most of the new anacoracid genera and species were diagnosed as new taxa year earlier, see Glickman and Zhelezko 1979.

[24]Misprinted as *Phychocorax* and *Ptachorocax*.

37. Glickman L.S. and Dolganov V.N. 1980. On the worldwide distribution of the shark *Isurus oxyrhinchus* in the World ocean. In: Biologiya korallovyh rifov (morfologiya, sistematika, ekologiya). Sbornik nauchnykh statey. Nauka Publishers, Moscow: 61–64. (1 figure, 7 references) [In Russian with English summary].

The species *Isurus oxyrhinus* Rafinesque, 1810 was usually considered to inhabit only the Atlantic Ocean. In the Pacific and Indian Oceans it was replaced by the closely related species *Isuropsis glaucus* (Müller & Henle, 1839) *sensu* Glickman (1964a). In 1977, a specimen of *Isurus oxyrhynchus* (female, TL=150.5 cm, weight 27 kg) was caught in the Pacific Ocean east of Japan (43°26´N, 158°26´E). Morphometric data on this specimen was presented including gastric contents (14 specimens of mackerel and 6 specimens of iwashi). However, the authors believed that the use of plastic characters for the identification and description of shark taxa (family, genus, species) is flawed and more anatomical features (skull, jaw, teeth) should be used in diagnosis[25]. The dental formula was 13/13 (within half of the upper and lower jaws). According to the results of sea floor sampling by R/V "Vityaz", *Isurus oxyrinchus* was a principal species in the Pacific and Indian Oceans, and *Isuropsis glaucus* was rare. In terms of tooth morphology, *Isuropsis glaucus* has larger anterior teeth in adults (up to 3.5–3.7 cm) than *Isurus oxyrhinchus* (up to 2–2.2 cm).

38. Glickman L.[S.] and Dolganov V.[M.] 1983. Sharks: facts, true stories and tall tales. In: Okean i chelovek (nauchno-populyarnyy sbornik). Dal'nevostochnoe knizhnoe izdatel'stvo, Vladivostok: 60–79. [In Russian].

The article in the scientific popular collection "The Ocean and the man" show some well-known published cases of shark attacks on human (1897–1963). Some of the "myths about sharks" in the Soviet and foreign literature of XX century were critically reviewed. It discussed sharks of different sizes (from 0.25 to 23 m), the most predatory of which reach 6 m (modern *Carcharodon*) or 25 m (extinct *Megaselachus*) and the "vocarity" of sharks and their stomachs contents. They discussed the myth of the primitiveness of sharks as a group and their evolutionary immutability. They also covered the anatomy and biology of sharks, including the highly developed sense organs. The last section entitled "The Sharks and the geological record" describes the evolutionary history of the group for the last 370 million years.

39. Glickman L.S. and Zhelezko V.I. 1985. Paleogene sharks of the Mangyshlak Peninsula and the Eocene/Oligocene boundary. *Byulleten' Moskovskogo obshhestva ispytatelej prirody. Otdel geologicheskiy*, **60**(5): 86–99. (2 figures, 2 tables, 1 plate, 20 references) [In Russian].

The paper provides a brief description of lithology, microfauna and ichthyofauna (sharks) from the Eocene (Amankizilit, Shorym and Aday formations) and the Oligocene formations (Uzunbass and Kuyuluss formations) of the Mangyshlak Peninsula. The distribution of 37 taxa (species, subspecies) of lamnoid and other sharks in the formations were analyzed. Stratigraphic logs for the localities Ungoza, Usak and Uzunbass were given. The phylogenetic relationships between Eocene–Oligocene shark species and subspecies of the biostratigraphicaly important genera *Striatolamia*, *Lamiostoma*, *Macrorhizodus*, *Procarcharodon* and *Jaekelotodus*, were demonstrated. On the basis of this scheme, paleoeichthyological zones (from bottom to the top) are assigned: (1) *Macrorhizodus praecursor* – *Striatolamia rossica prima*; (2) *Macrorhizodus* ex. gr. *americanus* – *Lamiostoma bajarunasi*; (3) *Macrorhizodus americanus* – *Striatolamia rossica usakensis*; (4) *Macrorhizodus falcatus*; (5) *M. falcatus maximus* – *Procarcharodon turgidus*; (6) *Lamiostoma gracilis*. These zonal assemblages reflect stages of shark evolution in the European paleobiogeographic area. Based on these stages, two major phases of shark evolution: an Eocene phase and an Oligocene can be identified. A clear boundary between these phases lies between zones (4) and (5). A comparison of the Mangyshlak formations with Eocene and Oligocene units from the England, France and Belgium based on sharks was carried out. These zones can be used to place the position of Paleogene stratigraphic units from European sections. In particular, it effectively identifies Rupelian stage of the Oligocene. From the Shorym Formation (Upper Eocene) of the Mangyshlak two new species were described: *Lamiostoma bajarunasi* Glückman & Zhelezko, 1985 (holotype IGG 2СП / 8-27-3) and *L. menneri* Glückman & Zhelezko, 1985 (holotype IGG 2СП / 34-5-3).

40. Glickman L.S., Mertiniene R.A., Nessov L.A., Rozhdestvensky A.K., Khosatzky L.I. and Yakovlev V.N. 1987. Vertebrates. In: Strati-

[25]This concept as well as validity of *Isuropsis glaucus* were criticized by Pinchuk (1983).

grafiya SSSR. Melovaya sistema. Polutom 2. Nedra, Moscow: 252–262. [In Russian].

This chapter reviews the Cretaceous vertebrates of the USSR including chondrichthyans (the section was prepared by first three authors). [Original text]: Cretaceous elasmobranchs are divided into three ecological groups: living mainly in the coastal areas of the sea with normal salinity, living in open sea and living in brackish estuary waters. The occurences of pelagic sharks into coastal waters and sometimes in estuaries allows the correlation of sediments of different facies. Cretaceous Holocephali were common in the coastal areas of shallow seas.

Remains of the elasmobranch orders Hybodontida, Orthodontia, Odontaspidida, Polyacrodontida, Hexanchida, Squatinida and Carcharhinida are known from Cretaceous of the USSR. The most biostratigraphically important taxa for normal marine Cretaceous sediments in the European part of the USSR, as well as Transcaucasia, western and partly southern Kazakhstan, Turkmenistan, Tajikistan and Sakhalin are Odontaspidida (Anacoracidae, Striatolamiidae [*nomen nudum*], Scapanorhynchidae, *Paraisurus, Cretoxyrhina, Cretolamna, Pseudocorax, Pseudoisurus, Rhaphiodus, Cretaspis*) and Hybodontida (Ptychodontidae). For the biostratigraphy of estuarine and brackish basins the most important elasmobranchs were the Hybodontidae, Hypolophidae, Sclerorhynchidae and Polyacrodontidae. Such basins, being mosaically interspersed with areas of coastal lowlands in the Cretaceous of the USSR were common along the periphery of the ancient landmass, for example in the late Cenomanian (the upper part of Hodzhakul Formation) and Late Turonian–Coniacian (Taykarshin Member) in Kyzylkum, in early Santonian of the north-eastern Aral Sea region (Bostobe Formation) and in the Fergana region (Yalovach Formation).

Sharks of the family Striatolamiidae (Neocomian–early Oligocene) were most common in the boreal Cretaceous of the USSR; Anacoracidae are known from the Late Albian to Late Maastrichtian, Scapanorhynchidae – from the Late Cenomanian to Maastrichtian and from the Early Eocene of Turkmenistan. Most sharks of the order Odontaspidida markedly increased in size by the Campanian. Some species of this order did not survive longer that one stage. The main complexes of marine sharks from the Albian–Maastrichtian of the USSR correlete well with those from other regions of the World. However, some genera were restricted to the northern regions, while others – to the southern regions.

Hauterivian and Barremian shark remains in the USSR (*Sphenodus, Squalus, Notidanus*) are known only from the Crimea. Teeth of the Late Aptian Hybodontidae and Lamnae have been collected on the west ridge Sultan-Uwais Mountains in the Kyzylkum: *Asteracanthus* from the Absheron Peninsula (Caspian Sea) is also possibly Aptian in age. Late Albian *Cretaspis*, *Odontaspis, Squatina, Cretoxyrhina*, Heterodontidae and other sharks were known from Lithuania, Ukraine, Belgorod region, the Volga region, Mangyshlak, Karakalpakstan. By the end of the Albian *Paraisurus* had disappeared. *Palaeoanacorax* first appears the Cenomanian, *Ptychodus* – in the Late Cenomanian. Shark remains were collected from the Cenomanian of the European part of Russia, in Western Kazakhstan, Crimea, Turkmenistan, Karakalpakstan, Tajikistan, on Sakhalin Island (Far East). The estuaries from the Late Albian to Cenomanian and those of the Late Turonian–Coniacian *Hybodus* and *Ischyrhiza* genera have different species associations. The rays *Pseudohypolophus* were inhabited inlets in the Late Albian and, probably, in the Cenomanian of Kyzylkum desert. Turonian shark remains are known from the Ukraine, Western Kazakhstan, Mangyshlak, Kyzylkum and Tajikistan. *Ptychodus rugosus* Dixon (*Ptychodus* remains become common) and species of *Palaeoanacorax* (see Glickman 1980) appear in the Turonan. The Coniacian–Early Santonian sharks are known from Saratov part of the Volga River basin, from Caspian, northern Aral region, Kyzylkum, Fergana. *Squalicorax* genus is characteristic only of these deposits, while *Ptychocorax aulaticus* Glickman & Istchenko alone with *Praeptychocorax* are typical of Coniacian deposits. *Ptychodus rugosus* Dixon lived on Sakhalin Island in the Coniacian–Early Santonian. Late Turonian and Coniacian estuary complexes consist of the rays *Myledaphus tritus* Nessov, *Ptychotrigon*, and Early Santonian complexes consist of other species of *Ptychotrigon*, *Parapalaeobates* and *Baibishia*. Sharks from the Santonian normal salinity basins are known from the Aktobe Cis-Mugodzhary region. *Anacorax* was appeares in the Late Santonian. *Anacorax kaupi* (Agassiz) is characterisic of the Early Campanian, *A. lindstromi* (Davis) – for the Middle Campanian and *A. plicatus* (Priem) – for the Late Campanian. Campanian shark remains were collected from the Volga River basin, Cis-Mugodzhary region, Mangyshlak, Turkmenistan and Tajikistan.

Ptychodus does not occur in the Campanian of the USSR, but first records of *Pseudocorax, Apocopodon* and *Macrorhizodus* are known. Maastrichthian sharks are known from the Crimea, Armenia, Tuarkyr and Kopetdag (Middle Asia). At this time, *Anacorax pristodontus* (Agassiz) has shown a global distribution; *Cretolamna caraibea* (Leriche) and *Pseudocorax laevis* (Agassiz) are only known from the Maastrichtian. Anacoracidae, *Pseudocorax, Cretaspis, Rhaphiodus*, Polyacrodontida and Hybodontida become extinct at the end of the Maastrichtian. Danian shark faunas consists of typically Paleogene families Carcharhinidae, Lamiostomatidae and the genera *Otodus* and *Striatolamia*.

The Holocephali lived in the Albian of Lithuania (*Elasmodectes, Edaphodon, Ischyodus*), in the Late Albian – Cenomanian of Belgorod Province (*Edaphodon* cf. *sedgwicki* Agassiz, small *Edaphodon, Ganodus kiprijanoffi* Nessov, *Ischyodus*, *Chimaera* (?) *bogolubovi* Nessov, Rhinochimaeridae, Callorhynchidae (?)). In Albian and Cenomanian estuaries of Karakalpakstan small *Ischyodus* lived. An egg capsule of *Rhinochimaera* was collected from the Cretaceous of the northern Caucasus. Chimaeroid remains were collected from the "sponge horizon" (Coniacian–Santonian) of the Volga River basin and the Caspian region, from the Lower Campanian of Cis-Mugodzhary region, from the the Cretaceous of Ukraine and the Bryansk Province. *Ischyodus bashanovi* (Khosatzky, 1949) was described from the Maastrichtian of Ayat River (Kostanai region, northern Kazakhstan).

41. Glickman L.S. and Dolganov V.N. 1988a. Tooth formula and its significance in evolution of lamnoid sharks. *Izvestiya Akademii Nauk SSSR. Seriya geologicheskaya*, **11**: 34–42 (14 references) [In Russian].

The paper begins with a brief review of "dental formula" in different groups of mammals, which is a result of the high functionality of the individual teeth in a dentition. As a result of convergence, the lamnoid sharks show similar tooth functionality, allowing one to use of a similar scheme of dental formula in the taxonomy of the group. The use of dental formulae in sharks was introduced by Glickman (1964a) and (possibly) independently by Applegate (1965). The authors discuss the terminology and methods of constructing and recording of dental formula in lamnoid sharks and the methodology proposed by Applegate (1965). The toothless area in the shark jaws, similar with diastema in mammals, is termed the eodiastema. In lamnoid sharks an eodiastema only occurs in upper jaws and can accomodate of up to 4 tiny "eye" (intermediate) teeth. These teeth are also demonstrate an increase in teeth differentiation as in mammals. In the evolution of lamnoid dentitions, there is a trend to stabilize the dental formula (11–13 teeth in a half of the upper jaw and 11–13 teeth in the lower one). This formula is called here a "stabilized" one as opposed to an "unstabilized" formula which has more posterior teeth. There are two variants of evolutionary stabilization of dental formula within the shark order Odontaspidida: (1) a reduction of the number of tooth files and the formation of a "stabilized formula" (from the 15–20 files in Cenomanian *Palaeoanacorax* to 10–13 files in the Campanian *Paraanacorax obruchevi*); (2) a change in the formula by "fetalization" (= paedomorphosis) resulted in degeneration of teeth with a secondary increase of their number (posterior teeth of *Odontaspis taurus*, teeth of *Cetorhinus*).

42. Glickman L.S. and Dolganov V.N. 1988b. Sharks of the genus *Lamna*: presence of symphyseal teeth and a place in the system. *Izvestiya Akademii Nauk SSSR. Seriya geologicheskaya,* **12**: 111–114. (1 figure, 6 references) [In Russian].

This short paper discusses the systematic position of the shark genus *Lamna*. The authors believe that this shark has no fossil representatives and all fossil teeth previously attributed to this genus must be referred to other taxa (genera, families). The genus *Lamna* is geologically young; it has a boreal origin and had evolved from one of the representatives of the family Odontaspididae (evidently, *Synodontaspis*). The discovery in 1978 east of Japan an example of *Lamna ditropis* Hubbs & Follett, 1947 with a series of symphyseal teeth on the left side of the lower jaw (the jaw is figured) is commented on. The dental formula of this shark is (upper/lower jaws): 0 / 0–1 symphyseals, 2/2 anterials, 1/0 intermedials, 10/10 laterals, 2/1 posterolaterals. This atavistic character indicates that loss of symphysel teeth of this genus occurred in the recent geological past. It is concluded that the genus *Lamna* should be included in the family Odontaspididae.

43. Glickman L.S. 1993. Are you familiar with a shark? (Foreword and the notes to the book). In: McCormick H.W., Allen T., Young W.E. Shadows in the sea. The sharks, skates and rays. Translated from English by G.A. Ostrovsky. Second edition. Gidrometeoizdat, Saint Petersburg: 6–8 and 223–228. [In Russian].

Reissue without changes of a popular book by the authors, firstly published in Russian in 1968 (see Glickman 1968).

44. Averianov A.O. and Glickman L.S. 1994. Remains of chimaeroids (Chondrichthyes, Holocephali) from the "Sponge horizon" of the Upper Cretaceous of Saratov. *Paleontologicheskiy zhurnal*, **2**: 119–122. (1 figure, 18 references) [In Russian].

Based on a single right mandibular plate (Holotype CCMGE 5/12868) from the layer of sandstone, underlying the Lower Santonian "Sponge Layer" and dated in the paper as Upper Turonian – Lower Santonian, of Saratov (unknown locality in Saratov, Saratov Province, European Russia), a new species of chimaeroid fish (Chimaeridae) *Elasmodus *sinzovi* Averianov in Averianov & Glickman, 1994 is described.

45. Averianov A.O. and Glickman L.S. 1996. A new species of squaloid shark from the Lower Paleocene of the Saratov Province, Russia (Chondrichthyes: Squalidae). *Zoosystematica Rossica*, **4**: 317–319. (19 references, 6 figures).

Based on three isolated teeth, a new species of squalid sharks *Centrophoroides *volgensis* Averianov & Glickman, 1996 from the Early Paleocene (Danian) of Saratov Province, Russia is described. Material consists of a lower (?) anterior tooth (holotype, ZIN PC 1/1), a lower posterior (paratypes ZIN PC 2/1) and an upper (?) teeth (paratype ZIN PC 3/1). In the original description, the species was characterized by the relatively large size of the teeth, relatively high main cusps and the wide basement of the apron on tooth crowns. Other elasmobranch remains (N=211; collected by Glickman in 1954) from both this stratum[26] and Lysye Gory settlement, Lysye Gory District, consisted of teeth of *Carcharhias* sp., (85% of shark teeth collected), *Notidanodon loozi* (Vincent, 1876), *Scyliorhinus* sp., *Euchlaodus lundgreni* (David, 1890), *Synechodus* sp. and *Otodus* sp.

46. Glickman L.S. and Averianov A.O. 1998. Evolution of the Cretaceous Lamnoid sharks of the genus *Eostriatolamia*. *Paleontological Journal*, **32**(4): 376–384. (6 figures, 2 tables, 27 references.) [Original Russian text was published in *Paleontologicheskiy zhurnal*, **4**: 54–62].

[Original abstract]: The "archaic" tooth form and comparatively few tooth rows are characteristic of the Cretaceous sharks of the genus *Eostriatolamia* (Odontaspididae). This is in contrast to the conditions in the Cenozoic sand sharks and thus makes it possible to regard this as a valid genus. The evolution and systematics of *Eostriatolamia* are reconsidered using statistical methods. Cluster and principal component analyses were used to process a large quantity of teeth from 17 samples (totally 973 teeth) from the Albian–Campanian. Six or seven species are included in the genus *Eostriatolamia*: *E. gracilis* (Albian of Europe and Kazakhstan), *E. striatula* (Aptian–Albian of Europe), *E. subulata* (=*E. amonensis*?) (Cenomanian of Europe, Kazakhstan and ?USA), *E. venusta* (=*E. samhammeri*?, =*E. sanguinei*?) (Santonian–Early Campanian of Europe, ?Late Campanian of USA), *E. segedini* (=*E. aktobensis*?) (Santonian–Early Campanian of Kazakhstan), ?*E. lerichei* (the latest Early Campanian–beginning of the Late Campanian of Kazakhstan) and *E. holmdelensis* (Late Campanian of the USA).

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[26]The type stratum is inaccessible now for additional collecting; EVP pers. observation, 2000.

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APPENDIX 1. Summarized genera-based classification of fossil Elasmobranchii based on Glickman (1964a) with the taxa diagnosed in Glickman (1964b). New taxa are marked with (*) for Glickman (1964a) and (**) – for Glickman (1964b).

Subclass Elasmobranchii
Infraclass Orthodonti
Superorder Cladoselachii (Pleuropterygii)
Order Cladoselachida
Family Cladoselachidae Dean, 1894
Cladoselache Dean, 1893
Family Denaeidae Berg, 1940
Denaea Pruvost, 1922

Order Cladodontida
Family Cladodontidae Nicholson et Lydekker, 1889
Cladodus Agassiz, 1843
Family Symmoriidae Dean, 1909
Symmorium Cope, 1893
Family Tamiobatidae Hay, 1902
Tamiobatis Eastman, 1897
Protacrodus Jaekel, 1925

Superorder Xenacanthi (Ichthyotomi)
Order Xenacanthida
Family Xenacanthidae Fritsch, 1889
Xenacanthus Beyrich, 1848
Orthacanthus Agassiz, 1843
Triodus Jordan, 1849
Diacranodus Garman, 1885
? *Anodontacanthus* Davis, 1881

Superorder Polyacrodonti
Order Polyacrodontida
*/**Family Polyacrodontidae Gluckman, 1964ab
Polyacrodus Jaekel, 1889
Palaeobates Meyer, 1849

Superorder Chlamydoselachii
Order Chlamydoselachida
Family Chlamydoselachidae Garman, 1884
Chlamydoselachus Garman, 1884

Superorder Carcharhini
Order Hexanchida
Suborder Hexanchoidei
Family Hexanchidae Gill, 1885
Heptranchias Rafinesque, 1810[1]
Hexanchus Rafinesque, 1810[1]
Notorhynchus Ayres, 1855[1]
Notidanus Cuvier, 1817

Suborder Heterodontoidei
Family Heterodontidae Gill, 1862
Gyropleurodus Gill, 1862
Heterodontus Blainville, 1816

Order Squatinida
Suborder Echinorhinoidei

Family Echinorhinidae Gill, 1861
Echinorhinus Blainville, 1816

Suborder Squaloidei
Family Squalidae Bonnaterre, 1831
Squalus Linnaeus, 1758
Centrophorus Müller et Henle, 1837
Oxynotus Rafinesque, 1810
Etmopterus Rafinesque, 1810
Family Dalatiidae Gill, 1892
Dalatias Rafinesque, 1810
Isistius Gill, 1864
Somniosus Lesueur, 1818
Centroscymnus Bocage et Capello, 1864
Cheirostephanus Casier, 1958
Family Cetorhinidae Gill, 1872
Cetorhinus Blainville, 1816

Suborder Ginglymostomatoidei
Family Ginglymostomatidae Gill, 1862
Orectolobus Bonaparte, 1834
Chiloscyllium Müller et Henle, 1841
Cantioscyllium Woodward, 1889
Ginglymostoma Müller et Henle, 1837
Squatirhina Casier, 1947
Corysodon Saint-Seine, 1946[2]

Suborder Squatinoidei
Family Squatinidae Müller et Henle, 1837
Squatina Duméril, 1906

Suborder Pristiophoroidei
Family Pristiophorhidae Bleeker, 1859
Pristiophorus Müller et Henle, 1837
Pliotrema Regan, 1906
Protopristiophorus Woodward, 1932

Suborder Rajoidei
Superfamily Rhinobatoidea
Family Rhinobatidae Müller et Henle, 1841
Rhinobatus Bloch et Schneider, 1801
Trigonorhina Müller et Henle, 1841
Rhynchobatus Müller et Henle, 1837[3]
Family Asterodermidae Jordan, 1923
Asterodermus Agassiz, 1848[4]
Belemnobatis Thiollière, 1854
Family Platyrhinidae Norman, 1926
Platyrhina Müller et Henle, 1838
Superfamily Pristioidea
Family Pristidae Müller et Henle, 1837
Pristis Linck, 1790
Propristis Dames, 1883
Sclerorhynchus Woodward, 1889
Markgraphia Weiler, 1935
Onchopristis Stromer, 1917
Onchosaurus Gervais, 1852
Schizorhiza Weiler, 1930
Ctenopristis Arambourg, 1940

Superfamily Torpedinoidea
Family Torpedinidae Bonaparte, 1837
Torpedo Houttuyn, 1764
?*Eotorpedo* White, 1935
Superfamily Rajoidea
Family Rajidae Bonaparte, 1831
Raja Linnaeus, 1758
Cyclobatis Egerton, 1844
?Superfamily Myliobatoidea [5]
Family Trygonidae Müller et Henle, 1837
Trygon Cuvier, 1817
Oncobatis Leidy, 1870
Taeniura Müller et Henle, 1837
Ptychotrygon Jaekel, 1894[1]
Family Hypolophidae Leriche, 1913
Hypolophus Müller et Henle, 1837
Rhombodus Dames, 1881
Hypolophites Stromer, 1910
Parapalaeobates Weiler, 1930
Family Myliobatidae Müller et Henle, 1837
Apocopodon Cope, 1886
Rhinoptera Cuvier, 1829
Myliobatis Cuvier, 1817
Aetobatis Blainville, 1816

Order Carcharhinida
Family Palaeospinacidae Regan, 1906
Palaeospinax Egerton, 1872
Synechodus Woodward, 1883
Family Scyliorhinidae Gill, 1862
Mesitea Kramberger, 1885
Pristiurus Bonaparte, 1841
Scyliorhinus Blainville, 1816
?*Palaeoscyllium* Wagner, 1857
?*Thyellina* Agassiz, 1843
?*Scylliodus* Agassiz, 1843
?*Trygonodus* Winkler, 1876
Family Triakidae White, 1936
Triakis Müller et Henle, 1838
Mustelus Linck, 1790
Family Carcharhinidae Garman, 1913
Carcharhinus Blainville, 1816
Physodon Müller et Henle, 1841
Aprionodon Gill, 1861
Scoliodon Müller et Henle, 1837
Hypoprion Müller et Henle, 1841
Galeocerdo Müller et Henle, 1837
Galeorhinus Blainville, 1816
Hemipristis Agassiz, 1843
Prionace Cantor, 1849
Family Sphyrnidae Gill, 1872
Sphyrna Rafinesque, 1810

Infraclass Osteodonti
Superorder Ctenacanthii
Order Ctenacanthida Glickman, 1964a

Family Ctenacanthidae Dean, 1909
Ctenacanthus Agassiz, 1835
Goodrichthys Moy-Thomas, 1951

Order Tristychiida
Family Tristychiidae Moy-Thomas, 1939
Tristychius Agassiz, 1837
?*Hybocladodus* St.-John et Worthen, 1875[6]
Lambdodus St.-John etWorthen, 1875[6]
?*Dicrenodus* Romanovsky, 1863[1]
Incerti ordinis
Phoebodus St.-John et Worthen, 1875
Carcharopsis Agassiz, 1843
?*Coelosteus* Newberry, 1889
Lepracanthus Owen, 1869
Acondylacanthus St.-John et Worthen, 1875
Asteroprychius McCoy, 1848
Chalazacanthus Davis, 1883

Superorder Hybodonti
Order Hybodontida
Family Hybodontidae Owen, 1846
Wodnika Münster, 1843
Nemacanthus Agassiz, 1837
Bdellodus Quenstedt, 1882
Acrodus Agassiz, 1838
Asteracanthus Agassiz, 1837
Hybodus Agassiz, 1837
Family Ptychodontidae Jaekel, 1898
Ptychodus Agassiz, 1839
Heteroptychodus Yabe et Obata, 1930

Superorder Lamnae
Order Orthacodontida
Family Orthacodontidae Glückman, 1958
Sphenodus Agassiz, 1843
Euchlaodus Glückman, 1957
Paraorthacodus Glückman, 1957

Order Odontaspidida
Superfamily Odontaspidoidea
Family Odontaspididae Müller et Henle, 1839
Subfamily Odontaspidinae Müller et Henle, 1839
Odontaspis Agassiz, 1838
Synodontaspis White, 1931
Parodontaspis White, 1931
?*Pseudoisurus* Glückman, 1957
?*Carcharoides* Ameghino, 1901
?*Priodontaspis* Ameghino, 1901
**Striatolamia* Glückman, 1964a
Subfamily Lamnidae Richardson, 1846
Lamna Cuvier, 1817
Family *Jaekelotodontidae Glückman, 1964a
*/***Palaeohypotodus* Glückman, 1964ab
Hypotodus Jaekel, 1895
Jaekelotodus Menner, 1928
Anotodus Le Hon, 1871
Family *Otodontidae Glückman, 1964a
Otodus Agassiz, 1843
Palaecarcharodon Casier, 1960
**Megaselachus* Glückman, 1964
Family Carcharodontidae Gill, 1892
**Cosmopolitodus* Glückman, 1964a
Carcharodon Smith in Müller et Henle, 1838
Family Cretoxyrhinidae Glückman, 1958
Paraisurus Glückman, 1957
Cretoxyrhina Glückman, 1958
? *Cretolamna* Glückman, 1958
Family Alopiidae Gill, 1885
Alopias Rafinesque, 1810
Superfamily Isuroidea
Family Isuridae Grey, 1851
Isurus Rafinesque, 1810
Isuropsis Gill, 1862
Family *Lamiostomatidae Glückman, 1964a
Subfamily *Lamiostomatinae Glückman, 1964a
**Macrorhizodus* Glückman, 1964a
**Lamiostoma* Glückman, 1964a
Subfamily *Xiphodolamiinae Glückman, 1964a
Xiphodolamia Leidy, 1877
Superfamily Scapanorhynchoidea
Family Scapanorhynchidae Bigelow et Schröder, 1948
Scapanorhynchus Woodward, 1889
Family Mitsukurinidae Jordan, 1898
Mitsukurina Jordan, 1898
Superfamily Anacoracoidea
Family Anacoracidae Casier, 1947
Palaeocorax Glückman, 1956
Anacorax White et Moy-Thomas, 1940
Pseudocorax Priem, 1897[2]

Incertae sedis
Radamus Münster, 1843[2]

[1]Genera were absent and not diagnosed in Glickman (1964b), probably due to mistake.

[2]The genera (*Corysodon, Pseudocorax, Radamas)* were not indexed in Glickman (1964a).

[3]*Rhynchobatus* was only named but not diagnosed in Glickman (1964b).

[4]Genus *Asterodermus* was not indexed in Glickman (1964a), probably due to mistake.

[5]Superfamily Myliobatoidei was regarded as *incerti ordinis* in Glickman (1964a).

[6]Genus *Lambodus* (sic!) St.-John et Worthen, 1875 and ?*Hybocladodus* St.-John et Worthen, 1875 were referred as to *incerti ordinis* in Glickman (1964b).