

**HISTORY OF THE DINOSAUR FAUNA
OF ASIA AND OTHER CONTINENTS
AND QUESTIONS CONCERNING PALEOGEOGRAPHY***

The distribution and evolution of dinosaur faunas during the period of their existence, from the Late Triassic to the end of the Cretaceous, shows a close connection with the paleogeography of the Mesozoic. However these questions were hard to examine on a global scale until recently, because only the dinosaurs of North America were well known, where during the last century were found their richest deposits and where the best paleontologists were studying them — J. Leidy, E. Cope, O. Marsh, R. Lull, H. Osborn, C. Gilmore, B. Brown, and later many others. On the remaining continents, including Europe, where the study of dinosaurs started earlier than it did in America, the information was rather incomplete due to the fragmentary condition of the finds and rare, episodic studies. The Asian continent remained unexplored the longest, preventing any intercontinental comparisons.

Systematic exploration and large excavations of dinosaur locations in Asia, which began in the last fifty years (Osborn, 1930; Efremov, 1954; Rozhdestvenskiy, 1957a, 1961, 1969, 1971; Rozhdestvenskiy & Chzhou, 1960; Kielan-Jaworowska & Dovchin, 1968; Kurochkin, Kalandadze, & Reshetov, 1970; Barsbold, Voronin, & Zhegallo, 1971) showed that this continent has abundant dinosaur remains, particularly in its central part (Fig. 1). Their study makes it possible to establish a faunal connection between Asia and other continents, correlate the stratigraphy of continental deposits of the Mesozoic, because dinosaurs are reliable leading forms, as well as to make corrections in the existing paleogeographic structure. The latter, in their turn, promote a better understanding of the possible paths of distribution of the individual groups of dinosaurs, the reasons for their appearance, their development, and disappearance.

At the present time more than 60 genera have been described from Asia, which belonged to six suborders from the seven that are commonly known. Along with the skeletons, skulls, and isolated bones of dinosaurs were also often found remains of other animals: mammals, crocodiles, turtles, and lizards (and along with early dinosaurs, earlier reptilians), freshwater and shore fish, freshwater mollusks, arthropods (ostracods, phyllopoes, and insects), and also plants (mostly trunks, but occasionally leaves).

The variety and abundance of dinosaurs, which compose in quantity of species approximately as many as all other vertebrates contemporary with them, taken all together, in conjunction with worldwide distribution and fast change of species (and larger taxa) in time, make it possible to use dinosaurs as a leading element of the Mesozoic fauna of terrestrial vertebrates to identify concrete faunal complexes by them.

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For the Asian continent, starting with the Late Triassic and ending with Late Cretaceous, it is possible to identify through the dinosaurs, at least ten such complexes of varied age, which have close ties with the dinosaur faunas of Africa, Europe, and North America (tables 1, 2).

The most ancient is the Late Triassic Lufeng fauna from the province of Yunnan in southern China (Young, 1951), including the primitive carnivorous dinosaurs *Lukousaurus* and *Sinosaurus*, the prosauropod *Lufengosaurus huenei*, and also a recently described primitive dinosaur with a bird-like pelvis — *Tatisaurus* (Simmons, 1965), thecodonts, theromorph reptiles from the group of theriodonts — *Bienotherium* and others, and finally, fishes. The remains of vertebrates belong to two vertically close horizons close. This complex is completed by the late Triassic Maleri fauna (Jain, Robinson & Chowdhury, 1964), which was discovered in the basin of the Godavari River (India), and which consists of thecodonts and possibly carnivorous dinosaurs, and also labyrinthodonts and fishes.

The Lufeng fauna shows clear parallels with the faunas of the same period, including prosauropods found on other continents: in Europe (Swabia)—*Plateosaurus* (Huene, 1926), close to *Lufengosaurus*, in North America (Connecticut Valley) — *Anchisaurus* (Lull, 1915; Colbert, 1962) or carnivorous dinosaurs — *Procompsognathus triassicus* in Württemberg (Huene, 1921) and *Coelophysis* — in New Mexico (Colbert, 1948). In South Africa an analogous Late Triassic fauna includes early carnivorous dinosaurs, prosauropods, and primitive Ornithischia — heterodontosaurs and the closely related fabrosaur (Crompton & Charig, 1962; Ginsberg, 1964; Attridge & Charig, 1967; Thulborn, 1970a,b, 1971). *Pisanosaurus*, related to the latter, was discovered recently in the Upper Triassic of Argentina (Casamiquela, 1967).

The following faunal complex is represented by Late Jurassic carnivorous dinosaurs — such as *Sinocoelurus*, *Chienkosaurus*, and *Szechuanosaurus*, known only from fragmentary remains and therefore insufficiently studied, and large sauropods — *Tienschanosaurus*, *Omeisaurus* (which was initially considered Early Cretaceous) and *Mamenchisaurus* from Xinjiang and central China — Sichuan and Gansu (Young, 1937, 1939, 1942, 1954, 1958a). To the sauropods also belong *Sanpasaurus* (Rozhdestvenskiy, 1966) — a young specimen, originally taken for a iguanodont (Young, 1942) and apparently *Chialingosaurus*, described by Yan (Young, 1959) as a stegosaur. Proven remains of stegosaurs have not yet been discovered in Asia. Together with the dinosaur bones were found remains of turtles, crocodiles, and fish.

The described complex corresponds in time with the famous Tendaguru fauna from eastern Africa (Tanzania), which includes numerous specimens of gigantic sauropods — *Brachiosaurus brancai* and others, carnivorous dinosaurs (coelurosaur — *Elaphrosaurus bambergi* and carnosaurs), stegosaurs — *Kentrosaurus aethiopicus*, and iguanodonts — *Dysalotosaurus lettowvorbecki* (Janensch, 1914, 1925a,b, 1929, 1935–1936, 1955) from three bone-bearing horizons. In the United States, analogous representatives correspond to this fauna (Marsh, 1896), widely known from the Morrison Formation: a coelurosaur—*Ornitholestes hermanni* (Osborn, 1903), carnosaurs — *Antrodemus valens* and *Ceratosaurus nasicornis* (Gilmore, 1920), sauropods — *Diplodocus carnegii*, *Apatosaurus excelsus*, *Brachiosaurus altithorax* and others, a stegosaur — *Stegosaurus unguulatus*, iguanodonts — *Camptosaurus dispar* and others (Holland, 1906; Gilmore, 1909, 1914, 1936; Ostrom & McIntosh, 1966 and others). Along with the dinosaur skeletons are found remains of turtles, crocodiles, stegosaurs, mammals, fishes, and amphibians.

In Europe toward the end of the Jurassic is identified the well-known Solnhofen fauna of Bavaria with a single dinosaur from the coelurosaur group — *Compsognathus longipes*, the most

ancient bird — *Archaeopteryx lithographica*, and a variety of other vertebrates — fishes, turtles, crocodiles, pleurosaurs, lizards, pterosaurs, and also varied invertebrates (Kuhn, 1966).

Other dinosaurs from the Late Jurassic of Europe are represented mostly by carnosaur—*Megalosaurus* (Huene, 1923), insufficiently studied along with other forms due to incomplete remains.

Cretaceous dinosaurs of Asia start with psittacosaur — *Psittacosaurus mongoliensis*, characteristic for the first half of the Neocomian of Mongolia and Kuzbass (Osborn, 1923, 1924a; Rozhdestvenskiy, 1955, 1960). In Mongolia together with psittacosaur were found fragmented remains of carnosaur — *Prodeinodon* and the sauropod — *Asiatosaurus* (Osborn, 1924b). To the latter is close in age (and possibly phylogenetically) *Euhelopus zdanskyi* from eastern China (Wiman, 1929). Apparently *Mongolosaurus*, known only from fragments from Inner Mongolia (Gilmore, 1933a) is also close to them. Apparently this complex should be compared with the famous Wealden-age Bernissart fauna of Belgium (Casier, 1960) with iguanodonts—*Iguanodon bernissartensis*, accompanied by carnosaur (only an incomplete phalanx was found), turtles, crocodiles, and also fishes, amphibians, and insects. An analog to the Bernissart fauna is that of the Wealden dinosaurs from the Isle of Wight (southern England) which includes iguanodonts — *Iguanodon mantelli* (Owen, 1855–866) and *I. atherfieldensis* (Hooley, 1925), the ornithischian dinosaur *Hypsilophodon foxii* (Huxley, 1870; Galton, 1971), of an unclear systematic position, but possibly close to psittacosaur, as well as carnivorous dinosaurs and other reptiles.

As far as the psittacosaur from eastern China are concerned — *Psittacosaurus sinensis* and *P. youngi* (Young, 1958b; Chao, 1962), which originated from the Tsinghsan suite, then it is possible that they are of a later age than *P. mongoliensis*. It is necessary to add to this that recently the Joint Soviet-Mongolian Paleontological Expedition (Kurochkin, Kalandadze, & Reshetov, 1970; Kalandadze & Reshetov, 1971) in the Guchin-Us locality in the Prikhangaiskoy Gobi, which was discovered by P. K. Kozlovym (1949) but described under a different name — Bain-Ulan-Tsap, was excavated, and numerous small mammals (jaws and teeth) and turtles were found together with the skeletons of psittacosaur. But the material has not been studied yet, and the age of this faunal complex can be dated only within the borders of the Early Cretaceous. It is not excluded that the new fauna may prove to be more recent — Aptian–Albian.

The Asian iguanodonts — *Iguanodon orientalis* from the eastern Gobi and two species of *Probactrosaurus* — *P. gobiensis* and *P. alashanicus* from the Maortu locality in Inner Mongolia (Rozhdestvenskiy, 1952a, 1966), judging by their morphological level, are more likely to be of a later age than the European ones, that is, from the end of the Neocomian, at least for the first genus, and Aptian–Albian for the second. Together with *Probactrosaurus* were found remains of a carnosaur, named *Chilantaisaurus maortuensis* (Hu, 1964).

The described faunal complex possibly corresponds to the recently discovered rich fauna of ornithomorphs, carnivorous dinosaurs, and sauropods in the southern Sahara, east of Agadez (Taquet, 1970), in as much as its age is also dated as Aptian–Albian. The same age is established for the dinosaur fauna of Wyoming and Montana (Cloverly Formation) represented by the small carnivorous dinosaur *Deinonychus antirrhopus*, coelurosaur and carnosaur, sauropods, the iguanodont *Tenontosaurus tilletti*, ankylosaur, and also turtles, crocodiles, and fishes (Ostrom, 1969, 1970). Some authors (Eaton, 1960; Ostrom, 1965) also place the Dakota Formation at the end of the Lower Cretaceous, above the Cloverly Formation, in which occurs the remains of ankylosaur *Silvisaurus condrayi* (Eaton, 1960), whereby Ostrom (1965) for this same formation indicates another ankylosaur, *Nodosaurus textilis*, which was found earlier (Lull,

1921) in the overlying formation—Benton, which corresponds to the European Turonian, and in this case, Dakota corresponds to the Cenomanian (Lull & Wright, 1942; Irdly, 1954, Ostrom, 1961).

The scattered remains of carnivorous dinosaurs found in the USSR — *Antrodemus*¹ (?) from the Zabaykal'ye and *Embasaurus* in Kazakhstan (Ryabinin, 1915, 1931) — are dated as belonging to the Neocomian, however, it is still hard to decide whether it is closer to the fauna containing *Psittacosaurus mongoliensis* or to the later one with *Iguanodon orientalis*.

The Late Cretaceous faunas of Asia start with the armored dinosaur from Bain-shire in the eastern Gobi — *Talarurus plicatospineus* (Maleyev, 1952b, 1956), which was initially placed at the end of the Cretaceous, and later transferred to its beginning (Rozhdestvenskiy, 1957a). Apparently, the primitive hadrosaur *Bactrosaurus johnsoni*, which is of the same age as the armored dinosaur, from the neighboring region of Inner Mongolia, and found together with the remains of ornithomimid coelurosaurs and carnosaur — *Alectrosaurus* (Gilmore, 1933b) and *Chilantaisaurus tashuikouensis*, closely related to, if not identical with, the latter (Hu, 1964). This faunal complex, discovered in the eastern Gobi and Alashan', in relation to *Probactrosaurus*, should be dated as belonging to the Cenomanian (??). In terms of age and composition it can be compared with well-known Gosau fauna from Austria (Bunzel, 1871; Seeley, 1881), which includes carnosaur, ornithopods, an ankylosaur — *Struthiosaurus*, and also crocodiles and turtles.

Further on in the history of Central Asiatic dinosaur faunas forms a blank, which, however, is filled by the discoveries of the last ten years; the faunal complexes of Kazakhstan (Rozhdestvenskiy, 1964, 1968a; Rozhdestvenskiy & Khozatskiy, 1967). Here, first of all, belongs the Shakh-Shakh fauna of northern Priural'ye, with *Aralosaurus tuberiferus* (hadrosaur), carnivorous dinosaurs (coelurosaurs and carnosaur), sauropods, and ankylosaur, unfortunately represented by rather incomplete remains, together with which were found numerous carapaces of freshwater turtles from the families Trionychidae and Dermatemydidae, and numerous remains of crocodiles. The location is identified as belonging to the Beleytinsk suite and confirms its late Turonian age, but does not exclude the possibility of early Coniacian. It is possible to correlate another fauna with this complex, known from fragmentary remains of carnivorous dinosaurs, sauropods, and ankylosaur from the Lameta beds of India (Huene & Matley, 1933).

The Shakh-Shakh complex is followed by another fauna in the Aym-Tau locality (southern Kazakhstan), represented mostly by the hadrosaur *Jaxartosaurus aralensis* (Ryabinin, 1939), and also by carnivorous and the armored dinosaurs, not identified more precisely for lack of completeness of material. *J. aralensis* is very close morphologically to the helmeted hadrosaur from two horizons of the Wang-Shi suite of eastern China — *Tanius sinensis* and *Tsintaosaurus spinorhinus* (Wiman, 1929; Young, 1958b), of which the second possibly represents an independent species, but the same genus, as the first. The Kazakhstan hadrosaur is relatively close also to the American species *Corythosaurus* (Lull & Wright, 1942; Ostrom, 1961) from the Belly River suite (upper Santonian–Campanian). but most likely is somewhat older. The layers with *J. aralensis* were known earlier under the name of the “dinosaur horizon”, the age of which was often discussed as being in the interval from the Cenomanian to the Paleocene (inclusive). Now, after the study of the dinosaurs, in all probability it must be seen as being late Coniacian.

¹ A. N. Ryabinin (1915) indicated *Allosaurus*, which is now usually studied as a synonym of *Antrodemus*.

The Kazakhstan faunas are completed by a complex with another helmeted hadrosaur — *Procheneosaurus convincens*, represented in the Syuk-Syuk locality (Belen'kiy & Rozhdestvenskiy, 1963) by an almost complete skeleton from the layers above the “dinosaur horizon”. Species related to it (Lull & Wright, 1942) are known from the above-mentioned North American Belly River suite, but in as much as the Kazakhstan species was somewhat more primitive, it can be dated as belonging to the beginning of the Santonian.

Apparently, the complex with *P. convincens* corresponds the recently discovered fauna in the Kansai region in Fergana (Rozhdestvenskiy & Khozatskiy, 1967), represented by hadrosaurs, carnivorous dinosaurs, turtles, crocodiles, and fishes (material not yet fully studied).

Above follows another faunal complex of a well-known dinosaurs from the Mongolian National Republic: Bain-Dzak, and also Tugrikin-Us, Ulan-Tsoncha, and a series of smaller localities in Inner Mongolia near the border with the Mongolian National Republic (Rozhdestvenskiy, 1961). This complex is represented by the primitive horned dinosaur — *Protoceratops andrewsi* (Brown & Schlaikjer, 1940), skeletons of which are found in large quantities, the ankylosaur — *Pinacosaurus grangeri* (Gilmore, 1933a; Maleyev 1952a, 1954a; Maryanska, 1971)¹, and small carnivorous dinosaurs — *Velociraptor*, *Oviraptor*, and *Saurornithoides* (Osborn, 1924c), the exact systematic position of which remains not completely clear. Together with the dinosaurs are found remains of crocodiles, lizards, and turtles, and also primitive mammals from the groups Multituberculata and Insectivora (Kielan-Jaworowska, 1968, 1969, 1971). The age of the Bain Dzak fauna is most likely late Santonian, possibly even early Campanian, corresponding to a similar faunal composition in the Oldman Formation, or the Belly River and their equivalents in North America (L. S. Russell, 1930, 1964; Ostrom, 1965; D. A. Russell, 1967). Among the numerous and well-studied species of dinosaurs from the Belly River can be mentioned: carnivorous *Struthiomimus*² *altus* (Osborn, 1917), *Dromaeosaurus albertensis* (Colbert & Russell, 1969), *Gorgosaurus*³ *libratus* (Lambe, 1917), and the closely related *Daspletosaurus torosus* (D. Russell, 1970), hadrosaurs — *Kritosaurus notabilis*, *Prosaurolophus maximus*, *Lambeosaurus lambei*, *Corythosaurus casuarius*, and *Procheneosaurus praeceps* (Lull & Wright, 1942), ankylosaurs — *Panoplosaurus mirus* (Lambe, 1919; Sternberg, 1921) and *Palaeoscincus rugosidens* (Gilmore, 1930), ceratopsians — *Monoclonius flexus*, *Styracosaurus albertensis* and *Chasmosaurus belli* (Lull, 1933). Together with the dinosaurs were found remains of fishes, amphibians, turtles, crocodiles, and crocodile-like lepidosaurs — *Champsosaurus*, lizards, and also small mammals.

The last Cretaceous fauna—from the Nemegtinsk basin of the Mongolian National Republic — is represented by gigantic dinosaurs: carnosaurs — *Tarbosaurus bataar* (Maleyev, 1955a) which was originally classified as belonging to the genus *Tyrannosaurus*⁴, sauropods — *Nemegtosaurus mongoliensis* (Nowinski, 1971), hadrosaurs — *Saurolophus angustirostris* (Rozhdestvenskiy, 1952b, 1957b), and also ankylosaurs — *Dyoplosaurus* (Maleyev, 1956; Maryanska, 1970), and ornithomimids. To the same complex belong the exotic carnivorous dinosaurs (Rozhdestvenskiy, 1970), known only from very incomplete remains, such as *Therizinosaurus cheloniformis*, examined initially as a peculiar turtle-like pangolin (Maleyev,

¹ *Syrmosaurus viminicaudus* from Bain Dzak described by Maleyev is a synonym of *Pinacosaurus grangeri* (Rozhdestvenskiy, 1969; Maryanska, 1971); *Syrmosaurus* sp. from Ulan-Osha—*Psittacosaurus* (Rozhdestvenskiy, 1955).

² Some authors do not recognize the independence of this genus, considering it synonymous with *Ornithomimus*.

³ Several authors consider this genus a synonym of *Albertosaurus* or even *Deinodon*.

⁴ The remaining species of carnosaurs described by Maleyev (1955b), Rozhdestvenskiy (1965) and others are seen as synonyms of *Tarbosaurus bataar*.

1954b), and *Deinocheirus mirificus* (Osmólska & Roniewicz, 1970), analogs for which have not been found so far in other faunas. Besides these, from the same bone-bearing layers of Nemegt are known several small and large freshwater turtles — *Mongolemys elegans* and others (Khosatzkiy & Mlynarsky, 1971) and crocodiles (Konzhukova, 1954).

Concerning the first half of the dinosaur list, the species of which it is composed occupy a intermediate position between dinosaurs from the North American Edmonton Formation with the *Saurolophus osborni* (Brown, 1912, 1913), more primitive than *S. angustirostris*, and the Lance with *Tyrannosaurus rex* (Osborn, 1905, 1906—the last representative in the evolutionary series of carnosaurs. The age of the first formation, which besides *Saurolophus* includes remains of carnivorous dinosaurs — *Albertosaurus sarcophagus* (Osborn, 1905), other duck-billed dinosaurs — *Edmontosaurus regalis*, *Hypacrosaurus altispinus*, *Cheneosaurus tolmanensis* (Lull & Wright, 1942), and also ankylosaurs — *Edmontonia longiceps* (Sternberg, 1928), and ceratopsians — *Anchiceratops ornatus* (Lull, 1933), remains of turtles, lepidosaurs, fishes, and freshwater mollusks, dated as belonging to the Maastrichtian (D. Russell & Chamney, 1967). The second formation, which in addition to *Tyrannosaurus* includes remains of ornithomimids, hadrosaurs — *Anatosaurus annectens* (Lull & Wright, 1942), ankylosaurs — *Ankylosaurus magniventris* (Brown, 1908), and ceratopsians — *Triceratops calicornis*, *Torosaurus gladius*, and others (Lull, 1933), and also mammals, turtles, lepidosaurs, amphibians, fishes, and freshwater mollusks, which earlier was considered Danian and currently many feel is Maastrichtian. This comes as a result of a firm stratigraphic correlation between America and Europe. After a serious discussion arose concerning the border between the Cretaceous and Paleogene, and the majority was inclined toward the transference of the Danian stage into the Paleogene, American geologists and paleontologists supported the idea and started to investigate the Danian as belonging in the Lower Paleocene, correspondingly having moved the Monian into the Middle Paleocene, etc., while the Lance Formation (and its equivalents), which did not “allow” the dinosaurs into the Paleogene, remained in this manner within the Cretaceous, its upper part corresponding to the European Maastrichtian, if one is to count that there is nothing above it in the Cretaceous. However in any case the layers containing the Nemegtsk fauna, which completes the history of dinosaurs in Asia, correspond to the Maastrichtian.

It is possible that the Shiregin-Gashoon fauna (southern Gobi), which is somewhat older than the Nemegtsk but younger than the Bain Dzak, represented by the ankylosaur — *Syrmosaurus disparoserratus* (Maleyev, 1952a, 1954a), undefined as to genus from the existing material, hadrosaurs, carnosaurs, and also a crocodile — *Paralligator gracilifrons* (Konzhukova, 1954).

The Far Eastern hadrosaurs — *Mandschurosaurus amurensis* (Ryabinin, 1925, 1930) and *Nipponosaurus sachalinensis* (Nagao, 1936, 1938) — are represented by skeletal material of insufficiently complete preservation, and in the case of the former was also found in a redeposited condition (Rozhdestvenskiy, 1957c), and their correlation with other Asian forms is difficult. That is why the question of their more exact age within the confines of the second half of the Late Cretaceous currently remains open.

In the history of the dinosaur faunas of Asia, as with those of other continents, are noted several large stages — the Late Triassic, the Late Jurassic, the Early and Late Cretaceous. It is necessary to note the reverse correlation with the major geologic events of the Mesozoic, of redistribution of dry land and seas (see the paleogeographic maps) which had an impact on the conditions of animal life.

The faunal complexes that replaced one another in time, which are reflected on the paleogeographic maps (Figs. 2–5) as locations of different ages, are mostly assigned to the shore zone of dry land and sea. Of course, the taphonomic laws (Efremov, 1950) indicate that this is the most likely area for burial of terrestrial faunas, and consequently the possibility of encountering here the best locations, which accordingly are better known. However, functional analysis of the morphology of the skeleton of various dinosaurs suggests that the life of sauropods, for example, was directly tied to the sea, while a series of other groups lived near it (river deltas, swampy marshes) and only a few truly terrestrial dinosaurs lived at a considerable distance from the sea. In any case, even if we are to allow that due to the incompleteness of the geologic chronicle many terrestrial dinosaurs remain so far unknown, this in no way contradicts the sudden faunal changes observed in the coastal zone.

In the Late Triassic, among the terrestrial vertebrates (Romer, 1966) the Paleozoic groups of reptiles — cotylosaurs and therapsids — are extinguished (just like the ancient amphibians — the labyrinthodonts). The first are represented by a few small procolophonids and the second by the last dicynodonts and a small new group of theriodont tritylodonts — small rodent-like forms, which evolved in the direction of mammals. The archosaurs on the other hand gain fast development and distribution, some dinosaurs, basically carnivorous forms and prosauropods — the closest descendents of the Pseudosuchia, which they replace, preserving at the same time their bipedal mode of locomotion. The latter was undoubtedly a progressive factor that guaranteed the advantage of a high point of observation and speed of locomotion in comparison with the quadrupedal forms (Efremov, 1953).

The size of the huge continent, Gondwana, the mountain ranges of which were created by the Hercynian orogenesis, were already visibly denuded and could not serve as a serious obstacle to the highly mobile archosaurs, and helped their wide distribution. This is indicated by the Gondwanan localities in Central and southern Asia (Young, 1951; Jain, Robinson, & Chowdhury, 1964), South Africa (Attridge & Charig, 1967; Crompton, 1968) and South America (Colbert, 1948, 1963) which at the time were all part of the same continent, Laurasia*.

The dinosaurs, spreading out and getting used to new ecological niches, quickly diverged in the direction of carnivory (coelurosaurs and carnosaur) and omnivory (coelurosaurs and prosauropods) with a transition to herbivory (prosauropods, heterodontosaurs, and fabrosaurs). A possible center for the origin of dinosaurs (documented finds do not exist prior to the Late Triassic), judging by their archaism and variety, may be South Africa (Thulborn, 1970a,b, 1971). From here the distribution moved toward North Africa, and farther into the region of Gibraltar between Gondwana and Laurasia there was no continental isthmus, the presence of which, in the opinion of P. Furmar'ye (1971) is proven, then through an island system of the not-so-wide Tethys into Central Europe, and possibly from there westward — along the southern end of Laurasia into North America, although such a connection is doubted by the author.

The second branch, which possibly separated in North Africa from the branch that was moving toward Europe, went to the east — into southern Asia, moving possibly as far as Australia. Such a supposition is confirmed by the closeness of the well-studied prosauropods of Europe and China — *Plateosaurus* and *Lufengosaurus* (Huene, 1926; Young, 1951; Rozhdestvenskiy, 1965).

As far as the South American fauna of Triassic dinosaurs is concerned (Casamiquela, 1967), then the fragmentation of the finds makes their phylogenetic correlation with dinosaurs from other continents difficult, as well as any resolution of the problem of their history. One can

* sic: Gondwana.

only suppose, drawing conclusions based on logic, that most likely dinosaurs penetrated South America at the end of the Triassic by the shortest path — from South Africa, although the connection of these two continents is considered least likely by P. Furmar'ye (1971). One should not exclude the possibility of the penetration of Late Triassic dinosaurs into North America from South America, rather than from Europe.

The absence of Late Triassic dinosaurs from northern latitudes indicates not the slowness of their distribution, but rather natural obstacles — climatic (temperature), topographic, and others. Indirectly this is confirmed by the fact that, for example, there was no direct communication between the dinosaur fauna of Central Europe and that of South Asia through Siberia, because in Late Triassic localities (which belonged, true, to the beginning of the epoch) terrestrial vertebrates in the east of the Russian platform and in southern Priural'ye dinosaurs have not been discovered.

The Early and Middle Jurassic localities of dinosaurs are almost unknown. The border between the Triassic and Jurassic is characterized by considerable orogenic movements (ancient Kimmerian phase) and mighty volcanic activity, especially in the Gondwana region. The Jurassic Period as a whole corresponds to the active separation of the Gondwana continent, and the appearance of aquatic barriers to the further migration of terrestrial faunas. All this must have been reflected in the places of habitation of dinosaurs and reptiles. Some groups — prosauropods and heterodontosaurs — disappear from the chronicle, without passing on to the Jurassic. The same occurred with the therapsids, of which in the Jurassic are only known mouse-like tritylodonts, which at the end of the period are replaced by the primitive groups of mammals — multituberculates, triconodonts, symmetrodonts, pantotheres, and others — also mostly very small rodent-like, carnivorous, and possibly insectivorous forms (Romer, 1966).

The Late Jurassic was a time of great transgressions that led to the flooding (with swamping) of littoral plains. The sea covered almost all known zones of habitation of Triassic dinosaurs, the areas of whose distribution apparently started to diminish earlier. Toward the end of the Late Jurassic are found the largest localities of a new group of dinosaurs — sauropods — inhabitants of the sea-coastal zones (lagoons, in part) who fed on water plants¹. These localities are mostly found in the western part of North America (Ostrom & McIntosh, 1966) and in eastern Africa (Janensch, 1914) and central China (Young, 1958a). Together with the numerous sauropod skeletons are also found the rarer specimens of new groups of herbivorous dinosaurs — ornithopods and stegosaurs (with the exception of Asia, where the latter group is absent), and also carnivorous dinosaurs, which hunted their own kind and lived near pools with abundant vegetation (swampy coastal plains, river deltas, large lakes). In this manner the Late Jurassic dinosaur fauna has a completely different composition and a different ecological appearance in comparison with the Late Triassic fauna.

Only the paths of distribution of Late Jurassic sauropods and other dinosaurs remain unclear, although H. Osborn (1930) considered Central Asia as a likely place of origin, basing this conclusion on the notion that it was an ancient Mesozoic dry land which was conducive to the development of continental faunas. But if the prosauropods are found in all parts of the world other than Australia, then their descendants — the early sauropods — are known precisely from there (Longman, 1927), and the possibility is not excluded that from that continent the

¹ The notion that sauropods were inhabitants of savannahs (Bakker, 1971) is not supported by a multilateral functional analysis of their structure.

distribution could have occurred to others, possibly in the first half of the Jurassic². According to the phylogenetic closeness of Central Asian sauropods from Fergana (Rozhdestvenskiy, 1969) to the North American *Apatosaurus* (Gilmore, 1936), it is possible to suppose an original path in common of dinosaur faunas from the south to Central Asia. From here one branch could have gone to North America, and the other to Southern Asia. It is possible that the absence of stegosaurs in Asia can be explained by the fact that they may have appeared after the penetration of the Jurassic fauna. On other continents — in Europe, North America, and Africa — stegosaurs are found together with Late Jurassic sauropods, and possibly one of these continents was the center of their origin, from where, however, they did not penetrate into Asia.

How the population of Africa and Europe occurred, which at the end of the Jurassic were already apparently isolated continents, is unclear. All the localities where sauropods were found belong to the shoreline of the continents and the sea, with the exception of Central Asia, where a lack of precision is possible in the paleogeographic reconstruction (Strakhov, 1948). But if for sauropods, according to the conditions of burial, it is possible, due to their structure, a considerable displacement along the sea, for stegosaurs this was not very likely. In contrast to the close kinship between the sauropods of various continents (Janensch, 1929, 1935–1936), which testifies to their fast distribution, the stegosaurs of the New and Old Worlds (Gilmore, 1914; Janensch, 1925b) are fairly distant in terms of kinship, which indicates a slower rate of distribution. The possibility is not excluded that the European and African sauropods and stegosaurs are of American origin.

The Early Cretaceous is an epoch of considerable drying of the continents, which was caused by alternating orogenic movements on the border of the Jurassic and the Cretaceous (the new Kimmerian phase). The zones of habitation of Jurassic sauropods fall into the deep part of the continents, and the number of these dinosaurs is sharply reduced. The most important Early Cretaceous localities of dinosaurs are known from England and Belgium (Casier, 1960), Central Asia (Rozhdestvenskiy, 1966, 1969), North Africa (Taquet, 1970) and North America (Ostrom, 1970). They are located at a distance from the sea and consist basically of the remains of the more terrestrial dinosaurs — ornithopods (iguanodonts), stegosaurs, which were soon replaced by ankylosaurs, the remains of closely related psittacosaurs, and finally carnivorous dinosaurs, as well as the rare sauropods.

Judging by the evolutionary level of the iguanodonts — the most widely distributed group of dinosaurs from the Early Cretaceous — the distribution of dinosaur faunas at the end of the Jurassic and the beginning of the Cretaceous must have occurred from North America, from where are known more primitive Late Jurassic iguanodonts — camptosaurus (Gilmore, 1909) — into Europe, which is characterized by the Wealden genus *Iguanodon* (Casier, 1960), and later from here into North Africa and to the East — into Central Asia, where iguanodonts (Rozhdestvenskiy, 1952a, 1966) lived to the end of the Early Cretaceous and gave the rise to a new group of orthopods — hadrosaurs¹.

The find of tracks of iguanodonts in Spitsbergen (Heintz, 1962) indicates that in the Early Cretaceous this island was not covered by the sea, as was commonly shown on paleogeographic maps (Strakhov, 1948, and others) but was connected with continental dry land. Such a

² These facts, however, need confirmation, in as much as the herein-described *Rhoetosaurus brownei*, from vertebrae, may prove to be not an Early Jurassic sauropod, but rather a Late Triassic prosauropod.

¹ The discovery of iguanodonts from the end of the Early Cretaceous in the western part of the USA (Ostrom, 1970) does not reveal forms transitional to the hadrosaurs of North America, known here from the middle of the Late Cretaceous.

northerly distribution of dinosaurs is completed by the Siberian locality of Kuzbass (Rozhdestvenskiy, 1960) and in Vilyua (the material is in the author's possession at present, but has not been closely studied yet). Taking into consideration their reptilian (scaly) covering, even in the case of warm-bloodedness (Strel'nikov, 1959), one should presuppose an exclusively warm climate (most of all warm winters!) for these latitudes in the Early Cretaceous. It is also characteristic that in the Lower Cretaceous, dinosaur localities are rather widely distributed north of the equator and are not known south of it, with the exception of fragmentary remains in South Africa, South America, and western Australia (Lapparent, 1957 and others). Everything mentioned above suggests a displacement of climatic belts in the Early Cretaceous in comparison with the present. The absence of confirmed Lower Cretaceous dinosaur localities in South America allows us to suppose the loss of its connection with North America and Africa in the Early Cretaceous epoch, although on the paleogeographic maps South America and Africa are usually shown as one continent.

The Late Cretaceous transgressions, first in the Cenomanian and later in the Campanian and the Maastrichtian, literally flood all the area: of distribution of Early Cretaceous dinosaurs in North America, western Europe, and North Africa. Only the Asian dry land remains more or less untouched. During the Maastrichtian Cretaceous occurs a new increase in the numbers of sauropods (in the southern continents), the appearance and wide distribution of the descendants of iguanodonts — hadrosaurs — inhabitants of freshwater basins and areas adjacent to them. In the latter also settled ankylosaurs, a new group of ornithischians — ceratopsians — and naturally, carnivorous dinosaurs.

Most likely, it is precisely from Central Asia, which proved the most stable in the second half of the Mesozoic in terms of geologic and physiogeographic conditions, where the distribution of dinosaurs originated during the first half of the Cretaceous in a westward direction — into middle Asia, and then to the east into North America. The similarity of dinosaur faunas in Asia and America in the middle of the Late Cretaceous is confirmed by the finds of a helmeted hadrosaur — *Procheneosaurus* — near Tashkent (Rozhdestvenskiy, 1968a), in Montana, and in Alberta (Lull & Wright, 1942).

The Cenomanian fauna of Gosau (Austria) and the close to it in age, but insignificant in scale, North African fauna (Lapparent, 1960) possibly represent relics that were preserved from the Early Cretaceous, just as the later Senonian faunas in the western part of Europe (Lapparent, 1966, 1967; Lapparent & Zbyszewski, 1957) in Romania (Nopcsa, 1899, 1915) and in Crimea (Ryabinin, 1945).

In the second half of the Late Cretaceous, judging by *Saurolophus*, an earlier species of which was known from Canada (Brown, 1912, 1913) and a later one from Mongolia (Rozhdestvenskiy, 1952b, 1957b), the opposite connection occurred — from North America into Central Asia. However, the real ceratopsians — Ceratopsidae, ancestors of which — Protoceratops (Protoceratopsidae), apparently came out of Asia and remained endemic in North America without migrating anywhere.

As far as the Late Cretaceous dinosaurs of India are concerned (Huene & Matley, 1933), they characterize only the first half of the epoch. The exact age of the dinosaurs of the Late Cretaceous of South Africa (Madagascar) and South America is not known due to incompleteness of the material and insufficient study of it.

The large finds of dinosaurs from the second half of the Late Cretaceous are located only in Central and Eastern Asia (Rozhdestvenskiy, 1969) and in the west of North America (L. S. Russell, 1930, 1964; Ostrom, 1965; D. A. Russell, 1967), that is, in the zone of the Pacific Ocean

rim. The last representatives of dinosaurs — hadrosaurs, ankylosaurs, ceratopsians, and carnivorous forms — are preserved only in a small area in North America (northern USA and southern Canada). Their remains are known from the Lance Formation and its equivalent the Hell Creek (sauropods are already disappearing at about this time, without reaching the end of the Cretaceous), crowning the division of the Cretaceous and directly preparing with an insignificant stratigraphic interruption in Wyoming and New Mexico or without one in Colorado and Utah — the Fort Union beds with Early Paleocene mammals (Spiker, 1963). The dinosaurs, in contrast to the commonly held notion of their mass and possibly even instant extinction, belong first of all to several species, among which, with the exception of ornithomimids, are found mostly very large animals, from 6 to 15 meters in length. It is doubtful they were plentiful. As a matter of fact, this is the last relic of a fauna which was once rich and varied.

It is quite clear that the dying out of dinosaurs at the end of the Cretaceous — first of the aquatic giants — sauropods, and subsequently of the other, less amphibious types, corresponds both in Asia and North America to the powerful orogenesis of the Pacific Ocean — the Ieshansk orogenesis in eastern Asia, including its central regions, and the Laramide in North America.

And thus, repeated changes occurred for the duration of the Mesozoic in the composition of dinosaur faunas, and the places of their habitation also changed noticeably, which correlates well in terms of time with the basic geologic transformation of the Earth's crust during the Mesozoic, which disturbed the balance that was established between animals and their environment.

Orogenesis invariably led to the reduction or elimination of water bodies, in or near which lived the majority of dinosaurs. Parallel with this the climate changed for the worse in terms of dinosaurs (continentality, lowering of temperature). The change of water and climate regimes acted directly on the dinosaurs, and on the flora, creating unfavorable conditions first for the herbivores, and later on the carnivores that fed on the former. Consequently the nutritional chain was interrupted. Dinosaurs were narrowly specialized animals, which is why they were put into a disadvantageous position in comparison with their contemporaries — turtles and crocodiles, which were morphologically more primitive and conservative (as indicated by the relatively few changes that occurred in them from the Mesozoic until the present), and less sensitive to alterations in the external environment.

It is also important to stress that during the Mesozoic, along with the dying of some groups of dinosaurs (of different taxonomic class from species to suborder), there also occurred the appearance of new groups (within the bounds of the same taxa), due to the appearance of suitable ecological niches. Thus, probably, transgressions, which brought about general flooding, and consequently this prolific development of vegetation and a milder climate, could have been suitable for the appearance first of amphibious forms (sauropods, hadrosaurs) and later on others, for which was found sufficient vegetable food in the adjacent regions (ankylosaurs, ceratopsians). The abundance of herbivorous dinosaurs guaranteed the necessary food for carnivorous dinosaurs.

The rising and lowering of the Earth's crust and the associated regressions and transgressions of seas must have considerably changed the conditions of existence in the coastal zone, leading to the dying out of the majority of narrowly specialized forms (such as dinosaurs) and the possible alteration of the few forms in the process of adaptation to the new conditions. Some of the species, apparently, may have migrated into more suitable regions. And that is why it is clear that the most sharply expressed change of dinosaur faunal complexes in the coastal zone was during the transgressive or regressive epochs.

The influence of possible continental drift (a possibility examined in Furmar'ye's book, 1971) on the distribution and formation of species, widely discussed in recent times, is rather doubtful for fast-moving animals such as dinosaurs. Apparently the maximal movement of the continents, measured in tens of kilometers over several millions of years, is easily overcome in a very short time not only by dinosaurs, but even by smaller animals. If one is to accept, that the duration of existence of a species among dinosaurs does not surpass a geologic epoch, that is about 5 million years, then apparently the small displacement of continents during that period of time, as well as the insignificant changes in climate and other ecologic conditions associated with this process, could hardly noticeably affect their species formation or the speed of their migration. Most likely this is true for most animals as well as plants, taking into consideration the possibility of the transfer of sexual products by currents, winds, birds, and other animals. That is why continental drift, if it existed or exists, does not provide a convincing explanation for the distribution and evolution of organic forms, in the same way as the latter, in turn does not contain sufficient proof for the support of the hypothesis of mobility.

At the same time, the vertical motion of the Earth's crust, even the plateau region, in the period of half a million years, and sometimes sooner, is able to bring about the rising or submersion of dry land up to several hundred meters, which would signify a considerable change in ecologic conditions and the inevitably associated changes in the composition of fauna and flora. This is well illustrated by the facts presented by G. U. Lindberg (1971) on the example of Far Eastern Pliocene ichthyo-fauna, which underwent many changes on the boundary between dry land and the sea as a result of the changes in ocean level and the transgression and regressions associated with it. It is clear that such sudden physico-geographic changes affect all fauna and flora of the coastal region as a whole. But on narrowly specialized forms this must have reflected considerably more.

In the light of the above, it is proposed that for the explanation of the similarity in the Mesozoic fauna and flora in the southern continents, it is not necessary to rely to the breaking away and drifting of parts of Gondwana, which most likely, underwent transgressions and regressions. Even the fairly rapid oceanic submersions of the most recent time period create at times difficult to explain isolations of human ethnicities, although in this case there is no possibility of a prolonged period of time, which was involved in the case of the flora and fauna of the Mesozoic.

In this manner, the reasons for the dying out of dinosaur faunas during, as well as at the end of, the Mesozoic, should be sought in the disappearance of the zones of their habitation or in sharp disruptions in the conditions of their existence, due to regular and constant alterations in the surface of the Earth's crust. This is why it is difficult to accept hypotheses offering chance or unlikely factors: 1) epizootic; 2) destruction of egg deposits of dinosaurs by other animals; 3) cosmic radiation; 4) so-called phylogenetic aging; 5) low physiologic level, etc.

Analyzing the history of Mesozoic marine reptiles (Rozhdestvenskiy & Tatarinov, 1964) — the more specialized forms in comparison with their terrestrial ancestors — it can be seen that the most significant changes in the composition of their faunas occurred at the same time as that of amphibious dinosaurs. The massive domination of the sea by reptiles had already started in the Triassic — apparently in connection with a wide radiation of reptiles in general. However this process reaches its peak toward the second half of the Late Jurassic — a time of frequent transgressions, which corresponds with the maximal distribution of aquatic dinosaurs — sauropods. The seas at this time teemed with a variety of plesiosaurs — inhabitants of the shoreline (ecologically similar to pinnipeds among mammals) and dolphin-like ichthyosaurs —

inhabitants of the open seas. In the Early Cretaceous the number of plesiosaurs is noticeably reduced, and ichthyosaurs disappear almost entirely. The same also occurs in the Late Cretaceous, especially in the second half of the epoch with alternating prolonged transgressions: the number of plesiosaurs increases noticeably and new marine reptiles appear — mosasaurs, the ecological successors of ichthyosaurs, which had not had time to reach their high level of specialization. Both apparently disappeared along with sauropods, without reaching the end of the Cretaceous.

Analogous alterations, although on a smaller scale, occurred among the marine groups of Mesozoic crocodiles and turtles. Thus, marine crocodiles — teleosaurs and metriorhynchids, characteristic for the Jurassic as a whole, are the most numerous at the end of this period; it is true that they pass into the Early Cretaceous, in which fresh-water crocodiles predominate. Among the marine turtles the first rather large group is that of the thalassemyids, the most numerous also in the Late Jurassic, but which passed in a small quantity into the Cretaceous, when it is the freshwater forms that receive (from the amphichelyids and the ??) and partially — terrestrial. The present-day sea turtles (Chelonioida) appeared in the Late Cretaceous, however a considerable number of them quickly disappeared at the end of the epoch without passing into the Paleocene.

The high point for the pterosaurs — inhabitants of the shore regions — also occurs in the second half of the Late Jurassic and Late Cretaceous; at the end of the latter they disappear entirely.

Similar changes may be observed among fishes (Obruchev, 1964), predominantly saltwater fish. For the Jurassic an abundance of chimaerids is quite common, particularly the sharks, and the bony ganoids are also numerous. Toward the very end of the Cretaceous die out, without passing into the Paleocene, many of the sharks from among the carcharines, all the hybodonts, some lamnids, a series of chimaerids, and from among the bony fishes — almost all the lungfishes and dipnoans, the majority of bony ganoids (holosteids), many of the primitive herring, glowing anchovies, and berycomorphs. Similar examples can be extended further, even to the invertebrates.

In other words, dinosaurs were subject to the laws of existence and development in the same way as other animal groups, and there is no basis for looking for special causes for their appearance or disappearance.

The history of dinosaur faunas is most clearly expressed on the boundary of the sea and dry land, where occurs a sudden change of faunal complexes between adjacent geologic epochs, which are characterized by sharp differentiations of the physico-geographic conditions, and this gives the opportunity to use dinosaurs as important indicators for the paleogeographic constructions in the Mesozoic.

LITERATURE

(Not listed.)

Table 1
Correlation of dinosaur faunas of Asia and other continents.
Late Triassic — Early Cretaceous

Region	Central Asia					
	China	MNP	Kazakhstan, Central Asia, Siberia	India, Africa	Western Europe	North America
Aptian–Albian	Inner Mongolia: carnosaur – <i>Chilantaisaurus</i> <i>maortuensis</i> , sauropods, iguanodonts – <i>Probactrosaurus gobiensis</i> and <i>P. alashanicus</i>			Southern Sahara (east of Agadez): theropods, sauropods, and ornithopods		Wyoming and Montana: <i>Deinonychus antirrhopus</i> and other theropods, sauropods, iguanodonts – <i>Tenontosaurus tilletti</i> , ankylosaurs, crocodiles, turtles, and freshwater fishes.
Neocomian	Eastern China (Shandong): sauropods – <i>Euhelopus</i> <i>zdankysi</i> and psittacosaur – <i>Psittacosaurus sinensis</i> and <i>P. youngi</i> . Inner Mongolia: sauropods – <i>Mongolosaurus</i>	Eastern Gobi: iguanodonts – <i>Iguanodon</i> <i>orientalis</i> and freshwater mollusks. Prihangaik Gobi: carnosaurs – <i>Prodeinodon</i> , sauropods – <i>Asiatosaurus</i> , psittacosaur – <i>Psittacosaurus</i> <i>mongoliensis</i> , small mammals, turtles, fishes, insects, and phyllopo	Kuzbass (Shestakovo): <i>Psittacosaurus</i> <i>mongoliensis</i>		Belgium (Bernissart): iguanodonts – <i>Iguanodon</i> <i>bernissartensis</i> , crocodiles, turtles, amphibians, and fishes. Southern England: <i>I.</i> <i>mantelli</i> , <i>Hypsilophodon</i> <i>foxii</i> , and other dinosaurs.	

Late Jurassic	Xinjiang: sauropods – <i>Tienshanosaurus</i> . central China (Sichuan and Gansu): theropods – <i>Sinocoelurus</i> , <i>Chienkosaurus</i> , and <i>Szechuanosaurus</i> , sauropods – <i>Omeisaurus</i> , <i>Mamenchisaurus</i> ; turtles, crocodiles, and fishes.		Fergana (Tash-Kumyr) – sauropods	Tanzania (Tendaguru): theropods – <i>Elaphrosaurus bambergi</i> and others; gigantic sauropods – <i>Brachiosaurus brancai</i> and others; stegosaurs – <i>Kentrosaurus aethiopicus</i> , and ornithopods (iguanodonts) – <i>Dysalotosaurus lettowvorbecki</i>	Southern England: theropods – <i>Megalosaurus</i> . Central Europe (Solnhofen): coelurosaur – <i>Compsognathus longipes</i> ; the most ancient bird – <i>Archaeopteryx lithographica</i> , and other vertebrates – fishes, turtles, crocodiles, pterosaurs, and lepidosaurs.	Western USA: theropods – <i>Ornitholestes hermanni</i> , <i>Antrodemus valens</i> , <i>Ceratopsaurus nasicornis</i> ; gigantic sauropods – <i>Diplodocus carnegii</i> , <i>Apatosaurus excelsus</i> , <i>Brachiosaurus altithorax</i> , and others; stegosaurs – <i>Stegosaurus unguatus</i> , and ornithopods (iguanodonts) – <i>Camptosaurus dispar</i> and others; turtles, crocodiles, pterosaurs, mammals, fishes, and amphibians.
Late Triassic	Yunnan: theropods — <i>Lukousaurus</i> and <i>Sinosaurus</i> , prosauropods — <i>Lufengosaurus huenei</i> , primitive ornithischian dinosaurs — <i>Tatisaurus</i> , theriodonts — <i>Bienotherium</i> , thecodonts, fishes.			Central India (Maleri): thecodonts, theropods (?), labyrinthodonts, fishes. South Africa: theropods, prosauropods, heterodontosaurs — <i>Heterodontosaurus tucki</i> , <i>Fabrosaurus australis</i> .	Central Europe: theropods – <i>Procompsognathus triassicus</i> , prosauropods – <i>Plateosaurus</i> .	New Mexico: theropods – <i>Coelophysis</i> . Connecticut Valley: prosauropods – <i>Anchisaurus</i> .

Table 2
Correlation of dinosaur faunas of Asia and other continents
Late Cretaceous

Region	Central Asia					
	China	MNR	Middle Asia and Kazakhstan	India	Western Europe	North America
Danian						Lance Formation fauna (and equivalents): carnivorous dinosaurs – <i>Ornithomimus velox</i> , <i>Tyrannosaurus rex</i> , hadrosaur – <i>Anatosaurus annectens</i> , ankylosaur – <i>Ankylosaurus magniventris</i> , ceratopsians – <i>Triceratops calicornis</i> , <i>Torosaurus gladius</i> , and other vertebrates.
Maastrichtian		Nemegt fauna from southern Gobi: small carnivorous dinosaurs, ornithomimids, carnosaur – <i>Tarbosaurus bataar</i> , sauropods – <i>Nemegtosaurus mongoliensis</i> , hadrosaur – <i>Saurolophus angustirostris</i> , ankylosaurs, turtles – <i>Mongolemys elegans</i> and others, crocodiles.				Edmonton Formation fauna (and equivalents): carnivorous dinosaurs – <i>Albertosaurus sarcophagus</i> and others, hadrosaurs – <i>Edmontosaurus regalis</i> , <i>Saurolophus osborni</i> , <i>Cheneosaurus tolmanensis</i> , and others, ankylosaurs – <i>Edmontonia longiceps</i> and others, ceratopsians – <i>Anchiceratops ornatus</i> and others.
Campanian	Inner Mongolia: ankylosaurs – <i>Pinacosaurus</i> and others; and primitive horned dinosaurs – <i>Microceratops</i>	Shiregin-Gashoon fauna (southern Gobi): carnosaur, hadrosaurs, and ankylosaurs – <i>Syrmosaurus disparoserratus</i> , and also crocodile – <i>Paralligator</i>				Belly River Formation fauna (and equivalents): carnivorous dinosaurs – <i>Dromaeosaurus albertensis</i> , <i>Struthiomimus altus</i> ,

Santonian	<i>Microceratops</i>	crocodile – <i>Paralligator gracilifrons</i> , and turtles. Bain-Dzak fauna from southern Gobi: small carnivorous dinosaurs – <i>Velociraptor</i> , <i>Oviraptor</i> , and <i>Saurornithoides</i> , ankylosaurs – <i>Pinacosaurus grangeri</i> , primitive horned dinosaur – <i>Protoceratops andrewsi</i> , crocodiles, lizards, turtles, and also primitive mammals from the groups Multituberculata and Insectivora.	Pre-Tashkent region (Syuk-Syuk): hadrosaur – <i>Procheneosaurus convincens</i> , and fauna from Kansai (Fergana): hadrosaurs, carnivorous dinosaurs, turtles, crocodiles, and fishes.			<i>Struthiomimus altus</i> , <i>Gorgosaurus libratus</i> , and others, hadrosaurs – <i>Kritosaurus notabilis</i> , <i>Prosaurolophus maximus</i> , <i>Procheneosaurus praeceps</i> , <i>Corythosaurus casuarius</i> , and others, ankylosaurs – <i>Panoplosaurus mirus</i> , <i>Palaeoscincus rugosidens</i> , and others, ceratopsians – <i>Monoclonius flexus</i> , <i>Chasmosaurus belli</i> , and other vertebrates.
Coniacian	Eastern China (Wang-Shi suite): hadrosaurs – <i>Tanius sinensis</i> and <i>T. spinorhinus</i>		Pre-Tashkent region (Alym-Tau): carnivorous dinosaurs and armored forms, and also hadrosaur – <i>Jaxartosaurus aralensis</i> .			
Turonian			Shakh-Shakh fauna from northern Priural'ye (Beleutinsk suite): carnivorous dinosaurs (coelurosaurs and carnosaur), sauropods, hadrosaur – <i>Aralosaurus tuberiferus</i> , ankylosaurs, turtles from the families Trionychidae and Dermatemydidae, and crocodiles.	Lameta Beds: carnivorous dinosaurs, sauropods, and ankylosaurs.		Wyoming (Benton Formation): ankylosaurs – <i>Nodosaurus textilis</i> and others.

Cenomanian	Inner Mongolia: ornithomimid coelurosaurs, carnosaur – <i>Alectrosaurus</i> and the closely related <i>Chilantaisaurus tashuikouensis</i> , primitive hadrosaur – <i>Bactrosaurus johnsoni</i>	Eastern Gobi: carnosaur, ornithopods, and ankylosaur – <i>Talarurus plicatospineus</i> , and also turtles.			Gosau fauna (Austria): carnosaur, ornithopods, and ankylosaur – <i>Struthiosaurus</i> and others, crocodiles, and turtles.	Dakota (Dakota Formation): ankylosaur – <i>Silvisaurus condrayi</i>
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* Due to the difficulty in correlation (insufficient precision), no diagram is given for the Far East, Africa, or South America.

FIGURE CAPTIONS

Fig. 1. The most significant occurrences of dinosaurs in Asia.

1—Late Triassic;	6—Chanshou;	18—Shakh-Shakh;
2—Late Jurassic;	7—Guan'-yuan';	19—Dzhara-Khuduk;
3—Early Cretaceous;	Early Cretaceous:	20—Jabalpur;
4—Late Cretaceous (first half);	8—Koi-Kara;	21—Laiyan;
5—Late Cretaceous (second half).	9—Shestakovo;	22—Alym-Tau;
Numbers designate occurrences	10—Kempendyay;	23—Syuk-Syuk;
Late Triassic:	11—Gusinoe Ozero;	24—Kansai;
1—Lufeng;	12—Osi-Nuru, Anda-khuduk, and Guchin-Us;	25—Karacheku and Kshi-Kalkan;
Late Jurassic:	13—Laiyan;	26—Bain-Dzak and Tugrikin-Us;
2—Maleri;	14—Khamarin-Khural;	Late Senonian:
3—Tashkumyr;	15—Maortu;	27—Nemegtu;
4—Chitai;	Late Cretaceous (Cenomanian-Santonian):	28—Blagoveshchensk;
5—Ibin';	16—Iren-Nor;	29—Belyye Kruchi;
	17—Bayn-Shire;	30—Sinegorsk

Fig. 2. Paleogeographic diagram and dinosaur occurrences in the Late Triassic.

1 — occurrences of dinosaurs (those shaded in black are the largest).

Boundary between dry land and sea

2 — Late Triassic;

3 — Early Jurassic;

4 — regions of land submerged by the sea;

5 — regions of sea converted into land;

6 — regions of intensive volcanic activity in the Early Jurassic.

Note. The paleogeographic diagram of the Late Triassic is from L. D. Kiparisova & A. B. Habakov, BSE, 2nd edition, vol. 43, 1956. The Early Jurassic — V. A. Vahrameyev & I. I. Tuchkov, BSE, 2nd edition, vol. 49, 1957.

Fig. 3. Paleogeographic diagram and dinosaur occurrences in the Late Jurassic.

1 — occurrences of dinosaurs (those shaded in black — the largest). *Boundary between dry land and sea:* 2 — Late Jurassic; 3 — Early Cretaceous; 4 — regions of land submerged by the sea; 5 — regions of sea converted into land.

Note. The paleogeographic diagram of the Late Jurassic is from V. A. Vahrameyev & I. I. Tuchkov, BSE, 2nd edition, vol. 49, 1957. For the Early Cretaceous — N. M. Strahov, 1948.

Fig. 4. Paleogeographic diagram and dinosaur occurrences in the Early Cretaceous.

1 — occurrences of dinosaurs (those shaded in black are the most abundant).

Boundary between dry land and sea:

2 — Early Cretaceous;

3 — Late Cretaceous;

4 — regions of dry land occupied by sea in the Late Cretaceous;

5 — regions of sea occupied by dry land in the Late Cretaceous.

Note. The paleogeographic diagram is from N. M. Strahov, 1948.

Fig. 5. Paleogeographic diagram and dinosaur occurrences in the Late Cretaceous.

1 — occurrences of dinosaurs (those shaded in black are the most abundant).

Boundary between dry land and sea:

2 — Late Cretaceous;

3 — Paleogene;

4 — regions of dry land occupied by sea in the Paleogene;

5 — regions of sea occupied by dry land in the Paleogene;

6 — regions of intensive volcanic activity in the Late Cretaceous;

7 — mountain building in areas of active orogenesis.

Note. The paleogeographic diagram is from N. M. Strahov, 1948.