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SMALL VERTEBRATES FROM THE LATE CRETACEOUS AND EARLY TERTIARY OF THE NORTHEASTERN ARAL SEA REGION, KAZAKHSTAN

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ABSTRACT—Field work conducted in the northeastern Aral Sea Region, southwestern Kazakhstan has produced a large number of vertebrates from late Cretaceous and early Tertiary sediments. Included among these vertebrates are sharks, bony fishes, amphibians, turtles, lizards, crocodiles, and dinosaurs. This fauna comes from three formations, the Turonian-Coniacian Zhirkindek, the Santonian-Campanian Bostobe, and the early Tertiary Akzhar formations. In this paper we describe the microvertebrate fauna. The Akzhar fauna consists only of marine sharks, one hexanchiform species (*Notidanodon* cf. *loozi*) and four lamniform species (*Carcharias teretidens, Striatolamia striata*, *Otodus obliquus* var. *minor*, and *Palaeocarcharodon orientalis*). These suggest a Paleocene age, most likely Selandian or earliest Thanetian. In addition to previously described components, the Bostobe fauna now includes a discoglossid frog and the lizard *Slavoia* cf. *darevskii.* This is the first Mesozoic record of each in Kazakhstan and the latest record anywhere of the latter. The Zhirkindek fauna is now known to include a varanid lizard.

INTRODUCTION

DURING THE Late Cretaceous and early Tertiary, Middle Asia lay on the northeastern part of the Turan plate. Recent work in Kazakhstan and Uzbekistan provides an improved picture of Middle Asian faunas, demonstrating important ecologic and biogeographic differences from contemporary upland faunas in Mongolia (Shilin and Suslov, 1982; Nessov and Mertinene, 1986; Nessov et al., 1994; Nessov, 1995; Averianov, 1997; Norman and Kurzanov, 1997; Kordikova, 1998; Archibald et al., 1998; Nessov et al., 1998). An expedition to the Lower Syr-Dar'ya Uplift in the north-eastern Aral Sea region of Kazakhstan was carried out in 1995 by the Kapchagay Geological Expedition of the Ministry of Geology of the Republic of Kazakhstan and the University of Michigan Museum of Paleontology. Vertebrates have long been known from this area (e.g., Rozhdestvenskii, 1968), but little has been published about either faunas or biostratigraphy. The 1995 expedition revisited classic localities, such as Shakh-Shakh, and prospected several new areas. Material was collected by surface prospecting and, in rich areas, matrix was collected, screen washed, and picked. Local sections were also measured. Chondrichthyans, osteichthyans, amphibians, turtles, dinosaurs, crocodiles, and lizards were recovered from the Zhirkindek, Bostobe, and Akzhar formations. Floras and faunas from these beds have been discussed (Rozhdestvenskii, 1968; Bazhanov, 1972; Shilin and Suslov, 1982; Shilin, 1986; Kuznetsov and Chkhikvadze, 1987; Efimov, 1988; Prizemlin, 1990; Nessov et al., 1994; Norman and Kurzanov, 1997; Kordikova, 1998), but the remains of small vertebrates have received little attention. Here we report on sharks, frogs, and lizards from these formations and provide a general overview of their geological setting. In this paper we use the Paleocene age Selandian following Knox et al. (1996). In their scheme, the Danian is NP1 to late NP4 (65.2–59.8 m.y.), the Selandian is NP4 to late NP6 (59.8–57.9), and the Thanetian is late NP6 to the base of NP10 (57.9–53.9 m.y.).

Abbreviations—B, Bartusken locality; cp, *crista parotica*; E, Egizkara locality; faa, *foramen acusticum anterius*; fap, *foramen acusticum posterius*; fe, *foramen endolymphaticum*; fj, *foramen jugularis*; fm, foramen magnum; fp, *foramen prooticum*; fps, *foramen perilymphaticum superius*; KGE, Kapchagay Geological Expedition; oc, occipital condyle; pdsa, *prominentia ductus semicircularis anterioris*; pdsp, *prominentia ductus semicircularis posterioris*; Sh, Shakh-Shakh locality; svj, *sulcus venae jugularis*; T, Tyul'kili locality.

All specimens are housed at the Kapchagay Geological Expedition of the Ministry of Ecology and National Resources of the Republic of Kazakhstan (Almaty). Casts of some described specimens are housed at the Museum of Paleontology, University of Michigan and at Queen Mary & Westfield College, London.

GEOLOGICAL SETTING

The Lower Syr-Dar'ya Uplift is north of the Syr-Dar'ya River and east of the Aral Sea. It lies along the Karatau thrust, which extends in a northwesterly direction from the Karatau Mountains in the southern part of the region. The area is about 90 km north northeast of Dzhusaly, a railway station along the Syr-Dar'ya River (Fig. 1). Prominent features in the region are Shakh-Shakh ridge, a long north-south trending outcrop that extends for about 30 km (the Shakh-Shakh locality referred to in this paper is along the ridge's southern half), Buroynak (to the north of Shakh-Shakh), Tyul'kili Hill (in the Kankazgan area), and Egizkara and Bartusken, which are two semi-isolated hills to the northwest of Shakh-Shakh. We examined three fossil-bearing beds in this region: the Zhirkindek, Bostobe, and Akzhar Formations. Much of the area is overlain by a Neogene pebble conglomerate known as the Kokkuryum Formation.

The lowermost unit that we discuss here is the Zhirkindek formation, which is composed of sands interbedded with clays and silts. At Tyul'kili Hill, where it is well exposed, it is about 45 m thick (Fig. 2). There is at least one fossiliferous horizon about 18 m above the base. The formation has a diverse fauna including gastropods, bivalves, brachiopods, crustaceans, selachians, osteichthyans, amphibians, lizards, trionychid turtles, crocodiles (*Turanosuchus aralensis*), and ornithomimid, tyrannosaurid, and dromaeosaurid dinosaurs (Fig. 3; Kordikova et al., 1996, 1997).

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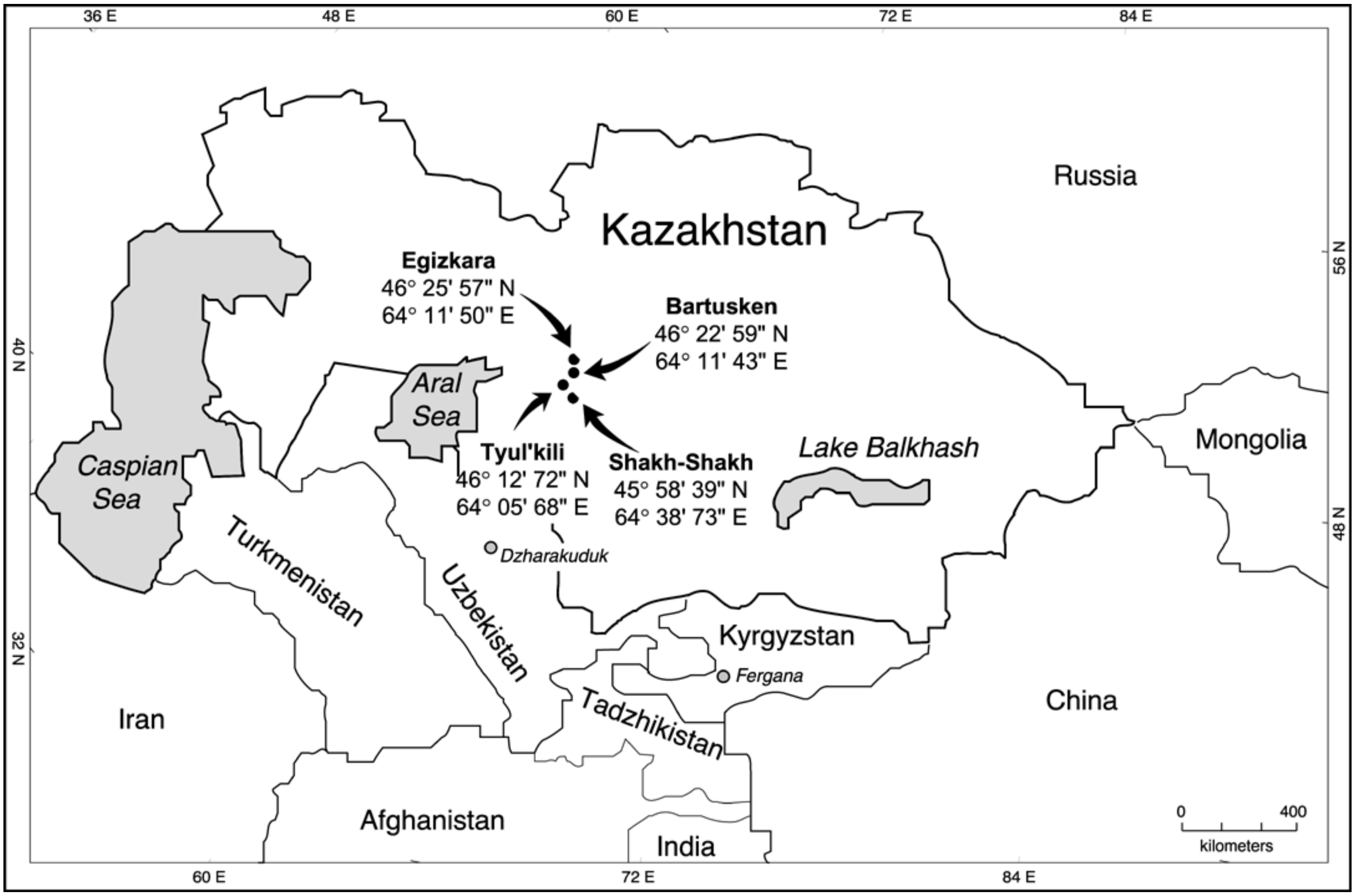


FIGURE *1*—Map of Kazakhstan and the surrounding region showing localities yielding the material described in this paper. Also shown are the Dzharakuduk area in Uzbekistan and the Fergana basin area in Kyrgyzstan which have yielded contemporary Late Cretaceous terrestrial vertebrate faunas.

Its flora is dominated by ferns, pines, *Sequoia,* laurels, and *Platanus* (Shilin, 1986). These indicate a low-lying coastal or coastal-marine environment. We have reservations about applying the name ''Zhirkindek'' to these rocks but formal redesignation must await detailed mapping. The lowermost Zhirkindek formation was assigned a Turonian age by Pyatkov et al. (1967) based on forams, while the middle and upper parts of the Zhirkindek were considered Coniacian contemporaries of the Bissekty formation in Uzbekistan based on the vertebrates and plants (Archibald et al., 1998; Nessov et al., 1998).

Overlying the Zhirkindek, probably conformably, is the Bostobe formation. This unit is best exposed along Shakh-Shakh ridge, where it is about 45 m thick. It is also exposed at Baybishe and Buroynak. The Bostobe formation is composed of gray clays and reddish sands. In places there are indurated cross-bedded sandstones. It is sparsely fossiliferous throughout with the greatest concentration in a dark, organic-rich layer about 9 meters from its base (Fig. 2). The Bostobe's fauna contains crustaceans, selachians, fishes, anurans, lizards, turtles (*Shachemys baibolatica, Anatolemys maximus, Axestemys riabinini*), and dinosaurs (*Aralosaurus tubiferus, Alectrosaurus,* cf. *Lophorothon,* segnosaurs, tyrannosaurids, and ankylosaurids) (Fig. 3; Bashanov, 1972; Nessov et al., 1994; Kordikova et al., 1996, 1997). The flora is dominated by *Sequoia,* cypresses, elms, oaks, willows, and cottonwoods (Shilin, 1986). The depositional environment was probably fluvial or estuarine and both the flora and the paleosols indicate an increasingly arid climate. The fauna is similar to that of the Yalovach Formation in the Fergana Basin of Tadzhikistan (Solun, 1937; Vyalov, 1945a, 1945b; Nessov et al., 1994). The Bostobe and Yalovach have been interpreted as Santonian and early Campanian in age (Archibald et al., 1998; Nessov et al., 1998; Kordikova, 1998), which we follow here. The Bostobe fauna is similar to Baynshirenian and Barungoyotian faunas from Mongolia (Jerzykiewicz and Russell, 1991).

Unconformably overlying the Bostobe is the thinner Akzhar formation. In places it is almost 15 meters thick and is composed of loose, light-colored sands and gravels capped with a layer of phosphorite nodules (Fig. 2). The formation is exposed at the Shakh-Shakh, Bartusken, and Egizkara localities. The Akzhar fauna—entirely marine—is composed of bivalves, crustaceans, selachians, and osteichthyans (Fig. 3). Its sharks (described below) indicate a late Paleocene (Selandian or early Thanetian) age for the Akzhar formation. There is some nomenclatorial confusion concerning the name Akzhar, and it may be that a new name should be applied to this unit.

SYSTEMATIC PALEONTOLOGY

Order HEXANCHIFORMES Berg, 1940
Family HEXANCHIDAE Gray, 1851
Genus NOTIDANODON Cappetta, 1975
NOTIDANODON cf. LOOZI (Vincent, 1876)
Figure 4.25–4.26

Description.—This antero-lateral tooth is large (about 45 mm in mesiodistal length) with apico-distally directed cusps. There

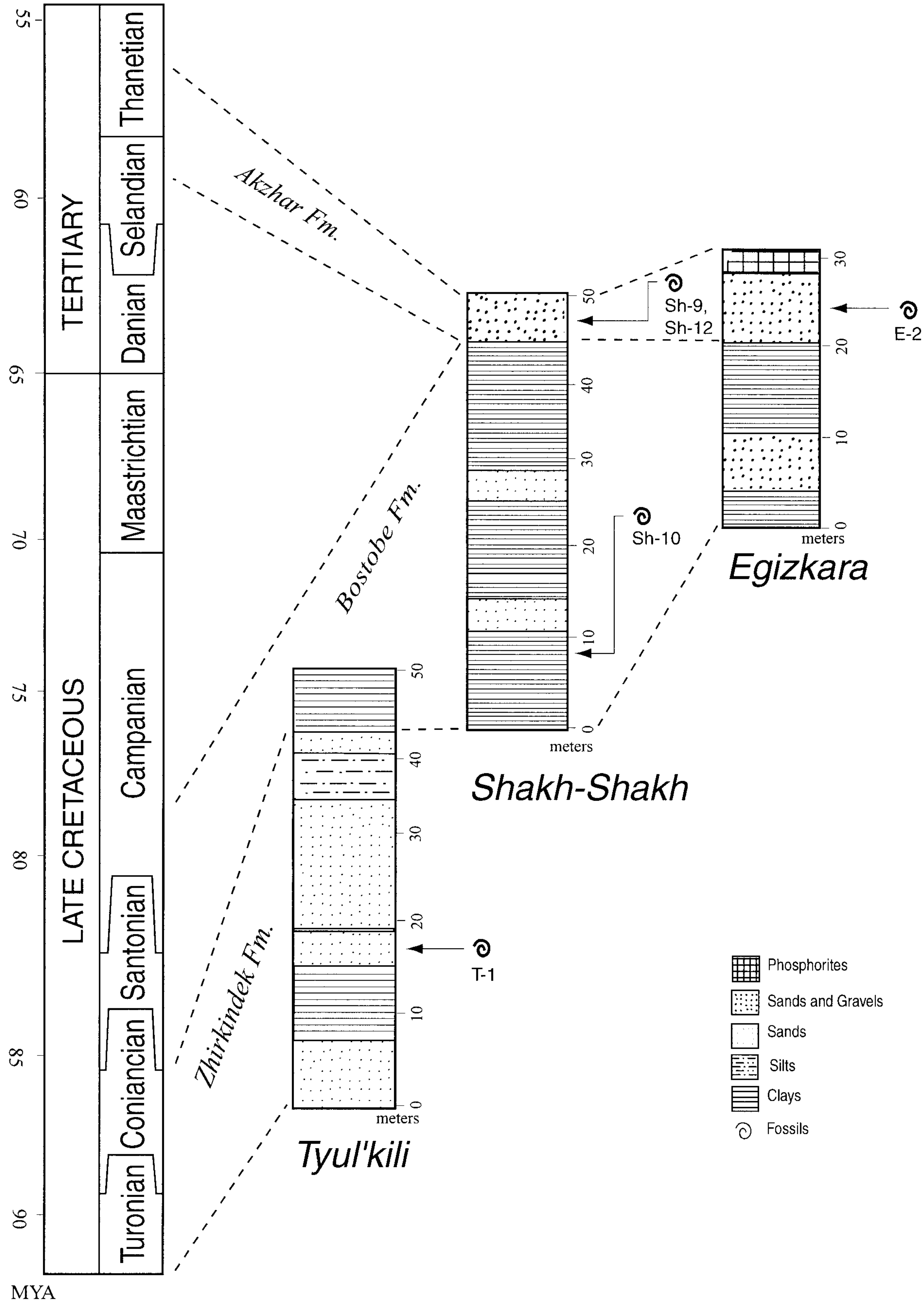


FIGURE 2—Measured sections from Tyul'kili, Shakh-Shakh, and Egizkara showing correlations among the three localities. Fossil bearing localities are indicated by name.

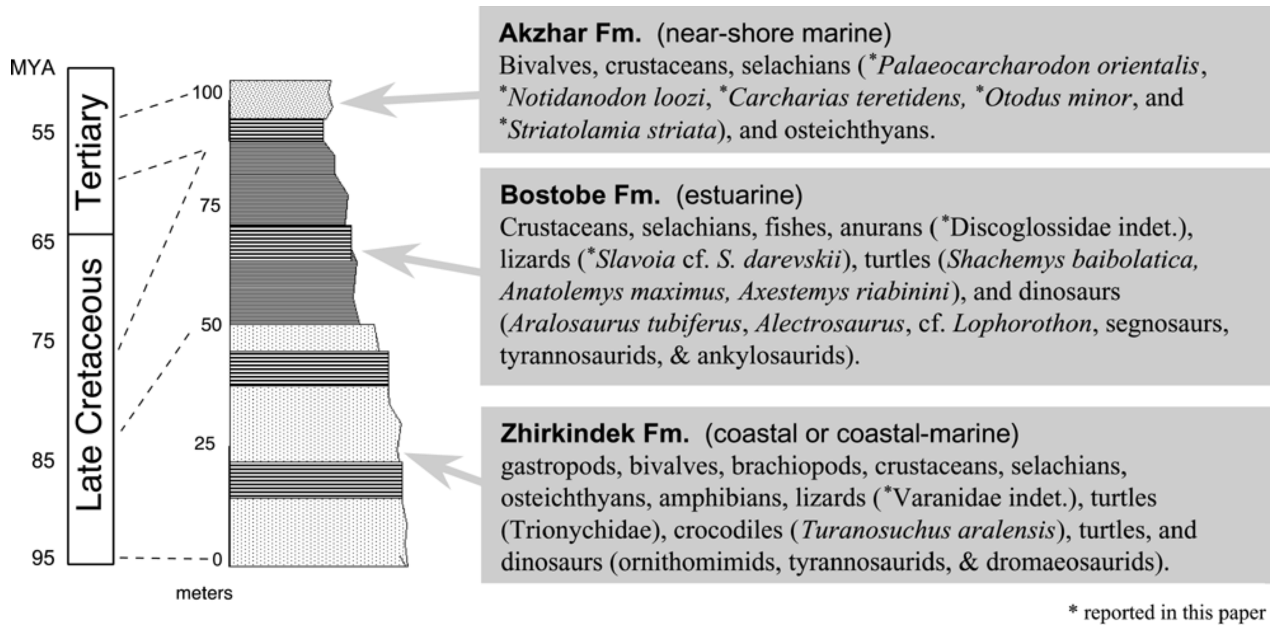


FIGURE 3—A composite section with details of the known fauna from the Akzhar, Bostobe, and Zhirkindek Formations. Taxa designated with an asterisk (*) are reported in the present paper.

are six mesial cusplets, a principal cusp, and seven distal cusplets (although the distal end is broken and there may have been more). The first four distal cusplets are as large as the principal cusp, but the more distal cusplets decrease in size rapidly. All cusps have convex cutting surfaces. The crown is low and the root is high and mesio-distally elongate. The labial face of the root has many vertical grooves. The root-crown junction is convex at the base of the principal cusp and the first distal cusplet. Based on its size and the number of cusplets, this tooth is probably lower antero-lateral 4 or 5 (Hovestadt et al., 1983).

Material examined.—KGE-E 2/1, lower antero-lateral tooth.

Occurrence.—This specimen is from Egizkara (46°25′57″N, 64°11′50″E), Akzhar formation. Other material of this species is known from the Paleocene of Kazakhstan, Russia (Glikman, 1964a), Belgium (Leriche, 1902; Casier, 1967; Herman, 1977; Hovestadt et al., 1983); and England (Gurr, 1962; Ward, 1979).

Discussion.—This specimen compares well with *Notidanodon loozi,* but differs from the type material (which is Selandian, NP3 in age) in having seven distal cusplets. *N. loozi* ss. rarely has more than six cusplets, while the older *N. brotzeni* (Danian, NP3) usually has more than seven. The Akzhar specimen is thus intermediate in morphology between the two, and may be temporally intermediate as well. A mid Selandian to early Thanetian age is suggested by this material. Furthermore, the presence of this taxon suggests a completely marine environment, as extant hexanchid sharks are all fully marine.

Order LAMNIFORMES Berg, 1958
Family ODONTASPIDIDAE Müller and Henle, 1834
Genus CARCHARIAS Rafinesque-Schmaltz, 1810
CARCHARIAS TERETIDENS (White, 1931)
Figure 4.3–4.11

Description.—Each anterior tooth has a slender cusp that is sigmoidal in lingual view with a strongly convex lingual face. Crown heights in this sample are up to 2 cm and the cutting surface reaches the base. Generally there is one pair of laterally placed, sharp cusplets at the base of the crown that are bent lingually. The root is high and has two distinct branches separated by a groove. Lateral teeth are flatter and wider at the base of the cusp compared to anterior teeth and often lack lateral cusplets. As in the anterior teeth, the cutting surfaces of lateral teeth reach the base of the crown and the two root branches are widely separated.

Material examined.—KGE-Sh 12/1 through KGE-Sh 12/25, 25 teeth.

Occurrence.—New material is from Shakh-Shakh 12 (46°00′95″N, 64°39′00″E), Akzhar formation. This species is also known from the Paleocene and early Eocene (Danian-Ypresian) of Kazakhstan, Russia (Glikman, 1964a), England (White, 1931), and eastern USA (Case, 1996).

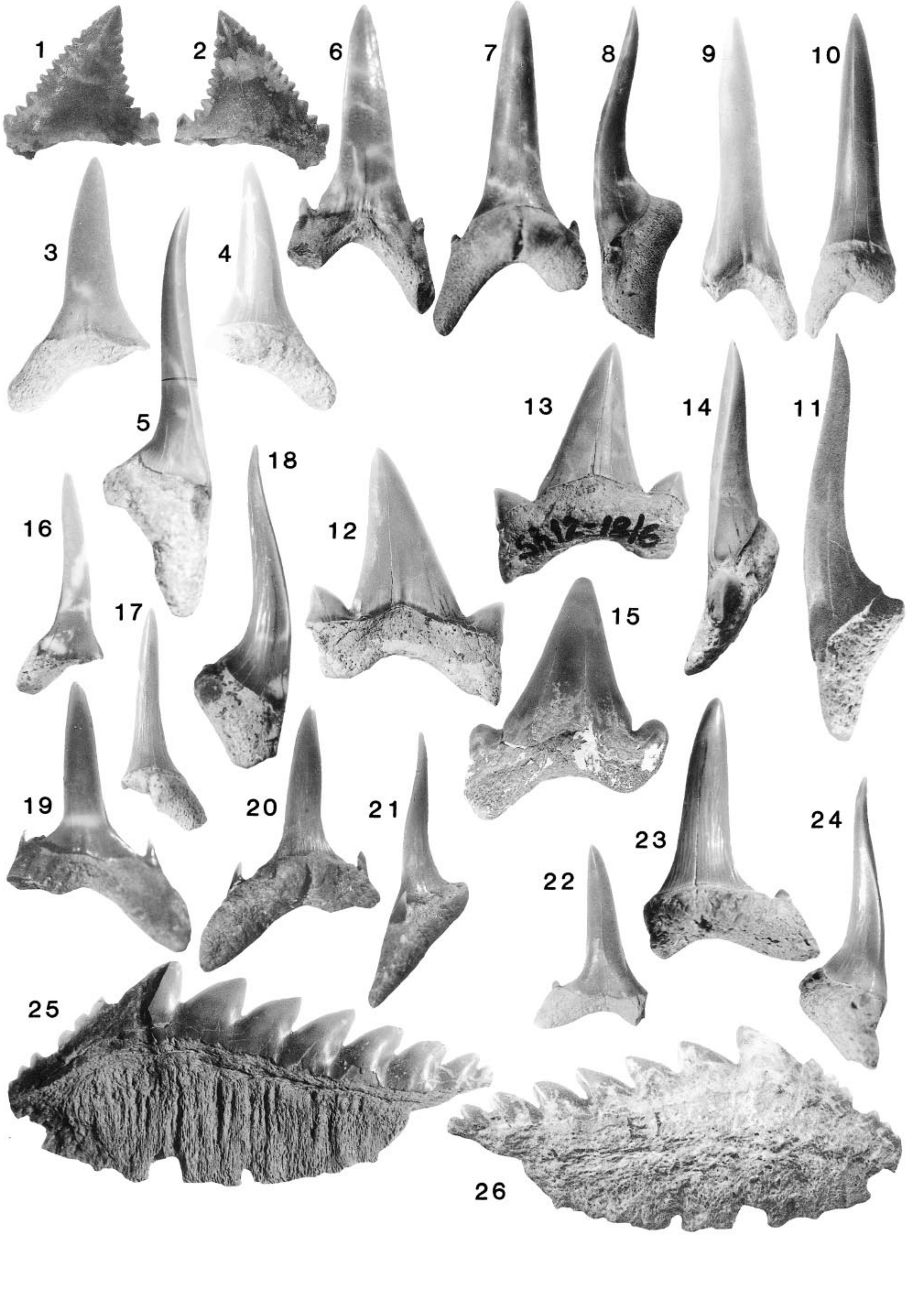
Discussion.—Extant odontaspidids are fully marine. *Carcharias teretidens* is mostly known from Paleocene localities but does apparently appear in the early Eocene at Abbey Wood in England (White, 1931). Thus, the stratigraphic distribution of *C. teretidens* is consistent with the proposed late Paleocene age of the Akzhar formation

Genus STRIATOLAMIA Glikman, 1964b
STRIATOLAMIA STRIATA (Winkler, 1874)
Figure 4.16–4.24

Description.—The crowns of the teeth of *S. striata* are elongate, relatively narrow, and triangular in cross-section. They are somewhat sigmoidal when viewed mesially and have relatively well developed, regularly spaced, striations on their lingual faces. Most of the striations are concentrated in the central area of the lingual face of the crown. Lateral cusplets range from relatively small and acute to absent.

Material examined.—KGE-Sh12/26 through KGE-Sh12/34, 9 teeth; KGE-Sh 9/1, tooth.

Occurrence.—This material is from Shakh-Shakh 9 (46°00′72″N, 64°38′87″E) and 12 (46°00′95″N, 64°39′00″E), Akzhar formation. This species is also known from the Paleocene through Eocene of Kazakhstan, Russia, Ukraine (Glikman, 1964a) and Europe (Cappetta, 1987).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Family OTODONTIDAE Glikman, 1964a
Genus OTODUS Agassiz, 1843
OTODUS OBLIQUUS Agassiz, 1843
OTODUS OBLIQUUS var. MINOR (Leriche, 1909)
Figure 4.12–4.15

Description.—The anterolateral teeth are relatively small (the largest in our sample is 1.9 cm in mesio-distal width with a crown height of 1.6 cm). The main cusp is broad and triangular and is slightly labiolingually compressed. The labial face of the crown is smooth and flat as are the cutting surfaces which extend to the base of the crown. There is one pair of lateral, sharp cusplets that are bent lingually. The root is bulky and thick with short and widely spaced branches.

Material examined.—KGE Sh 12-35, Sh 12-36, Sh 12-37, 3 teeth; KGE Sh 9-2, tooth.

Occurrence.—This material is from Shakh-Shakh 9 (46°00′72″N, 64°38′87″E) and 12 (46°00′95″N, 64°39′00″E), Akzhar formation. This species is also known from the Paleocene and Eocene of Kazakhstan, Russia, Uzbekistan (Glikman, 1964a), France (Leriche, 1909) and throughout Europe (Cappetta, 1987).

Discussion.—There is considerable variation, both within samples and through time, in *Otodus.* The taxonomic designation *Otodus minor* is thus questionable, possibly referring to a real, time-limited taxon or possibly applying simply to small or juvenile individuals. Following a reviewer's suggestion, we adopt the designation *O. obliquus* var. *minor* for these specimens. In Europe, the size of *Otodus* is similar to our material during the Selandian, but increases in the Thanetian.

Family CRETOXYRHINIDAE Glikman, 1958
Genus PALAEOCARCHARODON Casier, 1960
PALAEOCARCHARODON ORIENTALIS (Sinzow, 1899)
Figure 4.1–4.2

Description.—This lateral tooth is triangular with a relatively broad based crown (1 cm wide, 1 cm tall). The crown is compressed labio-lingually and the cutting edges have strong and irregular serrations that increase in size near the base of the crown. The root is lacking.

Material examined.—KGE B 2–1, tooth.

Occurrence.—This specimen is from Bartusken 2 (46°22′49″N, 64°11′43″E), Akzhar formation. This species is also known from the Paleocene (Danian–Thanetian) of Kazakhstan, Russia, Uzbekistan (Glikman, 1964b), the eastern USA (Case, 1989) and Morocco (Arambourg, 1952).

Discussion.—*Palaeocarcharodon orientalis* is restricted to the late Paleocene, and possibly ranging into the early Eocene at Akkurgan in Kazakhstan (Glickman, 1964a). The age of most deposits containing *Palaeocarcharodon* is problematic. In Europe, however, *Palaeocarcharadon* does not seem to range later than NP6, although in North America it ranges from NP5 to NP8. A Selandian or early Thanetian age for this specimen is, then, not unlikely.

Order ANURA Rafinesque, 1815
Family DISCOGLOSSIDAE Günther, 1859
DISCOGLOSSIDAE indeterminate
Figure 5.1–5.5

Description.—This specimen is a broken right prootic-exoccipital, including the right occipital condyle and the left wall of the braincase. The lateral portion of the bone is damaged and the margin of the foramen ovale is broken away so that its original shape and position are uncertain. The occipital condyle bears a distinct longitudinal depression on its surface. A jugular foramen pierces the lateral surface of the condyle's neck (Fig. 5.2). Dorsal and lateral to the occipital condyle is a prominence associated with the posterior semicircular canal (Fig. 5.2, 5.5) and at the anterior part of the bone—dorsal to the braincase—is a similar anterior prominence (Fig. 5.1, 5.3, 5.5). Both are broken. In spite of this it is obvious that the posterior prominence was laterally compressed (its proximal part is developed as a rounded ridge on the dorsal surface of the otic capsule), but it did not extend beyond the outlines of the posterior wall of the capsule. The medial wall of the capsule, which contributes to the lateral wall of the braincase, is pierced by four foramina (Fig. 5.3). The largest and most posterior of them is the jugular foramen; the short canal pierces the bone and appears on its outer surface lateral to the occipital condyle. The other three foramina connect the braincase with the interior of the capsule. A small foramen, which pierces the anterior wall of the jugular foramen rather than the partition between the otic capsule and the braincase, is the superior perilymphatic foramen. It is separated from the posterior acoustic foramen by a thin column of bone. The anteriormost of the three smaller foramina is the anterior acoustic foramen. It is about the same size as the jugular foramen. Above it is the foramen for the *ductus endolymphaticus.* The incisura of the prootic foramen is deep, continuing as a horizontal groove (*sulcus venae jugularis*) on the anterior outer surface of the prootic (Fig. 5.1, 5.3). Below the *prominentia ducti semicircularis* anterior the lower part of this sulcus becomes a short, bony canal, presumably transmitting a nerve (either the facial or abducens nerve, or both). Since there is no foramen in the anterior wall of the prootic except a tiny opening within the lateral orifice of this short canal it seems that abducens nerve pierced the wall here.

Material examined.—KGE-Sh 10/2, Right prootic-exoccipital.

Occurrence.—This specimen is from Shakh-Shakh (46°00′85″N, 64°38′83″E), Bostobe Formation.

Discussion.—The new specimen is referable to a large, extinct discoglossid species on the basis of the morphology of the condylar region, the prominentia of the posterior semicircular duct, and pattern of foramina piercing the medial wall of the otic capsule (Roček, 1994). In general, the prootic-exoccipital in the anurans, unlike their sphenethmoid, is evolutionarily conservative and its taxonomic value is low. Moreover, the foramina piercing the medial wall of the otic capsule vary in size and position and are also not of much taxonomic value (Stadtmüller, 1936). The same probably also holds true for the foramina conducting nerves

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FIGURE 4—Selachian teeth, Akzhar Formation, Paleocene, North-Eastern Aral Sea Region, Kazakhstan. *1, 2, Palaeocarcharodon orientalis,* upper lateral tooth (KGE-B 2/1) in labial (*1*) view and lingual (*2*) views (× 2.5). *3–11, Carcharias teretidens,* upper anterolateral tooth (KGE-Sh 12/19) in labial (*3*) and lingual (*4*) views (× 2.2), and in mesial (*5*) view (× 3.2); anterior tooth (KGE-Sh 12/20) in labial (*6*), lingual (*7*), and mesial (*8*) views (× 2.5); lower anterior tooth (KGE-Sh 12/21) in labial (*9*) and lingual (*10*) views (× 2.5), and in mesial (*11*) view (× 2.8). *12–15, Otodus minor,* upper lateral tooth (KGE-Sh 12/18) in labial (*12*) and lingual (*13*) views (× 1.8), and in mesial (*14*) view (× 2.3); upper lateral tooth (KGE-Sh 9/26) in lingual (*15*) view (× 1.9). *16–24, Striatolamia striata,* anterolateral tooth (KGE Sh 12–22) in labial (*16*) and lingual (*17*) views (× 2.4), and in mesial (*18*) view (× 3.3); lateral tooth (KGE Sh 9–26) in labial (*19*), lingual (*20*), and mesial (*21*) views (× 3.2); and lateral tooth (KGE Sh 12–23) in labial (*22*) view (× 2.4), and in lingual (*23*) and mesial (*24*) views (× 3.5). *25,26, Notidanodon* cf. *loozi,* lower anterolateral tooth (KGE-E 1/1) in labial (*25*) (× 2.0) and lingual (*26*) views (× 1.9).

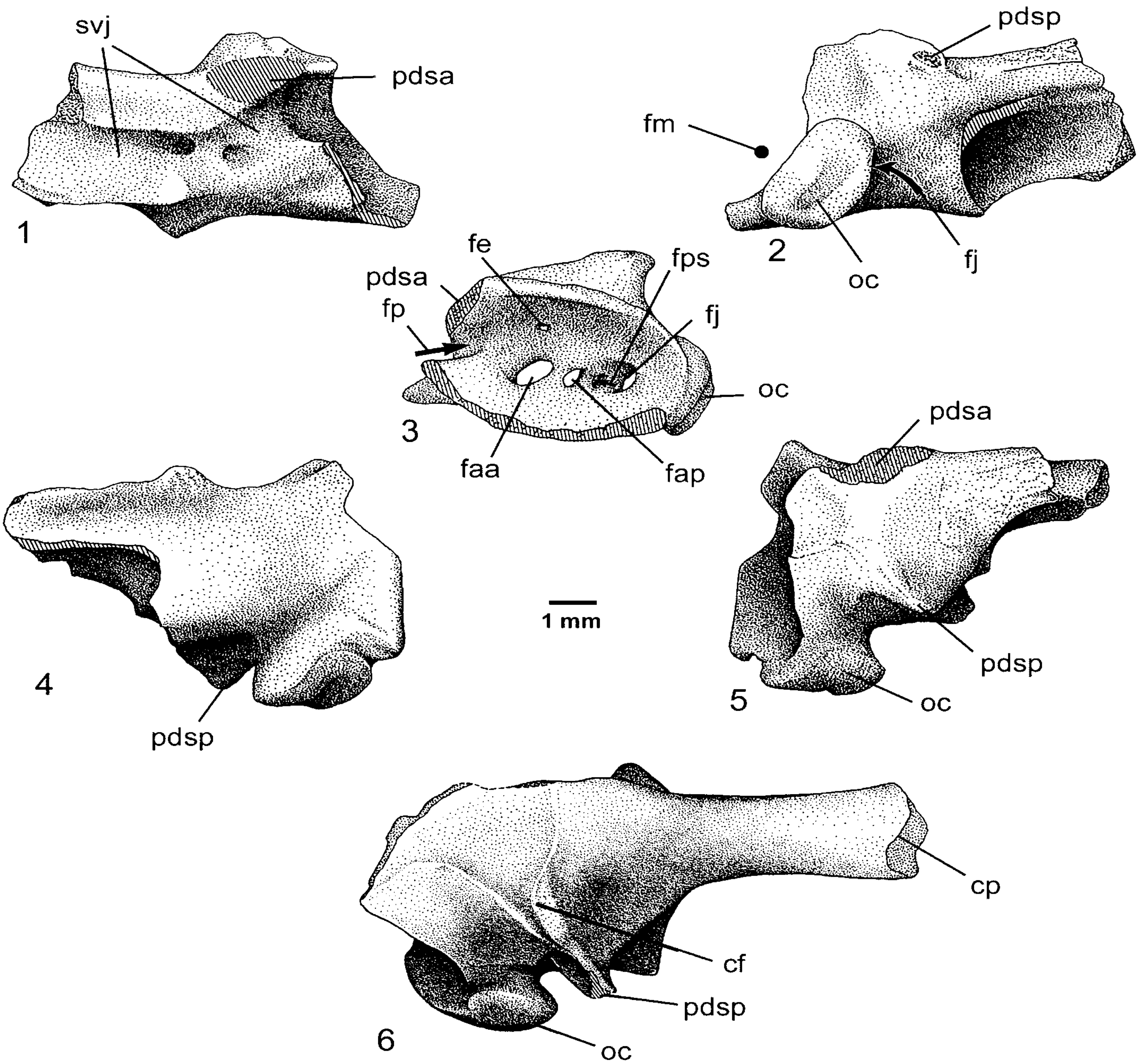

FIGURE 5—Discoglossidae indet., right prootic-exoccipitals. *1–5*, KGE-Sh 10/2, Shakh-Shakh locality, Bostobe Formation, Lower Santonian, Kazakhstan in anterior, posterior, medial, ventral, and dorsal views respectively; *6*,—LU-N 7/445, St. Petersburg University, Dept. of Zoology), Early Cenomanian-Coniacian, Uzbekistan from Roček and Nessov (1993) in dorsal view.

in the anterior wall of the otic capsule, though Stadtmüller (1936, p. 527) mentioned that in Discoglossus the prootic foramen (through which the *n. trigeminus* passes) is separate from the foramen for the facial nerve. Nevertheless two seemingly derived features unite this specimen with extant *Discoglossus*: the prootic-exoccipital bears a laterally compressed outgrowth on the surface of the *prominentia ducti semicircularis posterioris* (compare with the better preserved specimen in Fig. 5.6), and there is a well developed sulcus venae jugularis on the anterior surface of the capsule (Roček, 1994). Both these characters indicate that this material should be referred to Discoglossidae, probably even in the restricted sense of Ford and Cannatella (1993), although the redefinitions proposed by those authors were not accompanied by a rigorous character analysis which makes it difficult to place new material within their hierarchy.

Discoglossids from western Central Asia were previously known only from the Early Cenomanian through Coniacian of the central Kyzylkum Desert in Uzbekistan (Roček and Nessov, 1993). Previously known species include Kizylkuma antiqua, characterized by its low, elongate, and unornamented maxilla and by the unique morphology of its maxillary-pterygoid contact (Nessov, 1981); *Aralobatrachus robustus,* the only Cretaceous frog from Asia that reached the size of members of the extant genus *Discoglossus* (Nessov, 1981); and *Itemirella cretacea,* which has a smooth maxillary surface and—like *Soevesoederberghia egredia, Procerobatrachus paulus,* and *Estesina elegans*—

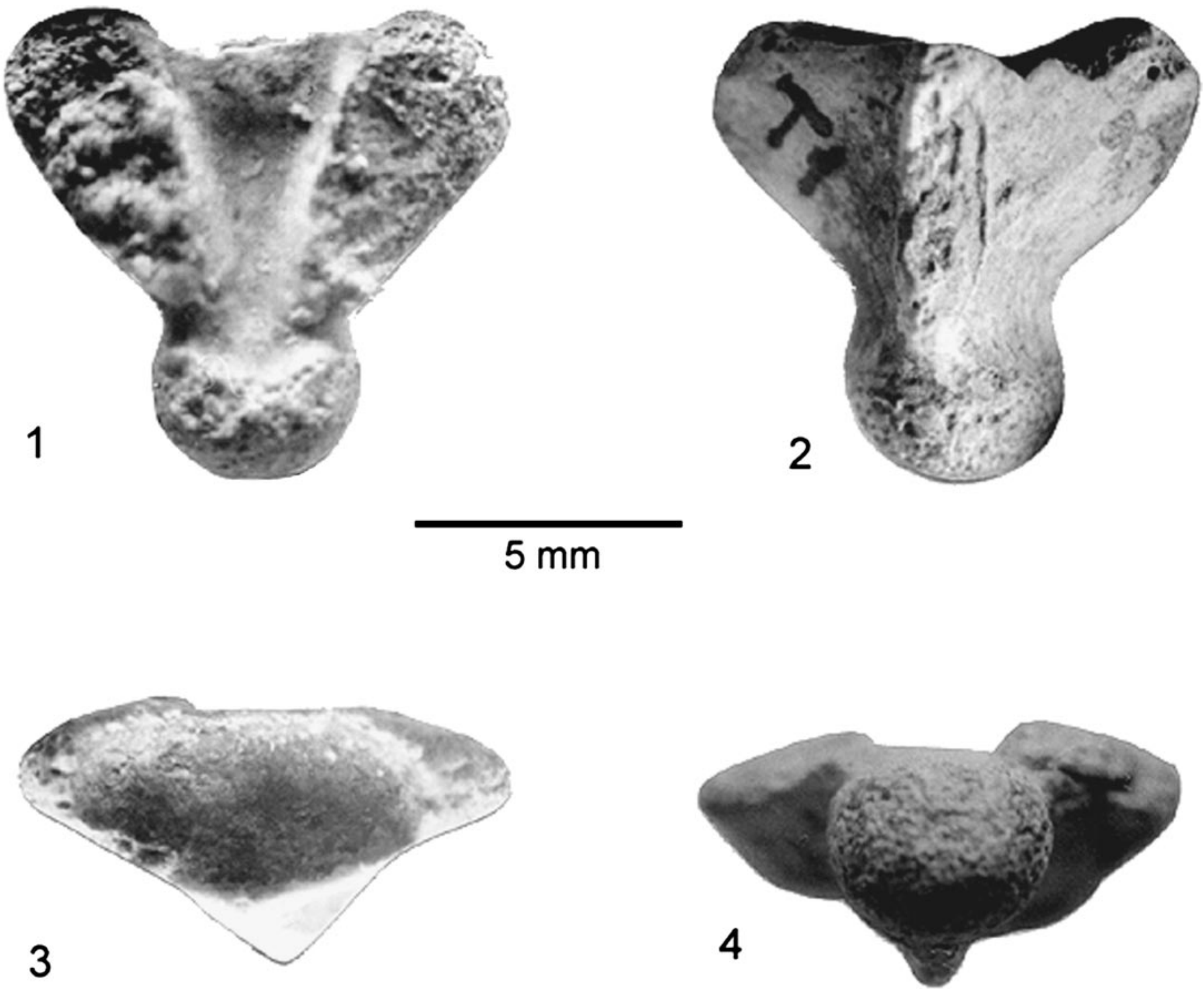

FIGURE 6—Cervical vertebra of a varanid lizard (KGE-T 1/1) from the Turonian-Coniacian Zhirkindek Formation at Tyul'kili, Kazakhstan in dorsal (*1*), ventral (*2*), anterior (*3*), and posterior (*4*) views.

is distinguished by the morphology of the horizontal lamina of the maxilla and its pterygoid process, by the shape of the orbital margin, by variability in the presence of the *processus frontalis* and *processus zygomatico-maxillaris*, and by posterior elongation of the tooth row (Roček and Nessov, 1993).

Order SQUAMATA Oppel, 1911
Family VARANIDAE Hardwicke and Gray, 1827
VARANIDAE indeterminate
Figure 6.1–6.4

Description.—This specimen is a procoelous cervical vertebra that is short, wide, and roughly triangular in ventral view. It is approximately 8.6 mm long and 9.4 mm wide. The neural arch is broken, but its heavy base is present (Fig. 6.1). There is a broad, elongated ventral peduncle which is also broken (Fig. 6.2). The body is subtriangular in cross-section with a broad anterior cotyle (Fig. 6.3). The posterior condyle is large and spherical with a markedly constricted neck (Fig. 6.4). In its general shape, the specimen is similar to the cervical vertebrae of *Saniwa* from North America.

Material examined.—KGE-T 1/1, a cervical vertebra.

Occurrence.—This specimen is from Tyul'kili (46°12′72″N, 64°05′68″E), Zhirkindek Formation.

Discussion.—The combination of ventral peduncle and constricted pre-condylar neck of this vertebra permit its tentative referral to Varanidae. A ventral peduncle or hypapophysis is characteristic of the cervical vertebrae of Varanoidea (Pregill et al., 1986). Precondylar constriction of the centrum is also characteristic of some varanoids (Hoffstetter and Gasc, 1969); Pregill et al. (1986) argued that the constriction is barely noticeable in non-varanid varanoids and considered marked constriction to be a synapomorphy of *Varanus*. But referral of this specimen to that genus seems premature given the limited nature of the new material. Because of uncertainties about the relationship of necrosaurids, *Saniwa*, and other extinct taxa to Varanoidea (Pregill et al., 1986; Norell et al., 1992; Evans, 1994) and the concomitant uncertainty about the distribution of diagnostic characters, this specimen may ultimately turn out to be referable to a taxon lying outside Varanidae.

The earliest varanids and varanoids (sensu Pregill et al., 1986)

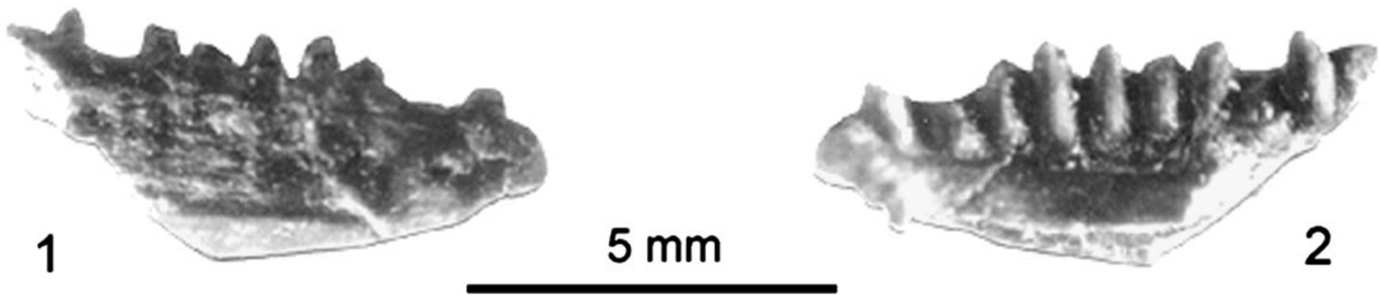

FIGURE 7—Right dentary of *Slavoia* cf. *darevskii* (KGE-Sh 10/1) from the Santonian-Campanian Bostobe Formation at Shakh-Shakh, Kazakhstan in buccal (*1*) and lingual (*2*) views.

were previously known from Barun Goyot and Nemegt in Mongolia (Gilmore, 1943; Borsuk-Bialynicka, 1984; Norell et al., 1992; Alifanov, 1993a, 1993b), the oldest of which are probably Coniacian in age (Lilligraven and McKenna, 1986; Jerzykiewicz and Russell, 1991). The new specimen from Kazakhstan, which may be as old as the Coniacian, is thus one of the oldest known varanids (sensu stricto).

Infraorder SCINCOMORPHA Camp, 1923
Family SLAVOIIDAE Alifanov, 1993b
Genus SLAVOIA Sulimski, 1984
SLAVOIA cf. DAREVSKII Sulimski, 1984
Figure 7.1–7.2

Description.—The specimen is a right dentary with ten pleurodont teeth. It is relatively short (about 8.0 mm long) and deepens posteriorly. The jaw symphysis is weakly developed and the Meckelian sulcus is expanded posteriorly (Fig. 7.2). The teeth are widely spaced with approximately one-third of their height above the labial wall. Each tooth is smooth surfaced, lacking any sculpturing, cylindrical, and thickest at mid-height. The anterior ones are slightly inclined anteriorly and the posterior ones slightly inclined posteriorly.

Material examined.—KGE-Sh 10/1, a right dentary.

Occurrence.—This specimen is from Shakh Shakh (46°00′85″N, 64°38′83″E), Bostobe Formation.

Discussion.—This specimen is virtually identical to the dentaries of *Slavoia darevskii* from the Barun Goyot Formation of Khulsan, Mongolia described by Sulimski (1984). Both are approximately the same size, have the same number of pleurodont, unsculptured teeth, and deepen posteriorly. Due to the fragmentary nature of the new material and the paucity of knowledge about Asian lizard diversity in the Cretaceous, we remain cautious about referring the new specimen to a species-level taxon; however, we can find no differences between this specimen and *Slavoia darevskii*. The phylogenetic position of *Slavoia* within Scincomorpha is disputed. Sulimski (1984) stated that *Slavoia* might be related to Gymnophthalmidae. But Borsuk-Bialynicka (1988) argued that *Slavoia* and *Globaura* (also from the Late Cretaceous of Mongolia) are primitive, indeterminate members of the Lacertiformes. Gao and Fox (1991) confirmed this, stating that *Slavoia* has none of the synapomorphies that would unite it with gymnophthalmids. It is possible that *Slavoia* and *Eoxanta* should be included in a separate family as suggested by Alifanov (1993b). Alifanov noted that these two taxa might be relatively closely related to the Late Jurassic *Eichstaettisaurus* from Germany as well as to extant Scincidae.

Slavoia was previously known only from Khulsan, Nemegt, and Khermeen Tsav (Barun Goyot Formation) in the Gobi Desert of Mongolia (Sulimski, 1984; Borsuk-Bialynicka, 1988), which are considered Campanian in age (Gradzinski et al., 1977; Lilligraven and McKenna, 1986; Jerzykiewicz and Russell, 1991). The new specimen may thus be the oldest member of the genus known if the lower Bostobe Formation is Santonian in age.

CONCLUSIONS

In this paper we reported on microvertebrates from the Zhirkindek, Bostobe, and Akzhar Formations of Kazakhstan. This area has long been known for its dinosaurian faunas, but detailed locality and stratigraphic information have been lacking in the published literature. The Akzhar fauna was previously undescribed. We found five species of shark from that formation: *Notidanodon* cf. *loozi*, *Carcharias teretidens*, *Striatolamia striata*, *Otodus obliquus* var. *minor*, and *Palaeocarcharodon orientalis*. These taxa suggest a Paleocene age for the formation, most likely Selandian or early Thanetian. We also reported the first Mesozoic discoglossids from Kazakhstan from the Santonian-Campanian aged Bostobe Formation. Discoglossids from western Central Asia were previously known only from the Early Cenomanian through Coniacian of the central Kyzylkum Desert in Uzbekistan (Roček and Nessov, 1993). We also reported the first Mesozoic varanids and slavoiids from Western Asia. *Slavoia* cf. *darevskii* was found in the Bostobe Formation, the first occurrence of the genus outside Mongolia. A varanid was found in the Turonian-Coniacian Zhirkindek Formation. This area of Kazakhstan promises to yield a particularly rich and diverse record of vertebrate life in the late Mesozoic and early Cenozoic. Our work has, however, uncovered problems with formation names as they are used in the area and problems with the correlation of the area's faunas both with other terrestrial Asian faunas and with the worldwide geologic time scale.

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