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FAUNA OF THE VALE AND CHOZA: II

Lysorophus: Vale and Choza

Diplocaulus, *Cacops* and Eryopidae: Choza

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INTRODUCTION

Lysorophus and *Trimerorhachis* are the most common amphibians in the fresh-water Permian deposits of Vale and Choza in north central Texas. The latter has been discussed in detail in the preceding paper of this series (Olson, 1955). Although individuals of *Lysorophus* outnumber those of *Trimerorhachis* by at least 10 to 1, they do not provide equivalent information on morphology and taxonomy. With rare exceptions only the vertebrae and ribs have been preserved, and these add nothing to what is already known of the skeletal structure from finds in the Arroyo, nor are they suitable for detailed taxonomic analysis. For these reasons, *Lysorophus* will be treated briefly in the present paper. In addition to these two genera of amphibians, remains of three others have been found in Choza beds. These represent three families, Diplocaulidae, Dissorophidae and Eryopidae, all of which are known from earlier Permian Formations. Specimens are uncommon and limited in both geographic and stratigraphic range. *Diplocaulus* and *Cacops* are members of the Diplocaulidae and Dissorophidae, respectively. The situation with respect to the Eryopidae is less clear. One specimen, a femur, may belong to the genus *Eryops*, well known from the earlier Permian Formations. A fragmentary mold of a large skull from the middle Choza is definitely an eryopid but is not *Eryops*. Unfortunately this specimen is not well enough preserved to yield critical information on its structure, so that it serves primarily to extend the known range of the family.

SUBCLASS LEPOSPONDYLI

Order Nectridia

Family Lysorophidae

Genus *Lysorophus**Lysorophus tricarinatus* Cope

General comments on taxonomy.—The genus *Lysorophus* was established on the basis of a few vertebrae (UC 6526) from the Pennsylvanian of Vermilion County, Illinois. When similar vertebrae were discovered in the Permian beds of Texas, they were referred to the Illinois genus and species, *L. tricarinatus*, since no morphological differences were apparent. It is quite possible that the Permian specimens are actually specifically different from those of the Pennsylvanian, but there is no morphological basis for differentiation and it seems best to retain the single specific name, with recognition that it may well express a "form" species. The inclusion of the Pennsylvanian and Permian specimens in a single specific group should not be taken as a basis for the inference that *Lysorophus* underwent no modifications over the long period of time involved.

One of the difficulties in the study of the taxonomy of *Lysorophus* stems from the fact that, in spite of the great number of individuals that are known, the preponderance of specimens consists of vertebrae and ribs. A fairly large number of skulls is known, however, and the morphology of the head has been worked out in detail (see, for example, Sollas, 1920). Well-preserved skulls, however, are known only from the Arroyo Formation, so that comparisons with the type materials and with specimens from other Permian horizons must be based on vertebrae and ribs. These structures are always difficult to use for specific differentiation, and this is particularly true in *Lysorophus*, in which there was a highly specialized and persistent mode of life.

There is a wide size range in the known vertebrae. A good index of trunk length is found in the length of the vertebral centrum, for this dimension is essentially the same throughout the pre-caudal vertebral column. The range of central length of specimens from the Arroyo is from less than 1 mm. to approximately 10 mm. There is a strong tendency for the individuals from a given site to have a restricted range of size, usually from 3 to 4 mm. It is possible that this is an indication of specific difference between various samples. Where, however, there is a complete range of sizes, as at

a few localities in the Vale and Choza, segregation into size groups is lacking and it would appear that the size grouping, characteristic of specimens from many pockets, results from concentration of animals at about the same stage of growth. In individuals of different size there are no morphological differences except those related to the degree of ossification, which, as would be expected in a growth series, increases with increase in size. The only possible evidence of specific differences in these materials, the size groups, seems to find a more logical explanation in the interpretation that different growth stages are involved.

Habits of Lysorophus.—*Lysorophus* was an elongated swimming and burrowing amphibian. It clearly had two phases in its life, one devoted to free swimming and the other to aestivation in burrows. The great majority of occurrences represent the latter phase. Specimens occur in high concentration; many are coiled, and often several individuals are matted or twined together. There seems little doubt that these occurrences represent preservation that occurred when the local aestivating population failed to return to the free swimming phase of life. Aestivation of the lung fish *Gnathorhiza* has been noted in both the Arroyo and Vale Formations (Romer and Olson, 1954).

Examples of preservation from the free phase are less common; in fact, I know of no site in the Arroyo that shows this phase. Three such sites have been found in higher beds, one in the Vale and two in the Choza. In two of these instances, *Lysorophus* appears to have lived in association with *Trimerorhachis*. In the other, the Vale instance, the habitat appears to have been a small, temporary pool, probably a rain pool. There are no other organic remains in this deposit. Only rarely are associated animals encountered in the concentrations derived from aestivating colonies of *Lysorophus*. A few instances of the presence of very small and immature specimens of *Diplocaulus magnicornis* are known. At one locality in the middle Arroyo, *Euryodus* and *Gnathorhiza serrata* have been found. These associations have been considered at greater length in an earlier paper (Olson, 1939).

Lysorophus of the Vale and Choza.—*Lysorophus* has been found at eighteen sites in the Vale and at five in the Choza. In addition, occasional vertebrae have been noted in the coarse, clay-pebble conglomerates of the channel deposits in the Vale. The Vale sites that contain *Lysorophus* range from the base to the very top of the formation. Except in three of the total of twenty-three sites in

the Vale and Choza, specimens occur in concentrations similar to those of the Arroyo, or in nodules that form part of the coarse materials in channel deposits. The latter probably were derived from Arroyo-like concentrations that were cut through by the streams after the formation of nodules had occurred. As in the Arroyo, vertebrae and ribs are usually preserved and skulls are very rare. None of the skulls that have been found are well enough preserved to be of value in taxonomic work.

High in the Vale, in locality KJ, there is a small pond deposit in which several hundred individuals are preserved. These specimens are not coiled and are not closely packed. The size range, based on length of centrum, is somewhat limited, with a spread of about 2 mm. on either side of the mean of 6 mm. This locality gives evidence of *Lysorophus* in its free swimming phase, in what was probably a temporary pond. Presumably it is from such restricted groups that the aestivating colonies were formed as a dry period set in. There are no other animals in association.

Two Choza sites, both in locality FA, present a somewhat different situation. These have been termed the pipe site and the green nodule site. The former includes deposits that appear to have been formed by a persistent pond (see Olson, 1955, for discussion and illustrations). There is no indication of an aestivating phase at this site. Typical coiling and packing of individuals do not occur. The size, based on length of the centrum, ranges from less than 1 mm. to about 13 mm. *Trimerorhachis* is directly associated with *Lysorophus*. Apparently terrestrial animals, *Dimetrodon*, *Labidosaurikos* and *Captorhinikos*, are present in small numbers in the beds. These presumably found sources of food in the pond but cannot be considered as direct associates of *Lysorophus* as in the case of the aquatic *Trimerorhachis*.

There are no evident morphological differences between the Vale and Choza specimens and those of the underlying Arroyo Formation. The size range of the Vale and Choza specimens, however, is greater. In the Vale, centra from two pockets range from 9 to 13 mm. in length, exceeding by 3 mm. the maximum length in the Arroyo and indicating the existence of a size group not found earlier. The maximum length is about the same as the maximum of central length found at the pipe and green nodule sites. It would seem that there was an additional growth stage in the Vale and Choza as compared to the Arroyo. Such a difference might, of course, be genetic, but it could result merely from environmental differences

and carry no taxonomic significance. There is, of course, no basis for a decision concerning the actual meaning and, in the absence of any supporting morphological evidence, it seems to me unwise to recognize this difference as a basis for specific differentiation. All of the Clear Fork specimens, thus, are provisionally assigned to *Lysorophus tricarinatus*.

Family Diplocaulidae

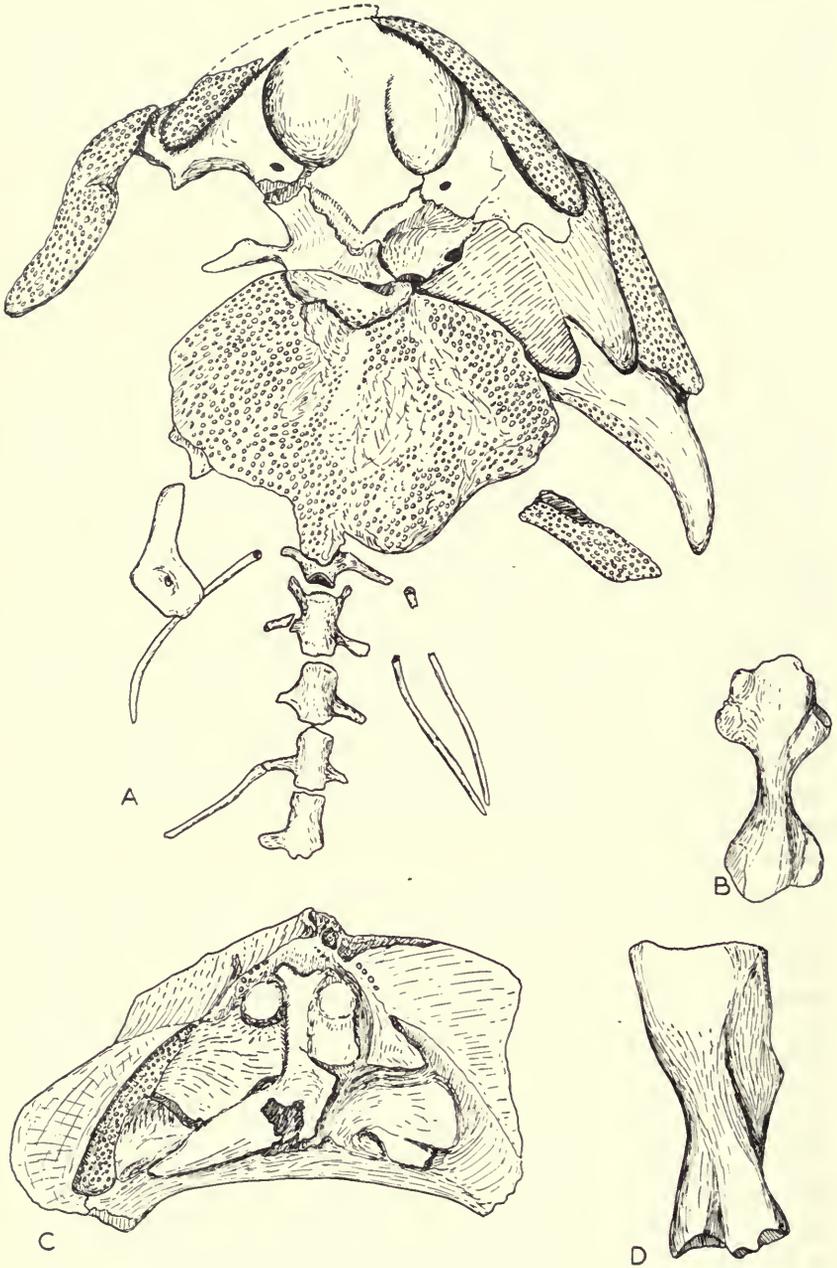
Genus Diplocaulus

Diplocaulus recurvatus Olson

All of the Choza specimens of the amphibian *Diplocaulus* have come from a single site, termed the "*Diplocaulus* site," in locality FA, Foard County, Texas.¹ The specimens occur in fine-grained siltstones that were formed in a series of small channels. Lateral to the channels are somewhat coarser siltstones, in which a few non-aquatic animals are preserved. Fossil remains are fairly abundant in the channel deposits, but are, for the most part, scattered and broken. The initial porosity of the matrix, and small cracks, developed during weathering, have permitted waters bearing calcium sulphate to percolate to the bones. Crystallization of this salt has resulted in destruction of most of the bone, so that the majority of specimens consist of natural molds. The molds, fortunately, are in excellent condition, so that latex casts reproduce much of the surface detail of the destroyed bone. The specimens shown in figure 131, A, *Diplocaulus*, and in 131, D, *?Eryops*, have been drawn from latex casts.

The material of *Diplocaulus* from the channels consists largely of parts of skulls and jaws, series of vertebrae, and parts of girdles and limb bones. By far the most complete specimen is UR 167, shown in figure 131, A. A partial skull, UR 168 (fig. 131, C), consists of a natural cast of the dorsal side of a skull. Numerous vertebrae have been included in a composite specimen, UR 169. The assignment of the postcranial elements to *Diplocaulus* poses no problem, but only the skull materials provide any basis for specific assignment. UR 167 shows the presence of recurved "horns" encountered in two species of *Diplocaulus*, *D. brevirostris* of the Arroyo and *D. recurvatus* of the Vale (Olson, 1951, 1952). The position of the orbits is shown in UR 168. They occur well back of the anterior rim of the skull,

¹ Aerial photographic index of site: CZW 1C 59, 2.49-3.79.



in the position characteristic of *D. recurvatus* and *D. magnicornis* rather than *D. brevirostris*, in which the orbits lie close to the anterior margin. The nature of the "horns" and the position of the orbits clearly show that the Choza specimens are closer to *D. recurvatus* than to either of the other Clear Fork species.

Both of the skulls from the Choza are relatively small, with skull lengths between 60 and 65 mm. The range in adults of *D. recurvatus* from the Vale is from about 90 to 125 mm. (Olson, 1952). UR 167, however, shows evidence of immaturity in the degree of development of the horns and it is probable that both of these skulls are from immature individuals. That larger individuals were present is shown by vertebrae in which central lengths range up to 21 mm., in contrast to the average length of 15 mm. in UR 167. Size is the only feature in which there is any difference between the Choza skulls and those of *D. recurvatus* from the Vale. In view of the evident immaturity of at least one of the skulls, it seems safe to refer Choza specimens to *D. recurvatus*.

The *Diplocaulus*-bearing deposits of the Choza were formed in streams, and it seems highly probable, in view of the relative completeness of UR 167 and the excellent preservation of other less complete specimens, that this environment was the life habitat of the Choza specimens. A great deal of evidence has accumulated to indicate that *D. recurvatus* was exclusively a stream dweller in the Vale, and there seems to have been no shift in habitat between the Vale and Choza. No trace of *Diplocaulus* has been found in Choza pond deposits at the pipe or green nodule sites, where a wealth of remains of other aquatic amphibians has been preserved.

Directly associated with *Diplocaulus* in the stream deposits at the *Diplocaulus* site is *Xenacanthus*, the predaceous, fresh-water shark. No evidence of *Gnathorhiza dikeloda* has been found, although this lung fish does occur in stream deposits at about the same stratigraphic level. *Dimetrodon gigashomogenes* has been found in deposits marginal to the channels to the east and *Captorhinikos chozaensis* in those to the west. It is clear that they were contemporaries of *Diplocaulus* but that they inhabited quite different environmental subzones.

FIG. 131. A, *Diplocaulus recurvatus*, CNHM-UR 167, from *Diplocaulus* site, Choza; ventral aspect drawn from latex cast. B, Humerus of *Cacops* cf. *aspidophorus*, CNHM-UR 170, from pipe site, Choza; dorsal aspect of matrix cast. C, *Diplocaulus recurvatus*, CNHM-UR 168, from *Diplocaulus* site, Choza. D. Femur of *?Eryops*, CNHM-UR 171; dorsal aspect drawn from latex cast.

SUBCLASS APSIDOSPONDYLI

Order Rhachitomi

Family Dissorophidae

Genus *Cacops**Cacops* cf. *aspidophorus*

The only evidence of the family Dissorophidae in the Choza comes from two humeri of *Cacops*, UR 170, found close together at the pipe site of FA, Foard County, Texas. These humeri, figure 131, B, cannot be distinguished from those of *Cacops aspidophorus* and are tentatively assigned to this species. No dissorophids have been found in the Vale except for *Cacops aspidophorus* from the *Cacops* bone bed of Baylor County, Texas, and the stratigraphic position of this bed is open to some question. From the locality data, it would appear to belong in the Vale, but it may be very late Arroyo. It was thus rather surprising to find evidence of *Cacops* in the Choza. Dissorophids, however, are not common in the Texas Permian and it may well be that they did not, as a rule, live under circumstances in which preservation was likely to occur. The Choza specimens constitute the youngest recorded occurrence of this family, for no traces have been found in the middle Choza or in the overlying San Angelo and Flower Pot Formations.

Family Eryopidae

Genus ?*Eryops*

The genus *Eryops* is abundant in the upper part of the Wichita group in north central Texas and is fairly common in the Arroyo, with some decrease in the higher beds. It is known from the base to the top of the Vale Formation but finds are relatively rare. One species, *E. megacephalus*, appears to have been persistent throughout this time. Only one specimen that may pertain to this genus has been found in the Choza. This is a femur that has come from the "*Diplocaulus* site" of locality FA.

The Choza specimen, UR 171, is unfortunately immature and ossification is so poor that definitive characters are not well developed (fig. 131, D). The femur cannot be distinguished from femora of *Eryops* of comparable maturity, but femora of the large amphibians of the Permian are at best difficult to differentiate, even to genus, and when ossification is poor, the task is essentially im-

possible. While it is probable that the femur in question pertains to *Eryops*, it is not out of the question that it may actually be from an individual of another genus, possibly the one represented by a fragmentary skull higher in the Choza as discussed below.

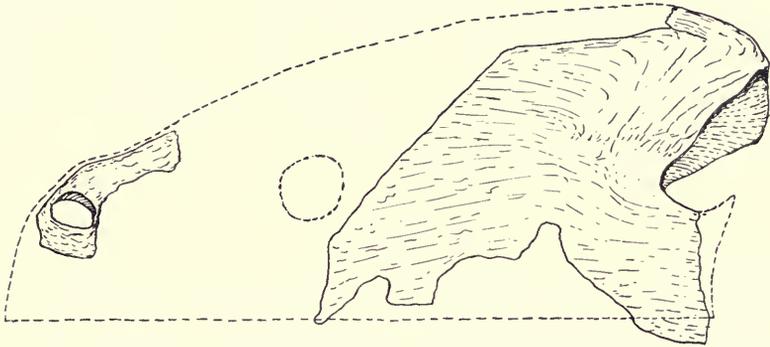


FIG. 132. Eryopid, gen. nov., CNHM-UR 172. From locality FF, middle Choza. Dorsal aspect of reconstruction with known parts drawn from latex cast.

Genus indet.

In locality FF,¹ in the middle Choza of Foard County, Texas, fragments of the mold of a large eryopid skull, UR 172, were found marginal to a fine-grained stream deposit. All fragments that could be found were picked up, but not enough was recovered to provide even a complete outline of the skull. A fairly large part of the posterior end has been pieced together and a part of the snout, with one of the external nares, is preserved. In addition there are many fragments. A reconstruction is shown in figure 132, based on latex casts of the mold, but the skull length is by no means certain.

The preserved parts show a definite resemblance to *Eryops*. The most striking difference lies in the position of the orbits. If this skull pertained to *Eryops*, the orbits should be preserved in the posterior part of the skull; their absence indicates that they lay anterior to the position occupied in specimens of *Eryops* of comparable size. This is a position that might be expected if this skull represents a departure from *Eryops* in the direction of stereospondyls.

Although there can be no doubt that this specimen does not belong in the genus *Eryops*, to which it is most closely related, it is not sufficiently complete to serve as an adequate type for a new genus.

¹ Aerial photographic index: CZW 2C 84, 3.2-3.7.

The beds in which it was found are the highest of the Choza in which vertebrates have been found. Extensive hunting in the even red and green shales and sands of higher Choza beds has revealed no trace of fossils. For the time being, at least, no further work is contemplated in these Choza deposits and, if it is undertaken later, the chances of discovering additional specimens of this amphibian genus in the areas covered seem very poor. At present, we only know that some modification of the family Eryopidae occurred during the Choza and, on scant evidence, that there was a trend in the general direction of the stereospondyls.

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