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A Gliding Reptile from the Triassic of New Jersey[1]

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INTRODUCTION

In the early autumn of 1960 the specimen that is described in the present paper was discovered in an old quarry in North Bergen, New Jersey, by three high school students, Alfred Siefker and Joseph Geiler of West New York, New Jersey, and Michael Bandrowski of Guttenberg, New Jersey. These young men, who for some time had been interested in the Triassic fossils of the region in which they lived, and who had devoted many hours in searching for such fossils, immediately realized the importance of the specimen and brought it to the American Museum of Natural History for identification. The fossil proved to be the remains of a small reptile of a type hitherto completely unknown and unsuspected in the Triassic beds of North America and therefore aroused much interest, not only among paleontologists, but, as a result of its description in press reports, among the general public as well.

The fossil is especially noteworthy because the ribs are enormously elongated, quite obviously as an adaptation for the support of a membrane or patagium for gliding from tree to tree, in a manner similar to that practised by the modern gliding lizard *Draco,* of the Orient, an

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animal that also has elongated ribs supporting a membrane. Here, supposedly, was an early example of aerial locomotion in a vertebrate.

A year or two prior to the discovery of the New Jersey fossil, the bones of a similar gliding reptile had been discovered in Triassic fissure fillings near Bristol, England. These fossils were excavated by Pamela Lamplugh Robinson of the University of London and have since been described by her as belonging to two species of a new genus, *Kuehneosaurus latus* and *Kuehneosaurus lattissimus.* Robinson has shown that these fossils represent

FIG. 1. A partial view of the Granton Quarry at about the time *Icarosaurus siefkeri* was collected. Much of the quarry has been leveled, but a considerable portion of the north end still remains. The type of *Icarosaurus siefkeri* was found in this part of the quarry, about 20 feet above the level of the quarry floor. A remnant of the igneous sill above the Lockatong sediments can be seen above the power shovel.

an early lizard, in fact, one of the first known lizards—which is interesting, because one would not *a priori* expect the early members of this order to be so very highly specialized. The relationships of the new fossil from New Jersey to *Kuehneosaurus* and other reptiles are briefly discussed in this paper, which is devoted to a preliminary description of the specimen. A more detailed consideration of the fossil will be given in a subsequent contribution, in which the many problems inherent in this interesting skeleton can be comprehensively dealt with.

Much credit is due to Messrs. Siefker, Bandrowski, and Geiler for the discovery of the fossil, and the thanks of the American Museum of Natural History as well as of the paleontological profession throughout the world is theirs for depositing the fossil in this institution for study and description. There is no doubt but that, had they not been so keenly interested in the Triassic fossils of New Jersey and had they not searched the outcrops of the Granton Quarry and vicinity so assiduously, this very important fossil would never have become available.

Much credit is due also to Mr. Gilbert Stucker of the paleontological

FIG. 2. Another view of the quarry, showing the Lockatong beds dipping to the northwest (to the left).

laboratory of the American Museum of Natural History for his skill in the preparation of the specimen. This fossil is delicate, and many months were involved in the process of removing matrix that covered the bones of the skeleton. The work of Mr. Stucker was facilitated by the use of a jet-abrasive machine, which made the exposure of the delicate bones possible with a finesse that would never have been achieved by direct use of steel tools.

Illustrations for this paper were done by Messrs. Michael Insinna, who executed the drawings, and Chester Tarka, who made the photographs.

GEOLOGICAL RELATIONSHIPS

The locality at which the fossil was found has long been known to geologists and paleontologists as the Granton Quarry. It should more correctly be designated as the Belmont-Gurnee Quarry, but since the use of the name "Granton Quarry" is so general, this name is employed in the present paper. The name comes from a railroad stop formerly only a short distance south of the quarry but long since abandoned. The name appears on old topographic maps of this area but is omitted from more recent maps.

The geological relationships of the sediments at the Granton Quarry have been outlined by me (Colbert, 1965) and need not be repeated here in detail.

The Granton Quarry was situated at the foot of the dip slope that trends in a westerly direction from the Palisades Sill, forming the escarpment along the west shore of the Hudson River, to the low swamps or "meadows" of the Hackensack River. This quarry was excavated in a complex series of sediments topped by a sill. Black shales and argillites were predominant in the sediments, these being an eastern outlier of the Lockatong lake facies of the Newark Group, characteristically exposed along the Delaware River where it forms the boundary between New Jersey and Pennsylvania. The sediments and the overlying sill of the Granton Quarry were stratigraphically above the Stockton Formation, within which the Palisades Sill is included.

The fine-grained argillites and shales of the Granton Quarry for many years yielded various fossils—plants and animals. Estherians in great profusion occurred in these sediments. As for fossil vertebrates, many fine examples of the coelacanth fish *Diplurus newarki* have been found and were described some years ago by Schaeffer (1952). The palaeoniscoid fish *Turseodus* also occurs at this locality. As for tetrapods, the recent contribution by the present author (Colbert, 1965) described a phytosaur identifiable as *Rutiodon carolinensis,* thus establishing a correlation of these sediments with the Lockatong in other northern areas of the Newark Group, and with the Cumnock Formation of the Carolina region. Fortunately the fine-grained shales and argillites of the Lockatong facies at Granton were obviously deposited in quiet, lacustrine waters (the expression of this facies at many of its exposures), in which the delicate skeletons of small fishes and reptiles, as well as more robust fossils, were entombed and preserved.

As noted in my earlier paper (1965), one must now write of the Granton Quarry largely in terms of the past, because the quarry has been systematically destroyed during the past few years to make way for stores, factories, and other establishments and at the present time only a very small remnant of the original remains.

DIAGNOSIS

CLASS REPTILIA

ORDER SQUAMATA

SUBORDER LACERTILIA

ICAROSAURUS,[1] NEW GENUS

Generic Type: *Icarosaurus siefkeri*, new species.

Diagnosis: *Icarosaurus* is a small reptile, the length of the skeleton, from the front of the skull to the sacrum being about 100 mm.; the individual bones being less than half of the size in linear dimensions of those of *Kuehneosaurus latus.* The bones are hollow. The orbit is large, with the lacrimal seemingly excluded from its border. The frontals are elongated, and the parietals are separate. The upper temporal opening is broad. The quadrate has a high ascending ramus and is movably articulated with the squamosal. The jugal is a crescentic bone with no posterior ramus. The jaws are long and closely set with simple, homodont teeth, with, on each side, perhaps as many as 30 dentary teeth and about an equal number of opposing teeth in the premaxilla and maxilla. There are 24 presacral vertebrae preserved, two sacrals, and, from the size of the four preserved caudals, it is evident that the tail was long. The vertebral centra are strongly constricted in the middle, and the neural arches are high. The first nine vertebrae are set apart distinctly from the more posterior vertebrae, to make a well-defined cervical region. The more anterior "thoracic" vertebrae have greatly elongated and broadened transverse processes, to the ends of which are articulated on each side 10 elongated, commonly curved ribs, the longest of which considerably exceeds the total length of the presacral series. The scapula is short, curved, and strong; the coracoid is a rather platelike bone. The ilium is deep and articulates with the pubis and ischium by sutures within a closed acetabulum. The two lower bones of the pelvis are expanded distally, but are not in contact with each other, so that the pelvis is open below. The limb bones are long, slender, and straight, and the hind limb is much longer than the forelimb. The humerus is distinguished by a strong proximal process and by an ectepicondylar foramen; the femur is about twice the length of the humerus. The manus has five elongated digits and is of specialized structure, with very narrow, deep unguals.

[1] Icarus, ικαροσ. In Greek mythology, Icarus, and his father Daedalus, manufactured wings with which to fly from Crete to escape the wrath of Minos; and *saurus*, σαῦροσ, lizard.

Icarosaurus obviously is very close to the genus *Kuehneosaurus*, which was described by Robinson in 1962. These two genera probably should be placed in one family, which is to be erected and defined by Robinson in a monograph that is now in press.

Icarosaurus siefkeri,[1] new species

TYPE: A skeleton, complete except for a portion of the tail, some ribs, the left manus, and the lower segments of the hind limbs.

HORIZON AND LOCALITY: Lockatong Formation of the Newark Group, Upper Triassic. From a locality at which was formerly situated the old Belmont-Gurnee, or "Granton," Quarry, immediately west of Tonnele Avenue, and about opposite Hamilton Avenue, North Bergen, New Jersey. The horizon at which the specimen was found has disappeared, its former position now being about 6 or 7 meters above the present artificial ground surface, occupied by buildings and parking lots.

DIAGNOSIS: See the diagnosis for the genus, above.

DESCRIPTION

Probably *Icarosaurus* is of lacertilian relationships, because of the structure of the jugal bone, which shows, by its lack of a posterior process, that the lateral temporal region of the skull is open below (see diagnosis above). Several other characters in the skeleton also show lizard relationships, for example, the slender squamosal bones (and probably the postorbitals as well) and the presence of an ectepicondylar foramen but the absence of an entepicondylar foramen in the humerus. More particularly, *Icarosaurus* shows many close similarities to *Kuehneosaurus*, from the Triassic fissure fillings of Bristol, England, which, as is demonstrated by Robinson, is a lizard. Indeed, there are so many close resemblances between these two genera that we may regard them as belonging to a single family. These points, as well as other comparisons and other problems of relationships, are dealt with in greater detail below.

THE SKULL AND LOWER JAW

The cranial roof of *Icarosaurus* is characterized by the long frontals and broad parietals and by the seeming presence of a parietal foramen at the common junctions of these four bones. These features are typical of *Kuehneosaurus*. There is a well-developed postfrontal, diminishing to a

[1] Named in honor of Mr. Alfred Siefker, who with two companions, Michael Bandrowski and Joseph Geiler, discovered the specimen and deposited it in the American Museum of Natural History.

point distally and evidently articulating along its posterior edge with one ramus of a three-pronged postorbital. The complexly shaped squamosal, in addition to a forward process that would join the posterior process of the postorbital, the two thereby forming the postorbital-squamosal bar that is characteristic of diapsid reptiles, has a long process extending medially to embrace a posterolateral extension of the parietal. Thus these several bones are joined to form a broad supratemporal fenestra, very similar in shape to the same opening in *Kuehneosaurus.*

The quadrate is a long, strongly curved bone, the concavity of its curve facing to the rear, and with a transversely broad condyle occupying its distal end. Since the quadrate has been displaced by the downward crushing to which the skull was subjected, with the proximal end occupying its proper articular position but with the bone rotated forward and in an approximately horizontal position, it seems evident that there was no bony bar to brace the quadrate against movement. Further proof is afforded by the shape of the jugal, which is a curved, sickle-shaped bone, without any remnant of a posterior horizontal bar. A close comparison may be made in this respect with *Kuehneosaurus.* Moreover, if we accept the absence of a jugal bar as a diagnostic character for the Lacertilia, we see in *Icarosaurus,* as in *Kuehneosaurus,* a definite lacertilian feature, as pointed out above. The quadratojugal seems to be absent.

The front of the skull is characterized by its long maxilla, the border of which contains closely set, homodont, simple teeth. There would seem to be at least 23 of these maxillary teeth. Between the maxilla and the skull roof, here represented by the frontals, there is on each side a peculiarly elongated and sickle-shaped prefrontal, the concave edge of which forms much of the anterior border of the orbit. In front of the frontals and prefrontals are the paired nasals, each posteriorly broad and curving anteriorly to a point, this anterior portion bounding in part the nasal opening. Apparently the lacrimal is excluded from the orbital border by the prefrontal, as is the case in *Kuehneosaurus,* so that it occupies an area in front of the prefrontal, below the nasal and above the maxilla. It contains a well-developed lacrimal foramen.

The ventral aspect of the skull is only partially visible. It shows a moderately broad basioccipital with a well-rounded condyle, and with very large basal tubera. The basisphenoid tapers anteriorly, and apparently there was a rather long parasphenoid that extended forward. The vomer is partially seen (in dorsal view) as a large and well-developed bone.

FIG. 3. *Icarosaurus siefkeri,* new genus and new species, type specimen. ×¾.

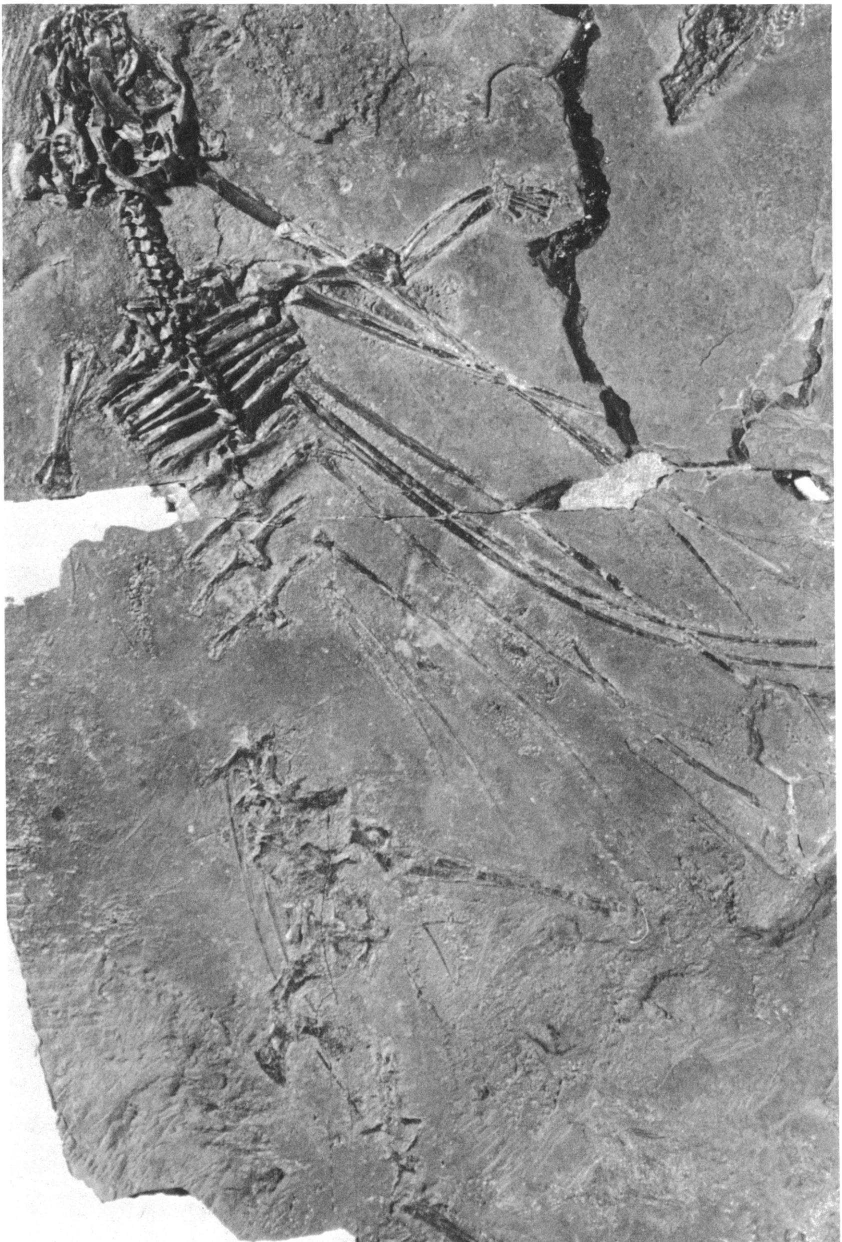

FIG. 4. *Icarosaurus siefkeri,* new genus and new species, type specimen; tips of some of the elongated ribs on the right side not shown. ×1.

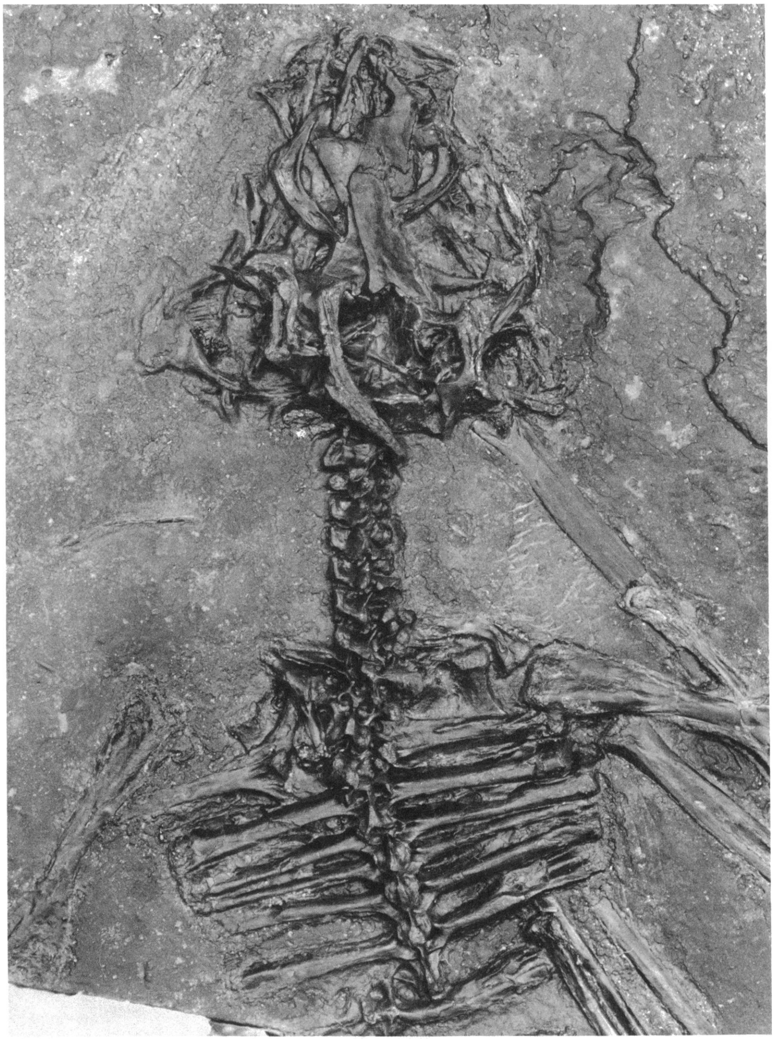

FIG. 5. *Icarosaurus siefkeri,* new genus and new species, skull and pectoral region of type specimen. ×2.

The lower jaw is long and very slender, and the margin of the dentary carries an extended array of closely set, simple teeth, corresponding in size and number to the teeth of the skull. A prominent suture, almost in the nature of a joint, separates the dentary from the postdentary bones, a lacertilian feature also seen in *Kuehneosaurus.* There is little else to say concerning the other bones of the mandible, except that so far

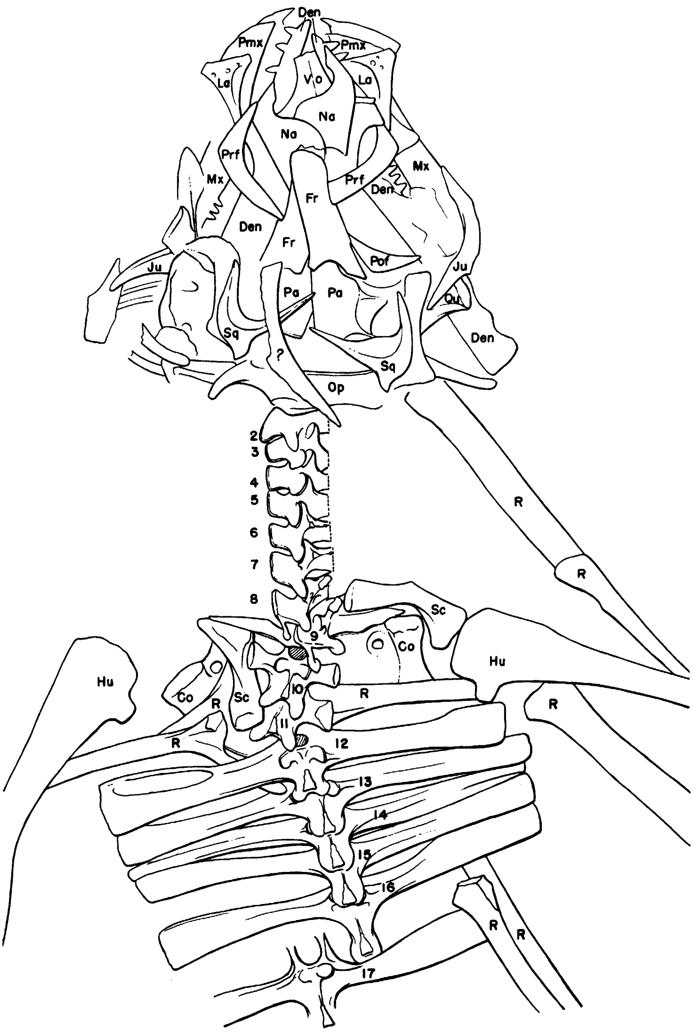

FIG. 6. Key to figure 5, showing the identification of certain bones.

Abbreviations: Skull: Den, dentary; Fr, frontal; Ju, jugal; La, lacrimal; Mx, maxilla; Na, nasal; Op, opisthotic; Pa, parietal; Pmx, premaxilla; Prf, prefrontal; Pof, postfrontal; Qu, quadrate; Sq, squamosal; Vo, vomer. Postcranial elements: 2–17, presacral vertebrae; Co, coracoid; Hu, humerus; R, ribs; Sc, scapula.

as they are visible they seem to add to the evidence already cited concerning the lacertilian nature of the lower jaw.

FIG. 7. *Icarosaurus siefkeri*, new genus and new species, right forelimb and adjacent bones. ×2.

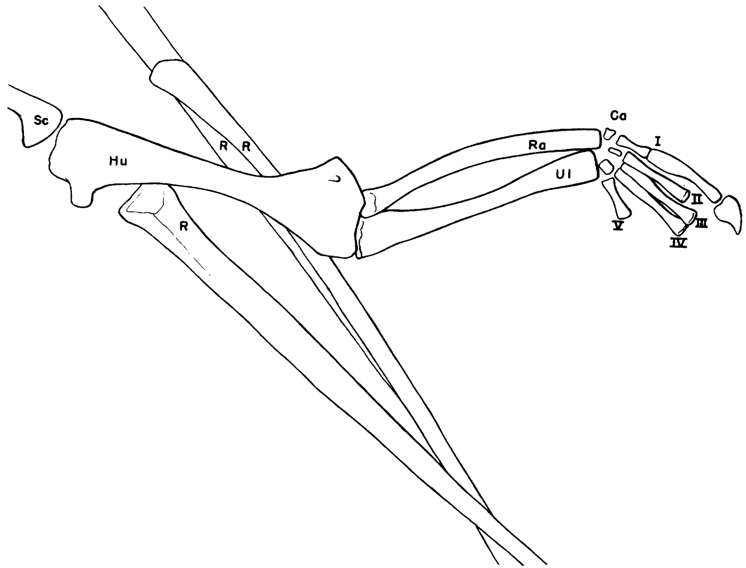

Fig. 8. Key to figure 7, showing the identification of certain bones. *Abbreviations:* I–V, metacarpals, showing also the phalanges of digit I; Ca, carpals; Hu, humerus; R, ribs; Ra, radius; Sc, scapula; Ul, ulna.

THE POSTCRANIAL SKELETON

There seemingly are 24 presacral vertebrae in the skeleton of *Icarosaurus,* the first 16 of which are in close articulation with those following displaced laterally toward the left. There is a marked gap between the twentieth vertebra and the one behind and to the left of it, and it might be supposed that this gap represents a missing vertebra, in which case the number would be 25. A close examination shows, however, that the gap is hardly great enough in its anteroposterior extent to accommodate a vertebra, so the number is here postulated as 24.

The vertebrae are amphicoelous and are strongly constricted in their middle portions. The first nine presacral vertebrae have short centra, but the centra become progressively longer as one proceeds from the anterior to the posterior end of the column.

The first nine presacral vertebrae, which may be considered as cervicals, have very high neural arches, but low spines elongated from front to back, which, with the exception of the atlas, are very straight on top. The expanded flat zygapophyses articulate along planes that are but slightly inclined from the horizontal, and the anterior ones are carried on strong pedicles arising from the sides of the neural arch. Such a construction must have provided *Icarosaurus* with a very strong neck, which would have been advantageous because of the relatively large size of the skull and the presumed weight of the jaw muscles. In the last five of these cervicals are widely separated facets for cervical ribs.

The tenth and eleventh presacrals are set sharply apart from the cervicals by their peculiar short, heavy straight ribs, which strongly resemble in size and shape the extended and inflated transverse processes of the next half-dozen or so vertebrae—the anterior members of the "thoracic" series. In all these vertebrae the neural arches, though high, are not so high as in the cervicals, and the spines are still low and anteroposteriorly elongated. The zygapophyseal articulations are distinctive in being strongly curved, so that the two zygapophyses form portions of a semicircular arc. It is thus evident that there was rotational movement of the vertebrae on one another, but no lateral twisting of this front portion of the thoracic region. This fact, together with the fact that the wide, expanded transverse processes of the anterior "thoracic" vertebrae are closely appressed, shows that the vertebral column in this region was strongly articulated for the support of the long ribs. In the posterior presacral vertebrae the transverse processes are elongated, but less so than in the anterior vertebrae, and they are slender and not in contact with one another, thus allowing for lateral twisting of the back in this region.

There are 10 elongated, single-headed ribs on each side, attaching to the tips of the transverse processes. The more anterior of these ribs are remarkably long. The first rib is straight; the following five ribs are probably even longer than the first rib, and are rather strongly curved, with the concavity of the curve facing downward. The remaining four ribs decrease in length and become straighter from front to rear. It seems obvious that the ribs supported a membrane, which together with the ribs formed a wing with a straight leading edge and with its upper surface convex, its lower surface concave.

This adaptation in *Icarosaurus* is very similar to what has been described for *Kuehneosaurus,* particularly *Kuehneosaurus latissimus,* and of course is paralleled on a more modest scale by the ribs and membrane of the modern lizard *Draco.*

The sacrum of *Icarosaurus* is composed of two vertebrae, the centra of which are comparable in length to those of the posterior presacrals. The transverse processes are widely expanded, to make firm and elongated connections with the ilia on each side. There are four proximal caudals preserved, each with a low, elongated neural spine and with long transverse processes. The centra increase somewhat in length from the more anterior to the more posterior of the four, and it seems evident that the tail in *Icarosaurus* was very long.

The pectoral girdle of *Icarosaurus* is partially obscured by the bones on top of it. The scapula is clearly shown as a short, stout bone, with a rather sharp bend at about the midpoint, along its anterior surface, matched by a strong curve on the posterior surface of the bone. The upper portion of the scapula is rather broad and bladelike; its lower portion is rounded in cross section. The coracoid seemingly is a flat bone with an expanded glenoid region and a large coracoid foramen. It appears to be more or less rectangular in outline, with a broadly concave lateral edge and a roughly convex medial edge opposed to the same bone of the opposite side. Clavicles and an interclavicle have not been seen, but they were probably present.

Both sides of the pelvis are present in the skeleton of *Icarosaurus,* and both have the medial surface exposed. The three bones of the pelvis meet in the acetabular region, with long sutures joining the two lower bones to the ilium but with the suture between the pubis and ischium very short, owing to the wide separation of these two lower bones throughout most of their respective lengths. The solid acetabulum is in harmony with an ilium of modified primitive type, this bone having a rather short vertebral edge and no preacetabular expansion. The ilium is rather deep. The large notch between the ischium and pubis can be regarded as an enlargement of the thyroid fenestra, expanded to such a degree as to

FIG. 9. *Icarosaurus siefkeri,* new genus and new species, posterior portion of skeleton. ×2.

engulf the obturator foramen. The blade of the pubis is broad; that of the ischium is very widely expanded.

The limbs of *Icarosaurus* are long and slender, the hind limb evidently being considerably longer than the forelimb, as indicated by the fact that the femur is about twice the length of the humerus. Even though

FIG. 10. Key to figure 9, showing the identification of certain bones.
Abbreviations: 21–24, presacral vertebrae; Caud, caudal vertebrae; Fe, femur; Il, ilium; Isch, ischium; Pu, pubis; R, ribs; Sa 1, Sa 2, sacral vertebrae.

so much shorter than the femur, the humerus is in itself a slender bone, proximally and distally expanded. The bone is interesting because of a prominent knob on the posterolateral surface, indicative of strong muscular attachments. Distally there is a well-developed ectepicondylar foramen, but no entepicondylar foramen, which are lacertilian characters.

The radius and ulna are shorter than the humerus, the radius being somewhat curved, the ulna straight.

The partially preserved right manus of *Icarosaurus* is interesting because of its high degree of specialization. Below the three carpal bones preserved in this specimen, there are five metacarpals. The first of these is very short, the second is long (almost three times the length of the first), the third and fourth make a pair a bit longer than the second, and the fifth is short and stout. Articulating with the first metacarpal are a very long proximal phalanx and a short, deep, laterally compressed claw. So far as the evidence goes, here is a manus that is remarkably similar to the manus of *Draco.* Therefore one may suppose that the phalanges of the other digits, not preserved in this specimen, may have been similar in general proportions and arrangement to the same bones in the manus of *Draco.* If the above observations and speculations are correct one sees here resemblances between *Icarosaurus* and *Draco,* which might be attributed to descent of the modern form from the ancient genus, but which, as would seem more probable, are the result of closely similar and parallel adaptations to a very specialized mode of life. This conclusion may be justified on the basis of the fact that in other respects the characters and adaptations of *Draco* are sufficiently different from those of *Icarosaurus* to indicate evolutionary parallelism, rather than descent.

Of the hind limbs of *Icarosaurus,* one femur is preserved, one tibia is partially so, and the feet are missing. The femur is a very long, straight bone, with the head set at a small angle to the shaft. The tibia, which is also a straight bone, seems to be about two-thirds of the length of the femur.

CONCLUSIONS

In the foregoing paragraphs a description, largely empirical, of *Icarosaurus* is presented. It is shown that this reptile, from the Upper Triassic of New Jersey, is technically a lacertilian, closely related to *Kuehneosaurus,* described by Robinson from the Triassic fissure fillings of the Bristol Channel area, England. *Kuehneosaurus* and *Icarosaurus* are the two known genera belonging to a family that seems to represent a group of very early yet nonetheless highly specialized lizards.

Icarosaurus is particularly noteworthy because of the great elongation of 10 ribs on each side, evidently to support a gliding membrane. This specialization, so very much like what is seen in the modern agamid *Draco,* is evidently independent of and in many respects more highly developed than the specialization of the recent lizard.

The problems of taxonomic and evolutionary relationships and of adaptations for gliding in *Icarosaurus* are so many, so important, and so interesting, that they require full and careful consideration, which will be accorded in a larger and more extensive paper.

ICAROSAURUS AND *RHABDOPELIX*

Some consideration is given here to the relationship of *Icarosaurus* to *Rhabdopelix,* since it has been suggested that the new fossil is none other than *Rhabdopelix longispinis* Cope, 1869.

An account of the October 23, 1866, meeting of the Academy of Natural Sciences of Philadelphia, published in the *Proceedings* of that Academy, mentioned a communication by Cope noting the discovery of reptile bones found in the "Mesozoic Sandstone" of Pennsylvania. Some of these fossils were stated to be "bones of a Pterodactyle . . . for which he [Cope] proposed the name *P. longispinis*" (p. 290). The name, as of that date, is a *nomen nudum.*

Subsequently Cope (1869–1870) described the materials in detail and established the name *Rhabdopelix longispinis.*[1]

Except for occasional references by Cope and a few other authors, nothing of consequence was published on *Rhabdopelix* until 1921, when von Huene described two bones that he tentatively referred to the Pterosauria. In his discussion he stated: "The probable pterosaurian remains described by Cope as *Rhabdopelix longispinis* from the Triassic of Gwynned, Montgomery Co., Pa., have not been found in the Cope collection. . . ." (von Huene, 1921, p. 572).

Since 1921 *Rhabdopelix* all but dropped out of the consciousness of paleontologists interested in fossil reptiles. The name does not appear in the comprehensive classifications of reptiles published in recent years by Romer (1956), Piveteau (1955), von Huene (1956), and Rhozdestvensky and Tatarinov (1964). This is not to be wondered at, since it is an obscure form of uncertain relationships, the type and the only known materials of which have long since been lost.[2]

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[1] There may be some confusion as to the date of Cope's description of the type of *Rhabdopelix longispinis.* It is cited as 1869 in Hay (1902). It should be noted, however, that Cope's monograph came out in three parts, each with its own title page. On the title page of part I the date is August, 1869; of part II, April, 1870; of part III, December, 1870. The description of *Rhabdopelix* is in part II.

[2] It seems evident from von Huene's remarks that a futile search was made many years ago in the Cope collection of the American Museum of Natural History for the type of *Rhabdopelix longispinis.* We have within the past year repeated this search, with no success. In January, 1965, the writer, in company with Donald Baird of Princeton University, spent a day making a thorough search through the collections of the Academy of Natural Sciences of Philadelphia, to supplement a previous similar search made by Dr. Horace Richards of that institution, all with no success. It can be safely assumed, therefore, that the type of *Rhabdopelix longispinis* is irrevocably lost.

In all fairness it should be added that the name *Rhabdopelix,* although omitted from the comprehensive classifications mentioned above, has received some attention in recent years. The genus was mentioned by Gregory (1957), Cramer (1960), and Colbert and Gregory (1957). All these are passing references and in none was any attempt made to investigate or analyze the status of the genus and its single species.

The problem now before us is, Can the specimen here described be equated with or excluded from *Rhabdopelix longispinis* on the basis of Cope's description and figure of 1870? One might think so, since Cope's description runs to five quarto pages, with many measurements included, while the figure, illustrating some 50 bone fragments, occupies a full half page. But comparisons are not easy.

Much time has been spent checking the figure (Cope, 1869–1870, fig. 46, p. 175), with virtually no positive results. Nothing in the figure, which is a wood cut, can be matched unequivocally with anything pertaining to the skeleton here under consideration. Nevertheless there are one or two possibilities. In Cope's figure some partial segments of long, thin ribs are shown. But whether these ribs, if entire, were like the ribs of the specimen described in the present contribution is a matter of pure conjecture. Of particular significance are the bones labeled in this figure by Cope as "20," and identified by him as two parallel "pubes." These bones might be identifiable as the rather heavy, short, prepatagial ribs characteristic of the Granton Quarry reptile, articulating with the tenth and eleventh presacral vertebrae. But the identity cannot be definitely established without having the type at hand, so one must regard the comparison as indicating an unprovable possibility. Otherwise, resemblances between the bones figured by Cope and the Granton Quarry reptile are anything but apparent, and in some instances there appear to be definite differences. Perhaps more than one type of animal was represented on the slab.

As for his description, Cope noted the following characters of *Rhabdopelix longispinis:*

1. The specimen occurred in a "hard indurated siliceous clay of a dark gray color" found at Gwynned, Pennsylvania.
2. The radius and ulna (or tibia and fibula) were confluent.
3. The distally free pubic element was subspatulate in shape.
4. The long bones were pneumatic.
5. There was a "lack of condyles of most of the latter" (long bones).
6. The ribs were curved and elongated.
7. The vertebral centra were "much depressed."
8. The centra projected considerably beyond the neural arch.
9. The neural spines were elongated.

10. The vertebrae were procoelous.
11. The diapophyses were long.

Of the characters in the foregoing list, the first certainly applies equally to *Rhabdopelix* and *Icarosaurus.* Both specimens were found in dark-colored shales; indeed, the matrix enclosing the skeleton of *Icarosaurus* is black rather than gray. Some of the other fossil bones from the Granton Quarry are in gray shales. It should be noted here that the Lockatong beds at the Granton Quarry are composed of cyclic deposits, each darker at the bottom than at the top, as is the case at Phoenixville. One may suppose that the sediments at the two localities represent marginal deposits on the opposite sides of a Lockatong lake and thus are essentially equivalent in environment, in flora and fauna, and in age.

The characters numbered 4, 5, 6, and perhaps 7 listed as typical of *Rhabdopelix* also apply equally well to *Icarosaurus.* But pneumatic or hollow bones without processes, and long, curved ribs (though not extremely long, as in *Icarosaurus*) are to be seen in other fossils from the Granton Quarry. As for the character listed as number 7, Cope's statement is difficult to interpret. He wrote that the vertebrae of *Rhabdopelix* were "much depressed." Perhaps this statement means that they are low in comparison to their length; if so, such can be said for many vertebrae from the Granton and Gwynned localities.

It might be supposed that there is a resemblance between the two specimens here being compared with respect to the third item of the above list. Cope mentioned a free pubic element of subspatulate shape, a description which fits the fossil from the Granton Quarry. However, as pointed out above, the bones that Cope identified as "pubes" are possibly short, expanded prepatagial ribs. If so, the comparison implied does not exist, but another comparison does, involving bones of which Cope was not aware. Indeed, the possible resemblance of the "pubes" of *Rhabdopelix* to the prepatagial ribs of *Icarosaurus* is the best and perhaps the only reasonably good evidence for an identity between the two specimens on which the above names have been based.

The characters typical of *Rhabdopelix* numbered 2, 8, 9, 10, and 11 do not apply to *Icarosaurus.* Thus, in the reptile from the Granton Quarry there is no confluence of the bones in the lower arm or leg (2), the centra do not project beyond the neural arches to any noticeable extent (8), the neural spines are not elongated except to some degree in the posterior presacral and caudal regions as an effect of the lengthening of the vertebrae (9), the vertebrae are not procoelous but amphicoelous (10), and, although the diapophyses or transverse processes are long, the spines are not elevated (11). In this connection it can be pointed out that a slab of rock from the Granton Quarry, containing many bones as yet undescribed and obviously different from *Icarosaurus,* show procoelous vertebrae with very long transverse processes.

In this connection, it is interesting to compare measurements, although size is admittedly not necessarily crucial in the definition of reptilian genera and species. Nevertheless, the measurements of *Rhabdopelix* as given by Cope seem to indicate that the type specimen was larger than the Granton fossil. For example, Cope cited a portion of bone containing teeth, as showing four teeth within a distance of 2.5 lines. If a line is assumed to be a tenth of an inch, this would give four teeth to 6.35 mm. If a line is a twelfth of an inch, the four teeth would occupy a distance of 5.3 mm. In *Icarosaurus* four teeth occupy a distance of 1.7 mm., and 6.35 mm. contains 12 teeth. Thus the supposed teeth of *Rhabdopelix* indicate an animal about three times as large in the linear dimensions of the skull as *Icarosaurus.* Cope showed the femur of *Rhabdopelix* as having a minimum diameter of 1.35 lines, which on the basis of 10 lines to an inch would be 3.8 mm. The minimum diameter of the femur in *Icarosaurus* is 1.8 mm.—a ratio of about one to two.

One other point may be mentioned, the implication of the name. The generic name, *Rhabdopelix* ("rod-basin" or "rod-pelvis"), was based on Cope's misidentification of bones that he thought were pubes. The trivial name, *longispinis,* is of course an allusion to long spines or ribs, and one may assume that this character of the fossil was so striking as to impress Cope.

On the basis of these considerations one comes to the conclusion that, although Cope may have been looking at a fossil generically if not specifically the same as the specimen from the Granton Quarry, it is equally possible that such was not the case. Apparently Cope was describing a reptile considerably larger than the Granton fossil, and the type of *Rhabdopelix longispinis* was preserved in a block of matrix containing other fossil reptiles as well. Moreover it appears that the slab in which this type and associated materials were preserved is lost and probably never will be found. Such being the case, it is proposed that, rather than to strain many points in order to establish a supposed identity between the fossils from Phoenixville and Granton, a far better course is to regard Cope's type as a *nomen vanum* or, in terms of the International Code as revised in 1961, as a *nomen dubium.*

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