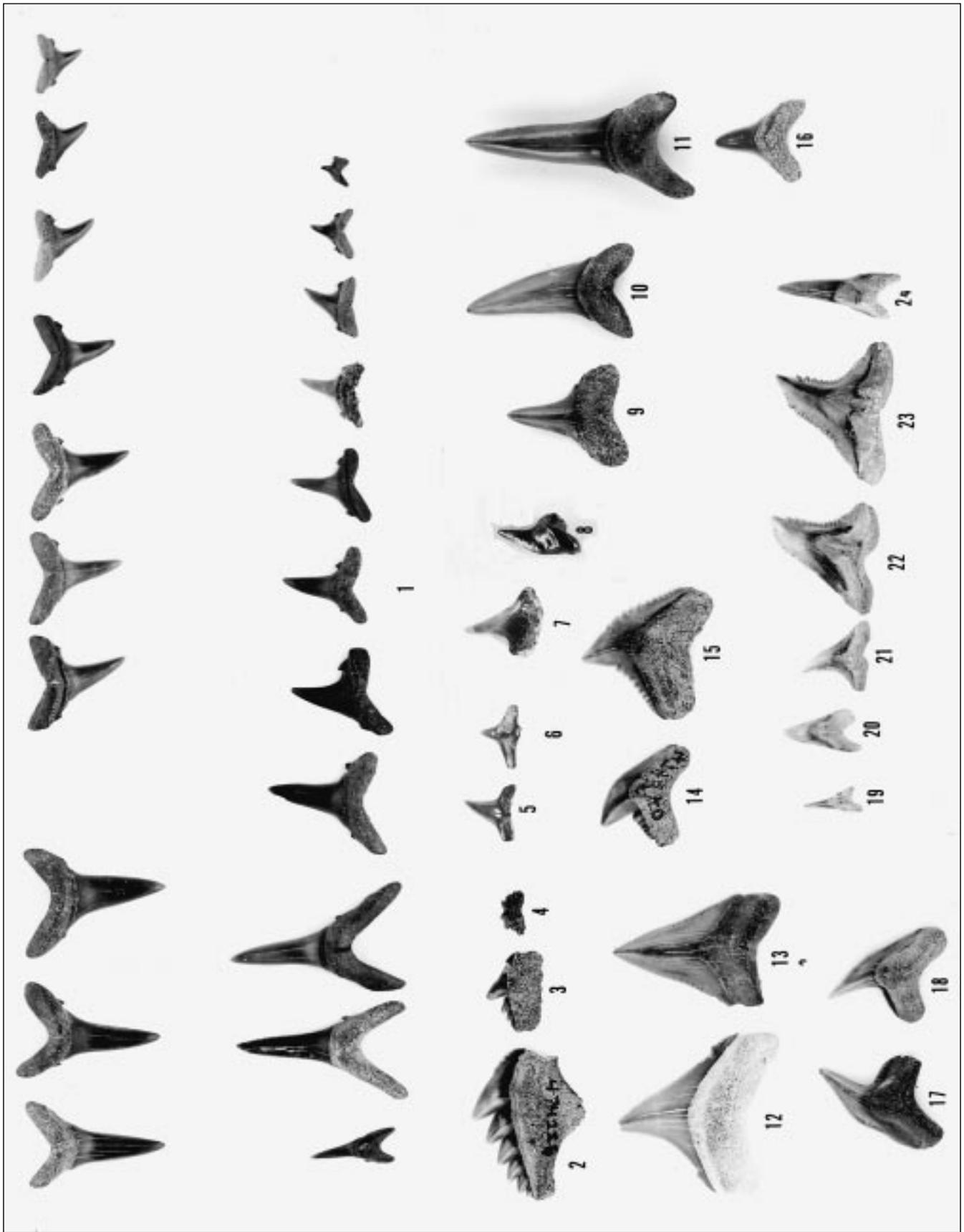


## **PLATES**

## PLATE 1

All figures are 1X unless otherwise noted.

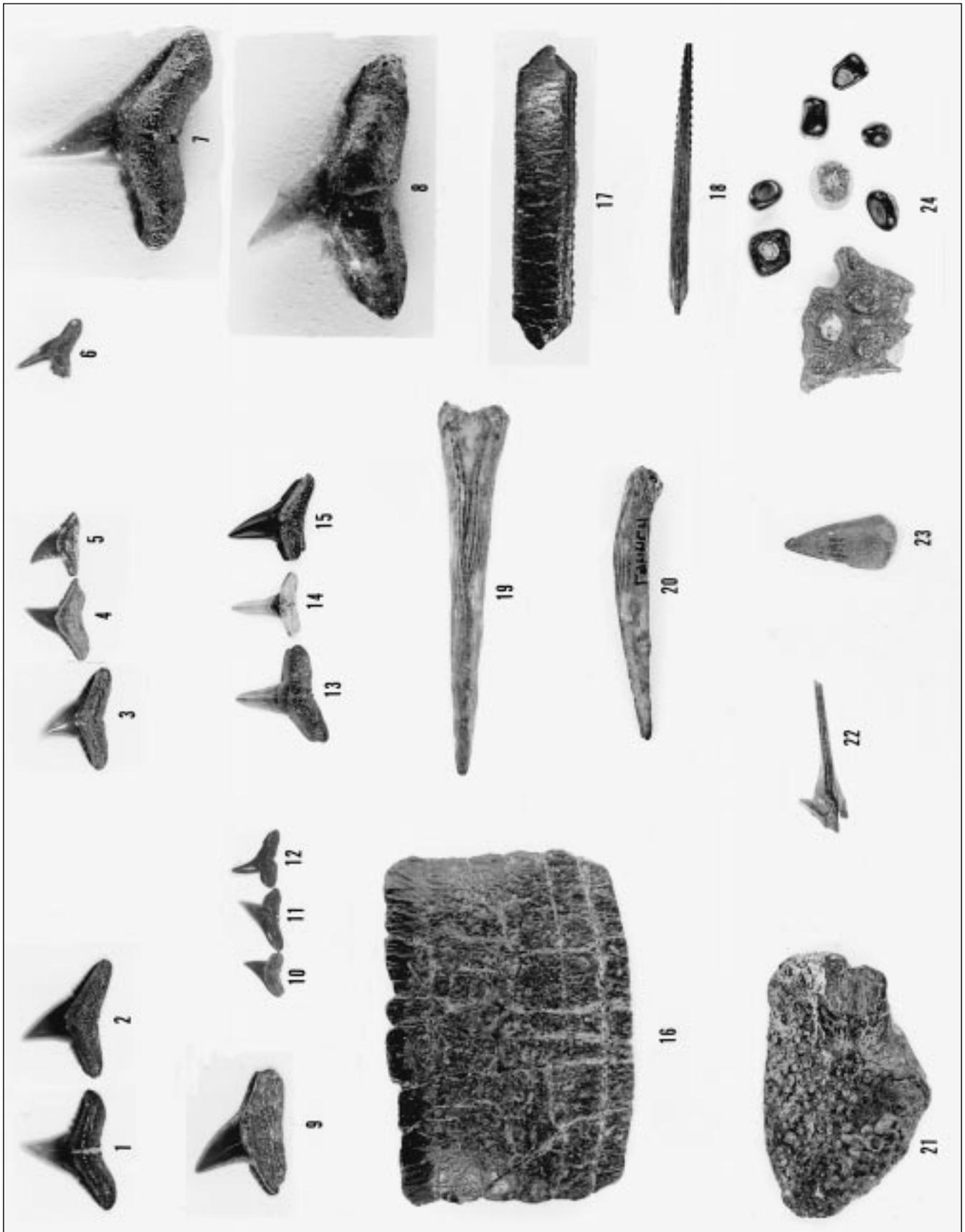
1. *Carcharias cuspidata* (Agassiz), composite dentition, lingual view, USNM 474258, collectors: Bohaska et al.
2. *Notorynchus* sp., lower anterolateral tooth, lingual view, USNM 474226, collector & donor: T.R. O'Hagan.
3. *Notorynchus* sp., upper anterolateral tooth, lingual view, USNM 474227, collectors: Bohaska & Purdy.
4. *Notorynchus* sp., median tooth, lingual view, USNM 474225, collectors: Bohaska et al.
5. *Squatina* sp., tooth, labial view, USNM 474486, collector: R. Eshelman.
6. *Squatina* sp., tooth, labial view, USNM 474487, collector: R. Eshelman.
7. Orectolobid, tooth, labial view, USNM 474539, collector: R. Eshelman.
8. *Rhincodon* sp., tooth, lateral view, USNM 474505, collector: Bohaska et al.
9. *Isurus hastalis* (Agassiz), lower lateral tooth, lingual view, USNM 474247, collector and donor: G. Simonson.
10. *Isurus hastalis* (Agassiz), upper, second anterior tooth, lingual view, USNM 474239, collectors: Bohaska & Simonson.
11. *Isurus oxyrinchus* (Rafinesque), lower, second anterior tooth, lingual view, USNM 474504, collectors: Bohaska & Purdy.
12. *Carcharodon subauriculatus* (Agassiz), lower lateral tooth, lingual view, USNM 474246, collector: R. Eshelman.
13. *Carcharodon subauriculatus* (Agassiz), upper, second anterior tooth, lingual view, USNM 474344, collector: R. Eshelman.
14. *Galeocerdo aduncus* Agassiz, anterolateral tooth, lingual view, USNM 474540, photo is reversed, collector and donor: G. Simonson.
15. *Galeocerdo aduncus* Agassiz, upper anterolateral tooth, lingual view, USNM 474277, photo is reversed, collector: R. Eshelman.
16. *Alopias* sp., lower tooth, lingual view, USNM 474236, collector and donor: K.A. Glunt.
17. *Galeocerdo contortus* Gibbes, upper anterolateral tooth, lingual view, USNM 474354, photo is reversed, collector and donor: G. Simonson.
18. *Galeocerdo contortus* Gibbes, lower anterolateral tooth, lingual view, USNM 474361, photo is reversed, collector and donor: G. Simonson.
19. *Hemipristis serra* Agassiz, lower symphyseal tooth, lingual view, USNM 474263, photo is reversed, collector: R. Eshelman.
20. *Hemipristis serra* Agassiz, lower lateral tooth, lingual view, USNM 474292, photo is reversed, collector: R. Eshelman.
21. *Hemipristis serra* Agassiz, upper lateral tooth, lingual view, USNM 474570, photo is reversed, collectors: Bohaska and Purdy.
22. *Hemipristis serra* Agassiz, upper lateral tooth, lingual view, USNM 474262, photo is reversed, collector: R. Eshelman.
23. *Hemipristis serra* Agassiz, upper lateral tooth, lingual view, USNM 474286, photo is reversed, collector: R. Eshelman.
24. *Hemipristis serra* Agassiz, lower anterior tooth, lingual view, USNM 474518, photo is reversed, collectors: Bohaska and Purdy.



## PLATE 2

All figures are 1X unless otherwise noted.

1. *Carcharhinus perezii* (Poey), upper anterolateral tooth, lingual view, 2X, USNM 494363, collector: G. Simonson.
2. *Carcharhinus perezii* (Poey), upper anterolateral tooth, lingual view, 2X, USNM 494364, collector: G. Simonson.
3. *Carcharhinus brachyurus* (Günther), upper anterolateral tooth, lingual view, 1.5X, USNM 494365, collector: G. Simonson.
4. *Carcharhinus brachyurus* (Günther), upper anterolateral tooth, lingual view, USNM 494366, collectors: Bohaska & Purdy.
5. *Carcharhinus brachyurus* (Günther), upper lateral tooth, lingual view, USNM 494367, collectors: Bohaska & Purdy.
6. *Paragaleus* sp., lower tooth, lingual view, USNM 474356, collectors: Bohaska and Purdy.
7. *Paragaleus* sp., lower tooth, lingual view, 3X, USNM 474338, collector and donor, G. Simonson.
8. *Paragaleus* sp., lower tooth, lingual view, 3X, USNM 474231, collectors: Bohaska et al.
9. *Sphyrna* sp., upper tooth, lingual view, 2X, USNM 474357, collectors: Bohaska and Purdy.
10. *Rhizoprionodon* sp., upper tooth, female, lingual view, USNM 474329, collectors, Bohaska and Purdy.
11. *Rhizoprionodon* sp., upper tooth, female, lingual view, USNM 474333, collectors: Bohaska and Purdy.
12. *Rhizoprionodon* sp., lower tooth, lingual view, USNM 474333 collectors: Bohaska and Purdy.
13. *Negaprion* sp., upper tooth, lingual view, USNM 474399, collectors: Bohaska and Purdy.
14. *Negaprion* sp., lower tooth, lingual view, USNM 474420, collector: G. Simonson.
15. *Negaprion* sp., upper anterolateral tooth, lingual view, USNM 494362, collector: D. J. Bohaska.
16. *Aetobatis* sp., upper dental battery, occlusal view, in the collection of Michael Miskofsky.
17. *Rhinoptera* sp., isolated tooth, occlusal view, USNM 494361, collector: G. Simonson.
18. Sting ray tail spine, USNM 494360, collector: D. J. Bohaska.
19. *Ictalurus* sp., dorsal spine, anterior view, 1.5X, USNM 474467, collector and donor: G. Simonson.
20. Same specimen, lateral view, 1X.
21. *Acipenser* sp., dermal scute, external view, USNM 474457, collector: R. Eshelman.
22. *Ictalurus* sp., pectoral spine, ventral view, USNM 474481, collector and donor: D. B. Duke.
23. *Sphyrna* sp., tooth, lateral view, USNM 474448, collector and donor: G. Simonson.
24. *Pogonias* sp., fragment of pharyngeal with isolated teeth, USNM 474470, collector: R. Eshelman.



# REPTILES OF THE LOWER MIOCENE (HEMINGFORDIAN) POLLACK FARM FOSSIL SITE, DELAWARE<sup>1</sup>

J. Alan Holman<sup>2</sup>

## ABSTRACT

The Pollack Farm Fossil Site near Cheswold, Kent County, Delaware has yielded a unique early Miocene (Hemingfordian) reptile fauna that, among other species, has yielded the first North American remains of small Miocene lizards and snakes east of the Great Plains and north of Florida. This fauna includes a thick-shelled kinosternid turtle (*Kinosternon* sp.), an emydid turtle (“*Chrysemys* group”), a very large land tortoise (*Geochelone* sp.), a very large crocodylian (cf. *Crocodylus* sp.), a glass lizard (*Ophisaurus* sp. indet.), a new species of the unique extinct boid genus *Pterygoboa* (*Pterygoboa delawarensis*), the extinct boid genus *Calamagras* (*Calamagras* sp. indet.), the extinct colubrid snake genus *Ameiseophis* (*Ameiseophis robinsoni*), a distinct new genus of colubrid snake (*Pollackophis depressus*), and an indeterminate (probably extinct) viperid snake (cf. *Crotalinae* gen. et sp. indet.).

*Pterygoboa* and *Ameiseophis* have never been recorded from eastern North America, both of these snakes being characteristic of Miocene assemblages in the northern High Plains (e.g., Nebraska, Wyoming, and South Dakota). The crocodylians and aquatic turtles indicate a large, sluggish, permanent body of water. The remainder of the reptile species probably preferred open brushy or grassy habitats with loose or sandy soil.

## INTRODUCTION

Records of small Miocene lizards and snakes are non-existent in a vast area of North America east of the Great Plains and north of Florida. Thus, the recovery of small fossil squamates from the lower Miocene Pollack Farm Site near Cheswold, Kent County, Delaware, is of considerable paleoherpetological importance. Moreover, records of aquatic turtles, a giant land tortoise, and a very large crocodylian from this site are of additional interest.

The fauna came from a borrow pit used for new highway construction that was located near Cheswold, Kent County, Delaware. During excavation the pit was referred to as the Pollack Farm Site. The Delaware Geological Survey (DGS) identifier for the site is Id11-a (39°14'08"N, 75°34'36"W). The fossils described here were recovered from the lower shell bed at the site (see Benson, 1998, fig. 2). The excavation exposed some of the Cheswold sands (DGS informal designation) of the Calvert Formation that are of early Miocene (Hemingfordian) age. The geological features of the site as well as the other faunal remains are detailed in other reports in this DGS Special Publication No. 21.

## Acknowledgments

I wish to thank Robert Purdy and Robert Emry of the National Museum of Natural History for allowing me to examine the Miocene reptiles from Delaware. Teresa Petersen made the figures. The manuscript was reviewed by Zbigniew Szyndlar and Dennis Parmley.

## CHECKLIST OF THE HERPETOFAUNA FROM THE POLLACK FARM SITE

*Kinosternon* sp. indet. Mud turtle.  
“*Chrysemys* group” turtle. Painted turtle, cooter, slider group.  
*Geochelone* sp. indet. Very large land tortoise.  
cf. *Crocodylus* sp. indet. Very large crocodile.  
*Ophisaurus* sp. indet. Legless lizard.  
*Pterygoboa delawarensis*. New species of distinctive small boid genus.

*Calamagras* sp. indet. Small boid.

*Ameiseophis robinsoni*. Extinct genus and species of small colubrid snake.

*Pollackophis depressus*. Distinctive new genus and species of small colubrid snake.

cf. *Crotalinae* gen. et sp. indet. Viperid snake.

## ANNOTATED LIST

Numbers are of the National Museum of Natural History (USNM) and measurements are in millimeters (mm). MSUVP refers to the Michigan State University Vertebrate Paleontology collection. The classification used here follows King and Burke (1989) for turtles and crocodylians, Estes (1983) for lizards, and Rage (1984) for snakes.

**Class REPTILIA Laurenti, 1768**  
**Order TESTUDINES Batsch, 1788**  
**Family KINOSTERNIDAE Baur, 1893**  
**Genus *Kinosternon* Spix, 1824**  
***Kinosternon* sp. indet.**

Material.—Two fragmentary costals, three peripherals, one left and two right hyoplastra, two left and one right hypoplastra; USNM 483389, collected March through August 1992. In addition, a pygal is from the private collection of John Ricard.

Remarks.—The genus *Kinosternon*, which presently ranges from Long Island to Argentina (Conant and Collins, 1991), may be osteologically distinguished from the similar kinosternid genus *Sternotherus* on the basis that *Kinosternon* has two transverse plastral hinges that allow upward movement of both the anterior and posterior plastral lobes. Well-developed hinge line grooves are present on two of the three Miocene hyoplastra (the third is so worn that this character cannot be identified) as in skeletons of modern *Kinosternon*. The three fossil hypoplastra are either too worn or incomplete to show this character.

Some *Kinosternon* species such as the North American *Kinosternon bauri* and the Mexican *Kinosternon herrerae*

<sup>1</sup> In Benson, R.N., ed., 1998, Geology and paleontology of the lower Miocene Pollack Farm Fossil Site, Delaware: Delaware Geological Survey Special Publication No. 21, p. 141–147.

cannot close the shell completely, but others such as the Mexican and Central American *Kinosternon leucostomum* and *Kinosternon scorpioides* have the ability to close up the shell completely in the manner of North American box turtles (*Terrapene*), although with two hinges rather than one.

In my examination of modern skeletons of *Kinosternon* (*Kinosternon acutum*, *K. bauri*, *K. flavescens*, *K. herrerae*, *K. hirtipes*, *K. integrum*, *K. leucostomum*, *K. scorpioides*, *K. sonoriense*, and *K. subrubrum*) I discovered that the species that were able to close the shell tightly (e.g., *K. leucostomum* and *K. scorpioides*) have much thicker shell bones than those species with limited shell-closing ability (e.g., *K. bauri* and *K. herrerae*). It would seem that having a thick as well as a tightly closable shell would offer greater protection against predators.

It is then of considerable interest that the Pollack Farm Site Miocene *Kinosternon* fossils have very thick shell bones as in *K. leucostomum* and *K. scorpioides*, thus differing from the *Kinosternon* that presently occur on the east coast of North America (*Kinosternon bauri* and *K. subrubrum*) that are thin-shelled forms that cannot close the shell completely.

The scute impressions on the hyo- and hypoplastral bones of the Pollack Farm fossils differ from those of modern *Kinosternon* that I have studied; thus, I strongly suspect that the Miocene fossils represent an undescribed species. More complete material from the Pollack Farm Site might confirm this suggestion.

**Family EMYDIDAE Lydekker, 1889**

**In Nicholson and Lydekker**

**“*Chrysemys* group”**

Material.—One fragmentary nuchal, two fragmentary costals, and one posterior peripheral; USNM 483390, collected in April and August 1992.

Remarks.—These bones closely resemble the “*Chrysemys* group” of emydid turtles which includes *Chrysemys*, *Pseudemys*, and *Trachemys*. This is a New World group that presently ranges from southern Canada to Brazil (Ernst and Barbour, 1989). The nuchal is from a small, probably immature specimen. The posterior peripheral is from a large turtle of the size of modern *Pseudemys* or *Trachemys* species. All of the species in the three modern genera prefer permanent, rather quiet bodies of water and some forms of *Pseudemys* inhabit brackish coastal rivers in Florida.

**Family TESTUDINIDAE Gray, 1825**

**Genus *Geochelone* Fitzinger, 1835**

***Geochelone* sp. indet.**

Material.—Entoplastron, posterior portion of left hypoplastron, three plastral fragments, two costal fragments, and one peripheral fragment; USNM 483391 collected from March to August 1992. In addition, a peripheral fragment is from the private collection of Tom Voss and a costal fragment is from the private collection of G. Simonson.

Remarks.—These are the remains of a very large tortoise. The left hypoplastron especially resembles that of the presently pantropical genus *Geochelone* in having a very thick posterior portion with a thick, triangular xiphiplastral articular surface. The scute impressions on the posterior part of the hypoplastron closely resemble those of *Geochelone wilsoni* (Auffenberg, 1964, fig. 1), a close relative of *Geochelone*

*ducatelli* (Collins and Lynn 1936) of the Barstovian Calvert Formation of Maryland, Zone A (Auffenberg, 1974), and it seems that the Pollack Farm Site tortoise material might belong to that species. The other large land tortoise elements from the Pollack Farm locality are indistinguishable from those of fossil *Geochelone* in the MSUVP collections but do not appear to be specifically diagnostic.

**Order CROCODYLIA (Gmelin, 1789)**

**Family CROCODYLIDAE (Cuvier, 1807)**

**cf. *Crocodylus* sp. indet.**

Material.—A very large mandibular tooth from the private collection of Robert D. Bowes.

Remarks.—The name *Thecachampsa* has sometimes been applied to crocodylian material from the Miocene of the eastern United States (*Thecachampsa contusa* Cope 1867 and *Thecachampsa sericodon* Cope 1867), but *Thecachampsa* is currently considered a synonym of *Crocodylus* Laurenti 1768 (Steel, 1973). The tooth from the Pollack Farm Site represents a very large specimen of Crocodylia. The tip of the tooth is striated as in many *Crocodylus* species rather than smooth as in *Alligator*. I am therefore tentatively referring the above Miocene tooth to the pantropical genus *Crocodylus*. The presence of very large crocodiles in Delaware in the Miocene is of great paleontological importance.

**Order SAURIA McCartney, 1802**

**Family ANGUIDAE Gray, 1825**

***Ophisaurus* Daudin, 1803**

The genus *Ophisaurus* occurs today in eastern United States south to Veracruz, Mexico, Morocco, southeastern Europe into Afghanistan, southeastern Asia, Borneo and Sumatra, and fossil *Ophisaurus* species are known from the Miocene to the Pleistocene of Europe and North America (Estes, 1983). The trunk vertebrae of *Ophisaurus* are easily identified based on the structure of the centrum, which has its ventral surface very smooth with no trace of a keel, and with two distinct anterior foramina, one usually larger than the other. The condyle on the centrum is very flattened. Dentary teeth of *Ophisaurus* are simple and unicuspid; some of them are slightly recurved and their tips are weakly striated.

***Ophisaurus* sp. indet.**

Material.—Trunk vertebra and a part of a right dentary with a single tooth; USNM 483392.

Remarks.—This vertebra is very worn, and I am unable to identify it to the specific level. It differs from *Ophisaurus canadensis* Holman 1970 from the medial Miocene Wood Mountain Formation of Saskatchewan and from *Ophisaurus ventralis* Linnaeus 1758 from the Miocene (Barstovian) of Nebraska in that, in dorsal view, the anterior edge of the neural arch ends well behind the anterior edges of the prezygapophyseal facets.

It is possible that this character might indicate that the specimen is from an undescribed species, but it does not seem wise to describe a new species on a single, worn vertebra.

Measurements.—The greatest length of the vertebra through the prezygapophyses and condyle is 3.7. The greatest width of the vertebra through the prezygapophyses is 3.9.

A very small fragment of a right dentary bone of an anguid lizard is also identified as *Ophisaurus* sp. indet. The

single tooth is similar to those that occur on the anterior part of the dentary bone in modern *Ophisaurus* in that it is unicuspid, slightly recurved, and has its tip weakly striated.

*Ophisaurus* does not presently occur in the fauna of Delaware, but *Ophisaurus ventralis* ranges as close as the southeastern tip of Virginia (Conant and Collins, 1991).

**Order SERPENTES Linnaeus, 1758**  
**Family BOIDAE Gray, 1825**

Several authors (e.g. Holman, 1979; Rage, 1984) have discussed the identification of the family Boidae on the basis of individual fossil vertebrae.

**Subfamily ERYCINAE Bonaparte, 1831**

Snakes of this boid subfamily are small semi-fossorial to fossorial forms many of which have unique, elaborated caudal vertebrae (Rage, 1984, fig. 15a). These vertebrae form the skeleton of the very blunt tail, that in outline, resembles the head of the snake. On the other hand, most fossil and modern Erycinae have rather simple trunk vertebrae. Erycinine boids were widely distributed in the Paleogene and Neogene of North America, but the only modern representatives are *Charina* and *Lichanura* of about the western one-fourth of the United States (Stebbins, 1985).

Only two erycine genera have elaborated trunk vertebrae. These are *Cadurceryx* Hoffstetter and Rage 1972 of the Eocene of France and *Pterygoboa* Holman 1976 of the Miocene of North America. Both have pterapophyses (wing-like processes) associated with the postzygapophyses (Rage, 1984), but they are structurally different in each of these genera (Holman, 1977; Rage, 1984).

***Pterygoboa* Holman, 1976**

This genus has been previously identified from only two Miocene localities of the northern High Plains of North America. The type material was collected from the Black Bear Quarry II of the Rosebud Formation (early Hemingfordian) of Bennett County, South Dakota (Holman, 1976a), and additional material was taken from the Myers Farm Site (Barstovian) of Webster County, Nebraska (Holman, 1977).

The trunk vertebrae of *Pterygoboa* are distinct from those of any other fossil snakes in North America in having pterapophyses associated with the postzygapophyses, coupled with having a very depressed neural arch. Two other North American genera, *Palaeophis* Marsh 1878 and *Pterosphenus* Lucas 1899 (Family Palaeopheididae) have pterapophyses, but they are very differently shaped than in *Pterygoboa*. Moreover, the vertebrae of *Palaeophis* and *Pterosphenus* have quite vaulted neural arches.

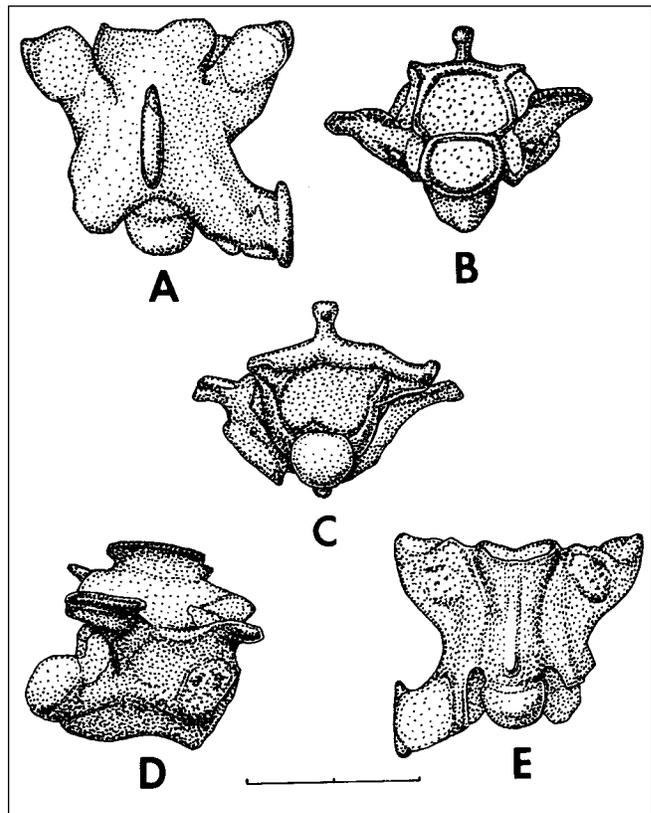
Only one species, *Pterygoboa miocenica* Holman 1976, has been described, and this species has been reported from both of the above localities. Among the herpetological material collected at the Pollack Farm Site is a single vertebra of *Pterygoboa* that is so different from that of *Pterygoboa miocenica* that it is described here as a new species.

***Pterygoboa delawarensis* sp. nov.**

**Figure 1**

Holotype.—Trunk vertebra; USNM 483393.

Type Locality and Horizon.—From the Pollack Farm



**Figure 1.** *Pterygoboa delawarensis* sp. nov., holotype trunk vertebra; USNM 483393. A, dorsal view; B, anterior view; C, posterior view; D, lateral view; E, ventral view. The line equals 2 mm and applies to all figures.

Site (Delaware Geological Survey site Id11-a), near Cheswold, Kent County, Delaware. Cheswold sands of the Calvert Formation; lower Miocene, Hemingfordian Age.

Etymology.—The specific name is for the state of Delaware where the type specimen was collected.

Diagnosis.—(1) Neural arch very depressed; (2) pterapophyses present on postzygapophyses; (3) pterapophyses pointed anteriorly and posteriorly; (4) neural spine low; (5) posterior neural arch flat across the top.

Description of the Holotype.—In dorsal view, the vertebra is moderately wider than long. The pterapophysis is slender and acutely pointed both anteriorly and posteriorly. The prezygapophyseal articular facets are round and have small, blunt prezygapophyseal accessory processes. The posterior border of the neural arch is broadly U-shaped. The anterior border of the neural arch is slightly concave. The neural spine is moderately swollen dorsally and extends from the posterior border of the neural arch to slightly beyond the posterior borders of the prezygapophyseal facets.

In anterior view, the neural spine is moderately high. The anterior neural arch is very slightly convex at the top. The prezygapophyses are slightly tilted upward. Pits occur on either side of the cotyle, but they are filled with matrix and it cannot be determined whether they contain foramina or not. The subrounded neural canal is about one-fourth larger than the round cotyle. The sides of the neural arch are bowed slightly outward.

In posterior view, the neural spine is low. The posterior neural arch is very flat across the top. The pterapophysis

appears rounded and delicate in this view. The rounded neural canal is about one-third larger than the round condyle. The sides of the neural arch are bowed outward.

In lateral view, the neural arch is very depressed. The pterapophyses are thin. The prezygapophyseal facets are slightly tilted upward. The hemal keel is well-developed and extends well below the level of the centrum. Both of the synapophyses are damaged so it is not possible to determine whether they have the divided or undivided condition.

In ventral view, the vertebra is wider than long. The hemal keel is moderately well-developed and moderately thick. Distinct subcentral ridges are present, and these have distinct valleys between themselves and the hemal keel. The postzygapophysis has an ovaloid face and the pterapophysis is acutely pointed both anteriorly and posteriorly. Both of the synapophyses are damaged, thus it is not possible to tell whether they have the divided or undivided condition.

Measurements.—The width of the vertebra through the prezygapophyses is 3.6. The length of the vertebra through the zygapophyses is 2.8. The length of the centrum through the cotyle and condyle is 2.3. The length of the pterapophysis is 1.0. The greatest width of the condyle is 0.8.

Remarks.—This record of the distinctive genus *Pterygoboa* from the eastern coastal state of Delaware is of special zoogeographic interest as the only previous records of the taxon are from isolated sites in Nebraska and South Dakota.

The new species differs from the only other species in the genus, *Pterygoboa miocenica* Holman as follows: (1) the vertebra is more lightly constructed; (2) the neural spine is lower; (3) the posterior neural arch is flatter across the top; (4) the pterapophyses are gracile and are more pointed anteriorly and posteriorly.

It would appear that the ancestral form of both species of *Pterygoboa* (*P. miocenica*, western form; and *P. delawarensis*, eastern form) must have lived in pre-Hemingfordian times, since the earliest records of both species are from the Hemingfordian (Holman, 1976a and this paper). It is difficult to speculate where the geographic location of this ancestor might have been.

#### ***Calamagras* Cope, 1873**

*Calamagras* is an extinct genus of erycine boid that occurs from the lower Eocene of France to the middle Miocene of North America, where it has been recorded from Saskatchewan, Wyoming, Colorado, Nebraska, and Florida (Holman, 1979). On the basis of trunk vertebrae characters, *Calamagras* is distinguished from the related erycine genus *Ogmophis* mainly on the basis of its shorter, usually thicker neural spine.

#### ***Calamagras* sp. indet.**

Material.—A fragmentary vertebra; USNM 483394.

Remarks.—This vertebra may be identified as *Calamagras* on the basis of its short, thick neural spine, but the specimen is too fragmentary to identify to the specific level. *Calamagras* represents a genus that is mainly western, except for its occurrence in Florida (Auffenberg, 1963).

#### **cf. ERYCINAE gen. et sp. indet.**

Material.—A fragmentary vertebra; USNM 483395.

Remarks.—On the basis of its short and wide vertebral form, its heavily-built construction, and its strong hemal

keel, this vertebra is tentatively referred to the boid subfamily Erycinae. The neural spine and other diagnostic characters are missing in this specimen.

#### **Family COLUBRIDAE Opper, 1811**

Several authors (e.g. Holman, 1979; Rage, 1984) have discussed the identification of taxa of the family Colubridae on the basis of individual vertebrae. The huge family Colubridae is a very derived one, and the first fossil colubrids occur in the late Eocene of Thailand (Rage et al., 1992). Fossil Colubridae are first known in Europe and North America in the early Oligocene. As far as I am aware, the accounts that follow represent the earliest records of colubrid snakes from eastern North America east of the Great Plains and north of Florida.

#### ***Ameiseophis* Holman, 1976**

This genus has been previously identified from only two localities, both in the Miocene of the northern High Plains of North America. The type material was collected from the Miocene Split Rock Formation of central Wyoming (Holman, 1976b). This *Ameiseophis* material occurred both in the lower Split Rock beds that have a snake assemblage similar to that of the early Hemingfordian Black Bear Quarry II fauna of South Dakota, as well as from the upper beds that have a snake assemblage that is similar to Barstovian ones in Nebraska (Holman, 1976b). Additional material of *Ameiseophis* was collected from the Bijou Hills local fauna (Barstovian) of south-central South Dakota (Holman, 1978).

*Ameiseophis* is a distinctive colubrid genus with a very strong hemal keel and with deep grooves between the hemal keel and the subcentral ridges. *Ameiseophis* may be distinguished from *Texasophis*, the other extinct North American genus with a very strong hemal keel, on the basis of its shorter vertebral form and higher neural spine. Only one species, *Ameiseophis robinsoni*, has been named, and it occurs in both localities in Wyoming and South Dakota.

#### ***Ameiseophis robinsoni* Holman, 1976**

Material.—Trunk vertebra; USNM 483396.

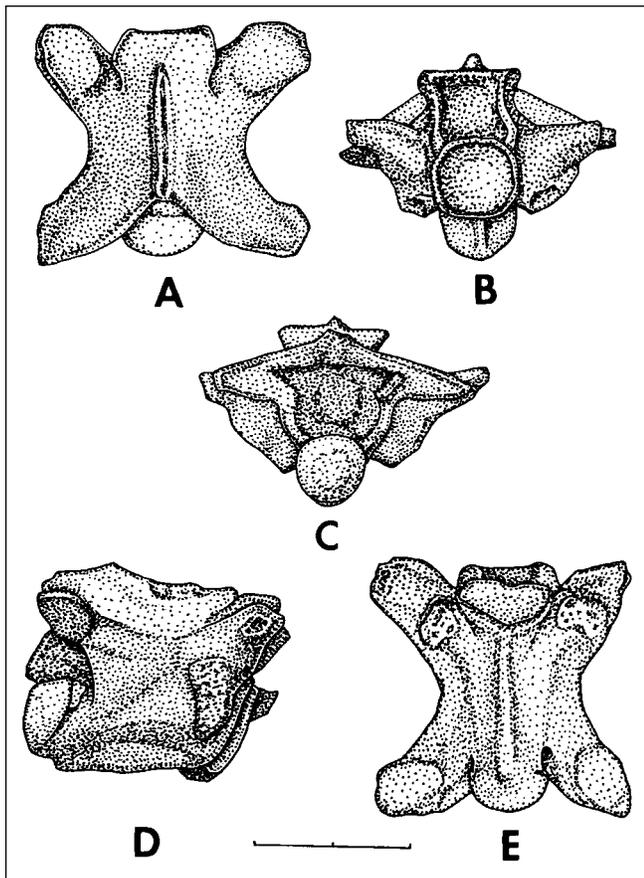
Remarks.—I cannot find any trenchant characters that separate the Pollack Farm vertebra from those of *Ameiseophis robinsoni* (see diagnosis of *A. robinsoni* in Holman, 1976b) except that the grooves between the hemal keel and the subcentral ridges are not quite as deep as in the holotype material. Measurements are as follow: the length of the vertebra through the zygapophyses is 4.8; the width through the prezygapophyses is 4.3 (but the tip of the left prezygapophysis is broken); the length of the centrum through the cotylar lip and the end of the condyle is 3.3.

This record of the distinctive *Ameiseophis robinsoni* in Delaware is of significant zoogeographic interest in that the only previous records of the taxon are from isolated localities in Wyoming and South Dakota. Holman (1976b) believes that *Ameiseophis* possibly represents an archaic colubrid line with no living descendants.

#### ***Pollackophis* gen. nov.**

Type species.—*Pollackophis depressus*

Locality and Horizon.—From the Pollack Farm Site (Delaware Geological Survey Site Id11-a), near Cheswold, Kent County, Delaware. Cheswold sands of the Calvert Formation; lower Miocene, Hemingfordian Age.



**Figure 2.** *Pollackophis depressus* gen. et sp. nov., holotype trunk vertebra; USNM 483397. A, dorsal view; B, anterior view; C, posterior view; D, lateral view; E, ventral view. The line equals 4 mm and applies to all figures.

**Etymology.**—The generic name is for the Pollack Farm Site where the type specimen was collected.

**Diagnosis.**—The diagnosis is the same as for the type and only known species.

***Pollackophis depressus* sp. nov.**

**Figure 2**

**Holotype.**—A single trunk vertebra; USNM 483397.

**Etymology.**—The name reflects the depressed shape of the vertebra.

**Diagnosis.**—(1) vertebra slightly wider than long; (2) neural spine long and thin; (3) neural arch depressed; (3) hemal keel well-developed, but narrow; (4) subcentral ridges weakly developed; epizygapophyseal spines absent.

**Description of the Holotype.**—In dorsal view, the vertebra is slightly wider than long. The left prezygapophysis is broken on its anterolateral edge and the right prezygapophyseal face is ovaloid. Prezygapophyseal processes are either lacking or have been eroded away. The anterior edge of the zygosphenon is very slightly concave. The neural spine is broken, but the basal portion is long and thin. Epizygapophyseal spines are lacking.

In anterior view, the roof of the zygosphenon is straight. The walls of the neural canal are slightly concave. The neural canal is slightly smaller than the rounded cotyle. The prezygapophyses are slightly tilted upward. In posterior view, the neural arch is depressed. The neural canal is about one-third larger than the round condyle. In lateral view, the vertebra is

moderately depressed. The borders of the subcentral ridges are moderately concave. The synapophyses are eroded.

In ventral view, the postzygapophyseal faces are subequal in shape and size; the right one is larger and has its apex directed medially; the left one is smaller and has its apex directed posteriorly. The hemal keel is well developed but thin. The subcentral ridges are weakly developed, and the synapophyses are eroded.

**Measurements.**—Greatest length through the zygapophyses 6.5. Greatest width through posterior zygapophyses 6.7.

**Discussion.**—*Pollackophis* is so distinct that I feel justified in naming a new genus on the basis of this single, well-preserved vertebra. The combination of a short, depressed vertebral form, with a well-developed, but thin hemal keel appears to be unique among fossil and modern Colubridae, thus it seems possible that *Pollackophis* is an archaic form that has left no modern descendants.

**Family VIPERIDAE Oppel, 1811**

The Viperidae is the most derived family of snakes and has evolved a very complex venom-injecting apparatus. This family is composed of 16 genera and is cosmopolitan in its distribution except for Madagascar and Australasia. The earliest viperid fossils are known from the lower Miocene both in Europe and North America (Rage, 1984).

**Subfamily CROTALINAE Oppel, 1811**

The Crotalinae (pit vipers) have the maxillary bone deeply excavated for a heat-sensitive loreal pit organ. This subfamily occurs only in the New World. In the United States there are 17 species in three genera: *Agkistrodon* Beauvois 1799; *Crotalus* Linnaeus 1758; and *Sistrurus* Garman 1883.

**cf. CROTALINAE gen. et sp. indet.**

**Material.**—Right compound bone and two vertebrae; USNM 483398.

**Remarks.**—The compound bone forms the posterior part of the lower jaw in snakes. It lacks teeth and has an inwardly directed retroarticular process on its posterior end. The compound bone is a very distinctive element in the Viperidae in that the distinct, deep groove on the dorsal part of the bone has a very low, almost obsolete lateral wall. Moreover, a deep, elongate fossa occurs just anterior to the retroarticular process.

The fossil compound bone appears to be somewhat closer to *Sistrurus* than to the other North American genera *Agkistrodon* and *Crotalus* in some features, but differs from all three of these genera in others. Comparisons with other New World and Old World viperid genera also indicate that the bone may represent a distinct genus or even a distinct subfamily. However, at present it seems best not to attempt a more specific identification of this specimen until more fossil and modern skeletal material becomes available for comparison.

Two very worn vertebrae also represent viperids in having the very thick hypapophyses that are characteristic of this family. These bones are assigned tentatively to the Crotalinae on the basis of zoogeographic grounds until more fossil and recent skeletal material becomes available.

The earliest record of the family Viperidae in North America is from the Harrison Formation in Nebraska which

represents the uppermost unit in the Arikareean Land Mammal Age (Holman, 1981), and hence the lowest part of the Miocene. Holman (1981) notes that the specimen, a vertebra, somewhat resembles the modern genus *Sistrurus*. As far as I can determine, this is the first published record of a Hemingfordian viperid snake, the first Miocene record of a viperid snake east of the Great Plains and north of Florida, and the oldest record of this family east of the Great Plains.

## DISCUSSION

The Pollack Farm Site has given us the first good window of Miocene reptile life in North America east of the Great Plains and north of Florida. Probably the most striking aspect of this small reptile fauna is that three of the ten identified taxa, *Pterygoboa*, *Calamagras* and *Ameiseophis*, are forms that are characteristic of the Miocene of the North American northern High Plains (Holman, 1979). The wide east-west occurrence of herpetological genera in the Miocene of North America has previously led to the suggestion that east-west rainfall zonation was not as pronounced as it is in the present (Holman, 1970).

Moreover, herpetofaunas from Barstovian Miocene sites in the northern High Plains, from Nebraska to Saskatchewan, have often contained large reptiles such as giant tortoises (*Geochelone*) and crocodylians. These occurrences have been interpreted as indicating subtropical climates in these areas (Holman, 1970, 1977); thus, it seems that the climate in Delaware during the deposition of the Pollack Farm fauna was probably subtropical.

One may get some idea of the ecological setting in which the reptile fauna at the Pollack Farm Site lived by a consideration of habits and habitats of their modern analogs. Large modern crocodiles normally need large, permanent bodies of water in which to live. "*Chrysemys* group" turtles are also aquatic and prefer still rather than rapidly flowing water, as do mud turtles (*Kinosternon*). Considering these three taxa, one could picture a large shallow lake or a river oxbow setting.

The second part of the fauna, however, indicates terrestrial conditions. Large land tortoises (*Geochelone*) have often been depicted as being species that preferred grassy or open terrestrial habitats as do most of their recent congeners.

Species of *Ophisaurus* are legless, snakelike lizards that today eat insects, spiders, snails, birds eggs, and small snakes and lizards (Conant and Collins, 1991). Some of the large southern European forms eat small mice as well. These lizards are excellent burrowers and may spend much of their lives below the ground. Typically, ophisaurids prefer sandy soil with a brushy or grassy ground cover.

The two small erycine boas (*Pterygoboa* and *Calamagras*) are not represented by living genera. Nevertheless, most modern erycine boas are semifossorial or fossorial species, and many of them are partial to loose or sandy soil. In fact, the skulls of many of these modern snakes are blunt in shape for burrowing through sand or loose soil. It thus seems probable that the two fossil genera might have inhabited rather open, sandy habitats, similar to those of the ophisaur. Both *Pterygoboa* and *Calamagras* probably killed their prey by constriction as do the boids of today. Holman (1977) suggested that *Pterygoboa miocenica* ate rodent prey.

*Ameiseophis robinsoni* is believed to be from an archaic line with no living relatives (Holman, 1976b).

Nevertheless, one can speculate on some of its habits based on its vertebral characteristics. Modern colubrid snakes with heavily-constructed vertebrae and massive vertebral processes (e.g., *Lampropeltis getulus*) are usually relatively slow-moving species that kill their prey by constriction. On the other hand, modern colubrid snakes with lightly-constructed vertebrae with gracile vertebral processes (e.g., *Coluber constrictor*) are usually fast, non-constricting species. Since *Ameiseophis* has a heavily-constructed vertebral form with a massive hemal keel, it may have been a slow-moving, constricting snake that could have fed on small rodent prey. Its small size may indicate that it had secretive or fossorial habits.

It is difficult to suggest feeding habits or habitat preferences for the new genus and species *Pollackophis depressus* because it apparently has no modern analogs. Nevertheless, it lacks the vertebral hypapophyses that occur on several genera of aquatic colubrid snakes and thus may have been terrestrial. Moreover, considering its small size, it seems possible that it was secretive.

Other than the fact that the viperid snake certainly must have killed its prey by the injection of venom, it is difficult to suggest specific habits or habitats for this form. But together, the terrestrial reptile assemblage from the Smyrna fossil sites suggests a group of forms that probably occupied a rather open grassy or brushy habitat with loose or sandy soil. This habitat was probably near a large sluggish lake or oxbow.

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