An Early Cretaceous scincomorph lizard dentary from Bornholm, Denmark

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Rees, J. 2000–11–30: An Early Cretaceous scincomorph lizard dentary from Bornholm, Denmark. *Bulletin of the Geological Society of Denmark*, Vol. 48, pp. 105–109. Copenhagen.
https://doi.org/10.37570/bgsd-2000-47-08

A single dentary of a terrestrial lizard was recently discovered in the lowermost part of the Early Cretaceous Jydegård Formation on the island of Bornholm, Denmark. The general outline of the dentary, including a large, partly open Meckelian groove, a coronoid process and a fairly large subdental shelf, in combination with the lack of an intramandibular septum, strongly indicate scincomorph affinity. Further identification is at present not possible as there are a limited number of characters preserved on the dentary. This is the first terrestrial Mesozoic lizard recorded from Scandinavia.

Key words: Lizard, dentary, Scincomorpha, Early Cretaceous, Bornholm, Denmark.

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Four subgroups of crown-group lizards are currently recognised; the Gekkota, Anguimorpha and Scincomorpha constitute the Scleroglossa (Estes, de Queiroz & Gauthier 1988) and the fourth group is the Iguania. The earliest fossils of crown-group lizards are found in Bathonian (Middle Jurassic) sediments in southern England (Evans 1998). This English assemblage includes both scincomorphs, anguimorphs and possibly also members of the Gekkota, indicating that the radiation of crown-group lizards started no later than the Early Jurassic (Evans 1998). Only the Iguania is missing from the Jurassic and the first occurrence of this group is in the Albian, Early Cretaceous (Gao & Nessov 1998). Apart from crown-group lizards, Jurassic and Early Cretaceous strata also yield remains from a number of taxa that are more primitive. The objective of this paper is to describe the first lizard fossil from the Early Cretaceous of Bornholm and discuss its affinity.

Geological setting

The Mesozoic strata on the island of Bornholm are strongly affected by block faulting (Gravesen, Rolle & Surlyk 1982). Early Cretaceous rocks are mainly found in the south-western part of the island (Fig. 1) and are exposed in a number of quarries and coastal outcrops. All Early Cretaceous deposits on the island are included in the Nyker Group, divided into the Rabekke, the Robbedale and the Jydegård Formations. Sedimentation in the Nyker Group commences with fluvial deposits and swamp sediments in the Rabekke Formation (Nielsen, Hansen & Simonsen 1996). Deposits of the Robbedale Formation were laid down in environments such as intertidal flats, coastal lagoons and beaches, while the overlying Jydegård Formation comprises lagoon, back-barrier and washover fan deposits (Gravesen et al. 1982). Sand is the dominating fraction in the upper parts of the Nyker Group but there are also thin layers of silt and clay. Trace fossils are common, particularly in the two lower formations (Nielsen et al. 1996), while other fossils are more scarce and often restricted to certain horizons.

The lizard dentary described in this paper was found in a sand layer in the lowermost part of the Jydegård Formation (see Fig. 2). The bivalve *Neomiodon* Fischer, 1887, present in a clay layer directly above the sand layer, is an indication of a non-marine environment. This bivalve is typical of freshwater to mesohaline (5–18‰) conditions (Fürsich 1994). The vertebrate fauna collected from the same layer as the lizard dentary includes teeth and scales of semionotiform fishes (i. e. *Lepidotes* Agassiz, 1833), remains of hybodont sharks, turtle scutes and possible crocodile teeth. This vertebrate fauna is similar to that of the Purbeck limestones from southern England, where all the sediments were deposited in non-marine environments.

The Nyker Group overlies the Middle Jurassic Bagå

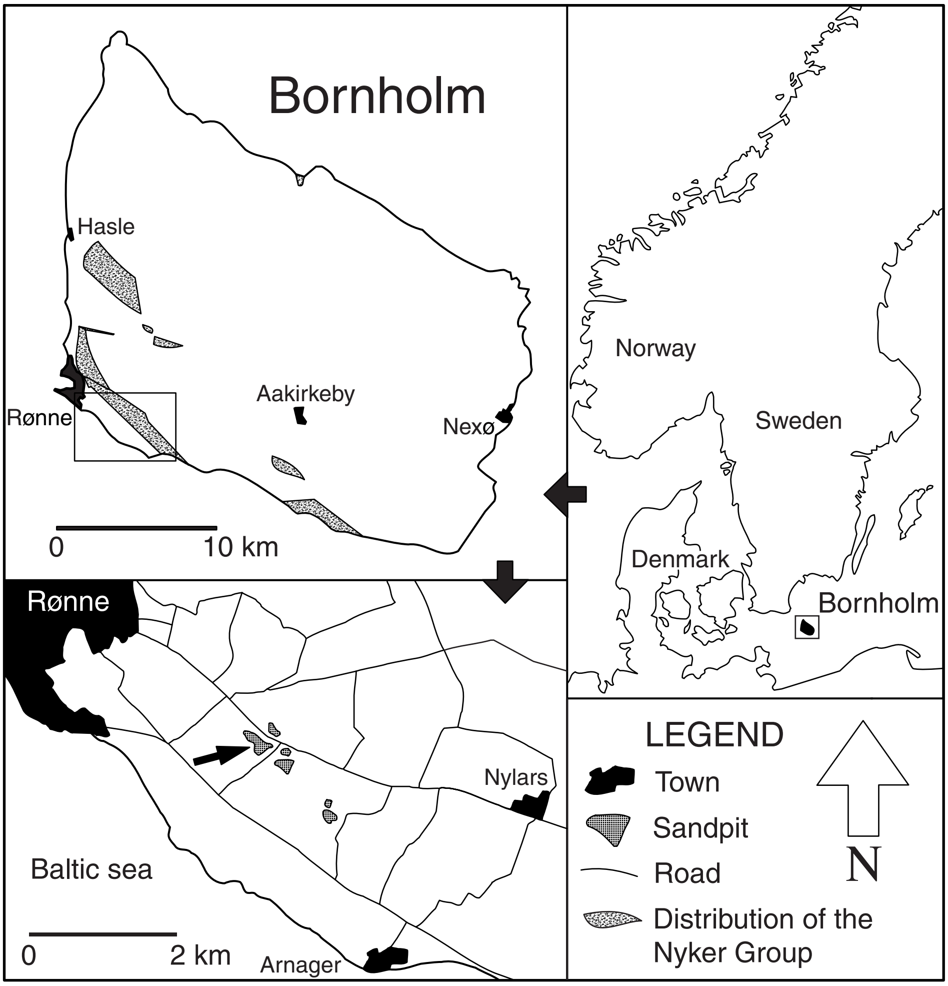


Fig. 1. General location of Bornholm, distribution of the Nyker Group (from Gravesen et al. 1982) and location of A/S Carl Nielsen's sand pit (at the arrow).

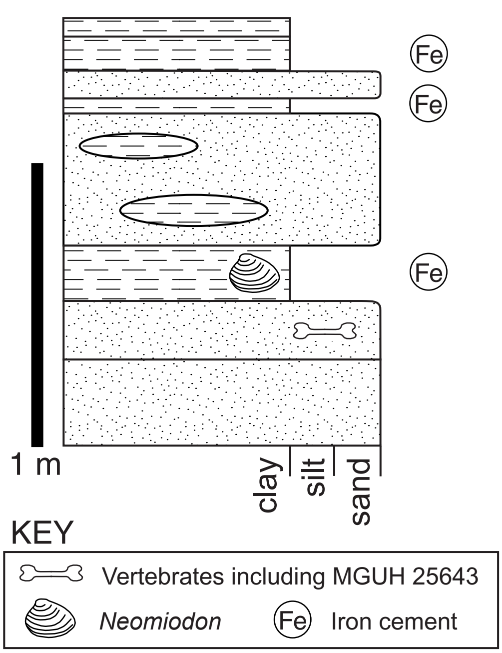


Fig. 2. The upper part of the southern wall at A/S Carl Nielsen's sand pit and the fossiliferous layers.

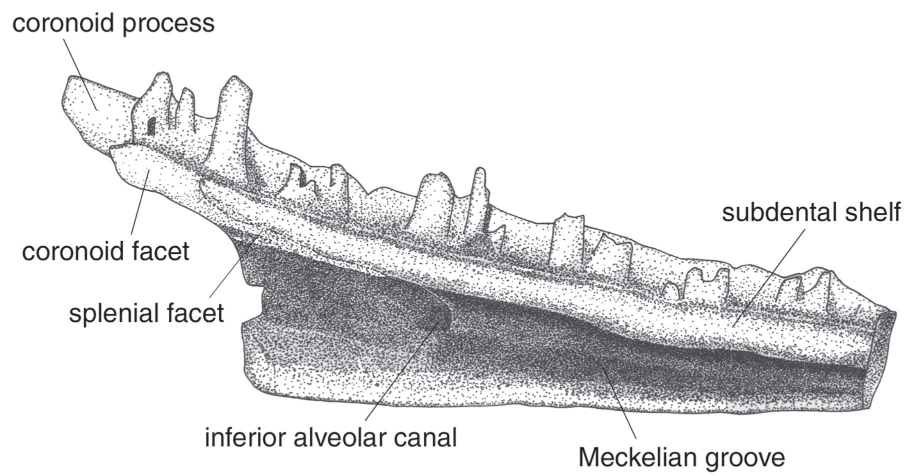
Formation unconformably and is overlain by the Late Cretaceous Arnager Greensand, also with an unconformable boundary (Gravesen et al. 1982). The precise age of the Nyker Group sediments is not known, since age diagnostic fossils are scarce, if at all present. On the basis of ostracods, Christensen (1963) considered the lower parts of the Jydegård Formation contemporary with the German Wealden 3. Surlyk (1980) correlated the Jydegård Formation with the Upper Purbeck and Lower Wealden, spanning the late Berriasian to Valanginian.

Systematic Palaeontology

Superorder Lepidosauria Haeckel, 1866
Order Squamata Oppel, 1811
Infraorder Scincomorpha Camp, 1923
Family, genus et species indet.
Figs 3–4.

Material. – A single right dentary, MGUH 25643, lack-

Fig. 3. Drawing of MGUH 25643 in medial view and the descriptive terms used in the text.



ing the anteriormost part and the Meckelian process. It is deposited in the type collection of the Geological Museum, University of Copenhagen, Denmark. The dentary was found in the lowermost part of the Jydegård Formation (Fig. 2), in the southern wall of A/S Carl Nielsen's sand pit (locality description in Gravesen et al. (1982)). Descriptive terms used in the text are shown in Figure 3.

Description. – The outer lateral surface of the dentary is slightly convex and three nerve foramina open on the mid part of the dentary. Ventrally, the border of the dentary is almost perfectly horizontal. The coronoid process on the dorsal side of the posterior part of the dentary is well developed and measures 2.2 mm in length. The large size indicates that it overlapped the coronoid. The Meckelian process is broken off. On the medial side, the dentary is characterised by a wide and moderately thick subdental shelf that is thicker anteriorly. The teeth are situated close to the lateral border of the dentary. The Meckelian groove may have been closed anteroventrally as the ventral border of the dentary is uprolled. The groove is rather wide and prominent facets are present both on the posterior and ventral surfaces of the subdental shelf. The facet on the ventral surface indicates the presence of a rather large splenial reaching at least the centre of the dentary. It is not clear, however, whether the splenial enclosed the Meckelian groove or not. The facet on the posterior surface of the subdental shelf was probably for the anterior medial process of the coronoid, at least in part. The well developed opening of the inferior alveolar canal is situated beneath the sixth tooth position from the coronoid process. There are thirteen tooth positions present, although only one tooth is preserved. The teeth are paired, except in the most posterior part of the dentary where three teeth are grouped together. A few additional teeth were most likely present in the lost anteriormost part of the dentary. All teeth in the dentition are pleurodont. Information on the tooth morphology is limited but the preserved posterior tooth is non-striated, with a slightly flattened and expanded tip. The dentary measures 7.7 mm in length.

Discussion. – Fragmentary remains of fossil lizards are often difficult to distinguish even at the family level, as there are few unique characters present on each skeletal element (Rieppel 1994). Naturally, this applies to isolated dentaries, and even though they are frequently used as type material, dentaries can be very similar in only distantly related taxa (Evans & Chure 1998b).

Among the earliest known scincomorphs are members of the Paramacellodidae Estes, 1983, a group ranging from the Middle Jurassic to the Middle Cretaceous (Evans & Chure 1998b). Paramacellodids were widespread and remains of this group have been found in Europe, North America, Africa and Asia (Evans & Chure 1998a). The dentary of paramacellodids resembles MGUH 25643 in having a horizontal ventral margin, a strong subdental shelf and an overlapping coronoid process. The teeth of paramacellodids, however, are lingually striated and often faceted (Broschinski & Sigogneau-Russell 1996; Evans & Chure 1998a), quite different from the preserved tooth in MGUH 25643. Three European genera can be included in the family with confidence; *Paramacellodus* Hoffstetter, 1967, *Becklesius* Estes, 1983 and *Pseudosaurillus* Hoffstetter, 1967. In addition, *Saurillus* Owen, 1854 is more loosely attached to the family (Evans & Chure 1998b). In *Paramacellodus*, the Meckelian groove is open ventrally to a larger degree than in MGUH 25643, particularly in the anterior part, where the subdental shelf is expanded. Since the anteriormost part is missing in MGUH 25643, detailed

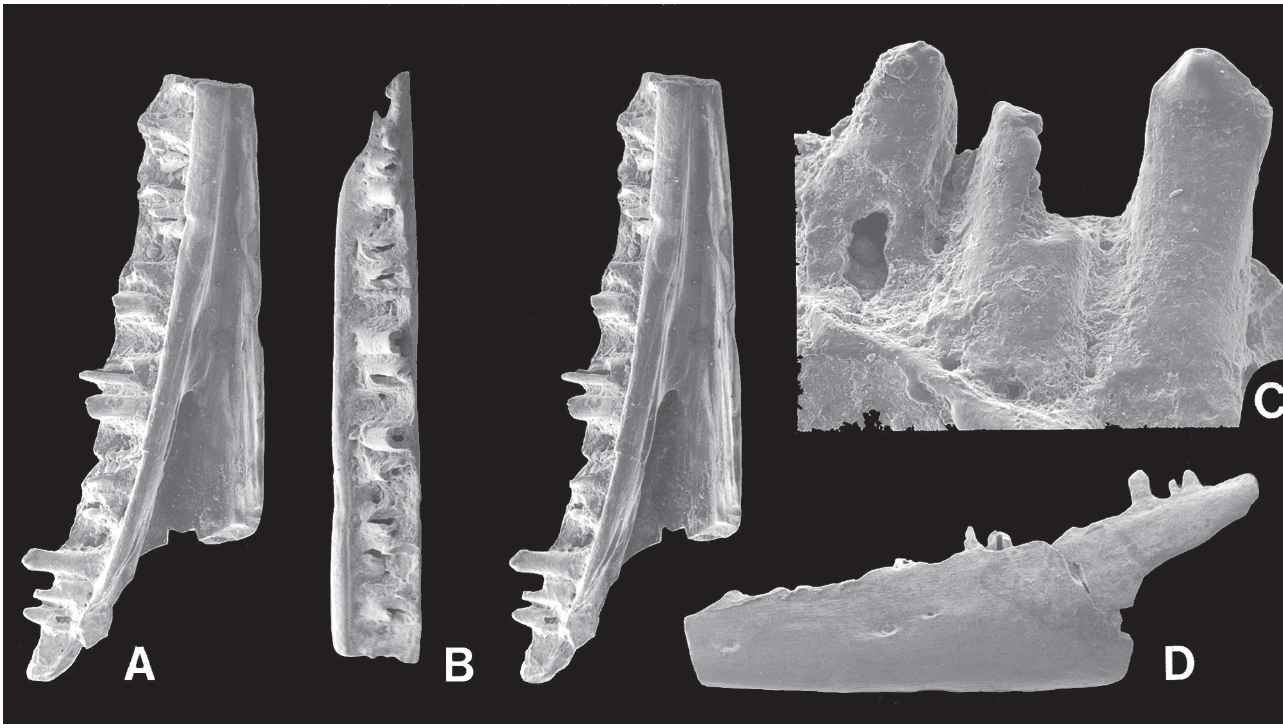


Fig. 4. SEM micrographs of the dentary, MGUH 25643, in A. medial view (stereo pair), B. dorsal view and D. lateral view. The dentary measures 7.7 mm in length. C. The posterior part of the dentary, including the complete tooth, in medial view. The width of the figured part is 1.25 mm.

comparisons are impossible. The teeth of *Becklesius* have expanded tips (Evans & Chure 1998b), more so than in MGUH 25643. In other aspects, the dentary is quite similar to MGUH 25643, even though the coronoid process is smaller in *Becklesius*. Dentary teeth of *Pseudosaurillus* are numerous (about 30), smaller and narrower (Estes 1983) than in MGUH 25643. Dentaries of *Saurillus* are more heavily built in most aspects and the coronoid process is smaller than it is in MGUH 25643. Another early scincomorph is *Meyasaurus* Vidal, 1915, known from the Berriasian to the Barremian of Spain and belonging to the Lacertoidea (Evans & Barbadillo 1997). Dentaries of this genus have a large number of teeth (about 30) that are bicuspid in the posterior part. The Meckelian groove is more open than it is in MGUH 25643, and there are eight or nine nerve foramina on the lateral side (Evans & Barbadillo 1997), as opposed to only three in MGUH 25643. Among extant scincomorph families, only the Teiidae Gray, 1827 have an Early Cretaceous record. This family was reported from Aptian or Albian strata in Texas by Winkler, Murry & Jacobs (1990). On teiid dentaries, there is normally a large amount of cementum at the tooth bases (Gao & Nessov 1998) and the ventral border is convex, both characters absent in MGUH 25643.

Two other roughly contemporary lizard families, Ardeosauridae Camp, 1923 and Bavarisauridae Kuhn, 1961, are known from the Tithonian lithographic limestones in southern Germany, the former also from the Liaoning province, China (Estes 1983). Both families have been placed within the Gekkota (Mateer 1982; Estes 1983), but this view has been questioned (Rieppel 1994). Most specimens assigned to either family are preserved in lithographic limestone and the morphology of the dentary is often obscured by the skull. However, a recent reinterpretation of *Bavarisaurus* Hoffstetter, 1953, one of two genera included in the Bavarisauridae, reveals some features of the dentary (Evans 1994). The teeth are recurved and the subdental shelf is very small or even absent, while the preserved tooth is not recurved and the subdental shelf is wide in MGUH 25643. The new characters discovered in *Bavarisaurus* also weakens the arguments for gekkotan affinity (Evans 1994). Members of the Gekkota usually have a Meckelian canal that is closed and fused (Estes et al. 1988).

The Early Cretaceous (Berriasian?) deposits of Anoual in Morocco have yielded a lizard fauna comprising paramacellodids and an enigmatic member of the Lacertilia, *Tarratosaurus anoualensis* Broschinski & Sigogneau-Russell, 1996. In the latter species, the dentary is thickened anteriorly and the Meckelian groove is almost closed (Broschinski & Sigogneau-

Russell 1996). The tooth bearing parts of the dentary are less posteriorly extended than they are in MGUH 25643. Teeth of *T. anoualensis* are striated lingually, but smooth in MGUH 25643.

Two endemic and more primitive lizards are known from the Early Cretaceous lithographic limestones in Spain, *Hoyalacerta sanzi* Evans & Barbadillo, 1999 and *Scandensia ciervensis* Evans & Barbadillo, 1998. The former species has an extremely long dentary with approximately 40 teeth and more or less parallel borders (Evans & Barbadillo 1999), while the dentary of the latter is poorly known. It appears to have a concave ventral border and a horizontal dorsal border (see Evans & Barbadillo 1998), while the ventral border is horizontal and the dorsal border is concave in MGUH 25643. However, the simple teeth, slightly labiolingually compressed, are similar to the only preserved tooth in MGUH 25643.

A modern group ranging from the Early Cretaceous is the Iguania, as it was recorded by Gao & Nessov (1998) in Albian strata of Uzbekistan. The Iguania comprises the Acrodonta and the Iguanidae Cuvier, 1807 (Estes et al. 1988), the former taxon being acrodont. The Iguanidae is considered to be a metataxon (Estes et al. 1988), as there are few, if any, characters to distinguish the group. Many iguanids are known to have an uprolled ventral border of the dentary, but this is not an unique character as it is also present in some scincomorphs, among others. The subdental shelf is small in iguanids and MGUH 25643 can consequently not belong to this group.

In conclusion, the dentary found in the Jydegård Formation is most likely from a scincomorph lizard but further determination is at present not possible.

Acknowledgements

Thanks are due to Dr Mikael Siverson (Lund University) who assisted in the fieldwork and commented upon an earlier version of the manuscript. Dr Susan Evans (University College, London) acted as referee and provided interesting comments that improved the contents of this publication. Lund Geological Fieldclub contributed with travel grants to Bornholm.

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