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## A new scincomorph lizard from the Palaeocene of Belgium and the origin of Scincoidea in Europe

Received: 17 March 2005 / Accepted: 3 August 2005 / Published online: 29 September 2005  
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**Abstract** Well-preserved jaw fragments and skull bones of a new scincomorph lizard are described from the continental Hainin Formation (Middle Palaeocene) of the Mons Basin in southwestern Belgium. This taxon, *Scincoideus haininensis* gen. et sp. nov., is characterised by vermiculate dermal rugosities and represents the earliest formally recognised scincoideid in Europe. It differs from cordylids (girdled lizards) by lacking the parietal down-growth and differs from scincids (skinks) by having robustly built bones and a well-developed lingual cusp on tooth crowns. By its mosaic characters, *S. haininensis* is considered here as being a basal scincoideid lizard close to the origin of cordylids and scincids. Palaeobiogeographic analysis suggests that scincoideids were present in Europe from the Palaeocene or maybe even before the Cretaceous/Palaeogene boundary and that they were replaced by modern scincoideids such as true scincids and cordylids during the Eocene. The origin of the latter two families in Europe was very likely related with the immigration of the first modern mammals.

**Electronic supplementary material** Supplementary material is available for this article at <http://dx.doi.org/10.1007/s00114-005-0043-4> and accessible for authorised users.

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### Introduction

Scincoideid lizards are represented by the extant families Cordylidae, Gerrhosauridae and Scincidae, but their origin is unclear. The presence of the cordylid *Konkasaurus mahalana* in the Maastrichtian of Madagascar suggests that the Cordylidae could have originated in Africa where they are still present [12]. Only two doubtful cordylid taxa are mentioned in North America, and both are in the Cretaceous [7, 21]. Two important immigrations of cordylids are known in Europe, the first one during the Eocene and the second one around the Oligocene–Miocene transition [1, 4].

The controversial gerrhosaurid family is restricted to Africa, and no fossil records are known before the Miocene [13].

The scincids are cosmopolitan and represent the most diversified lizards today. Following different authors, they originated either in Europe or in North America. The earliest scincids of North America are confirmed in the Campanian of Texas and Canada (Gao and Fox [7] and references therein). In Europe, [17] described a potential scincoideid already in the lower Cretaceous of Spain, but it is now considered as doubtful [21]. Moreover, in Europe there is a gap between this taxon that is contemporaneous with the archaic Paramacellodidae, the sister-group to scincoideids [6], and the first true European scincoideid, *Axonoscincus sabatieri*, described from the early Eocene of Prémontré (MP10, France, Augé [3]). Another potential scincoideid lizard is mentioned in the Palaeocene of Cernay (MP6, France, Augé [2]), but the absence of true scincoideid apomorphies indicates that it may be considered as a basal Scincoidea (Augé, personal communication).

Here we describe and discuss some very well-preserved bones from the Middle Palaeocene Hainin Formation of Belgium that are attributed to a new basal scincoideid lizard. These specimens were discovered from boreholes made in the 1970s by the Geological laboratory of the Faculté Polytechnique de Mons in the village of Hainin (Mons Basin, Belgium) to reach the marine Danian layers of the Lower Palaeocene [9]. At this occasion, a continental “Montian” vertebrate deposit was discovered between the

Danian and the Thanetian. This deposit yielded the earliest tertiary mammal fauna in Europe [10]. The important Hainin fauna, considered to be Middle Palaeocene in age, was specified as reference-level MP1-5 of the mammalian biochronological scale for the European Palaeogene [18]. After years of discontinued technical work to treat the sediment and to pick up the specimens from the residue (directed by BS), all specimens have now been isolated. The material is exceptional as it contains approximately 1,300 diversified and well-preserved herpetological fragments.

### Systematic palaeontology

- Order Squamata Opper 1811
- Sub-order Lacertilia Owen 1842
- Infra-order Scincomorpha Camp 1923
- Super-family Scincoidea Opper 1811
- *Scincoideus haininensis* gen. et sp. nov.

### Etymology

The generic name *Scincoideus* is derived from the super-family Scincoidea, and the species *haininensis* is named for the locality of Hainin.

### Holotype

IRSNB R 219 is a nearly complete right dentary.

### Paratypes

The paratypes are the following: four maxillae and maxillary fragments (IRSNB R 215-218), eight dentaries and dentary fragments (IRSNB R 220-227), one pair of frontals (IRSNB R 228), two isolated frontals (IRSNB R 229-230) and one incomplete parietal (IRSNB R 231).

### Type of locality and age

The specimens were from Hainin, Mons Basin, Hainaut Province, southwestern Belgium; continental “Montian”, Hainin Formation, Middle Palaeocene (MP1-5).

### Diagnosis

*S. haininensis* gen. et sp. nov. is characterised by the combination of the following characters: robustly built bones, tooth crowns bearing a well-developed lingual cusp, paired frontals with parallel postero-lateral borders and with highly digitated sutures between both frontals and with the parietal, unpaired parietal that lacks the down-growth and bears a wide pineal foramen. The dorsal side of

both the frontals and the parietal and the dorsal part of the maxilla facial process bear a vermiculate ornamentation with numerous small pits.

### Description

Three robustly built dentaries are well preserved. They present a sub-dental shelf with a deep and well-developed sulcus dentalis (Fig. 1a). Lingually, the Meckelian canal is open (Fig. 1b). The anterior limit of the splenial does not reach the intermandibular symphysis. Labially, the bone is smooth but presents a few foramina (Fig. 1c). The dentary is evenly curved on its ventral border (Fig. 2g) and its posterior part overlaps the coronoid.

The maxilla presents a well-developed facial process that is slightly convex labially and dorso-labially ornamented by a vermiculate structure with numerous small pits (Fig. 2e). The posterior part of the bone is smooth and wide. Lingually, there is no lingual carina (Fig. 2f).

Teeth are pleurodont, smooth and slightly lingually enlarged at the middle of their height (Fig. 3). Replacement pits are developed at the tooth bases. Crown tips present no striae, but bear a wide and well-developed lingual cusp. Both the lingual and the labial cusp are triangular shaped. The mesial crest is longer than the distal crest so that the tip of the crowns seems to be posteriorly oriented.

The frontals are paired. The lateral borders are not highly constricted medially, the postero-lateral borders are parallel and the sutures between both frontals and with the parietal are highly digitated. The frontoparietal suture is longer than the frontonasal suture. Dorsally, the frontals are covered by a vermiculate ornamentation with numerous small pits

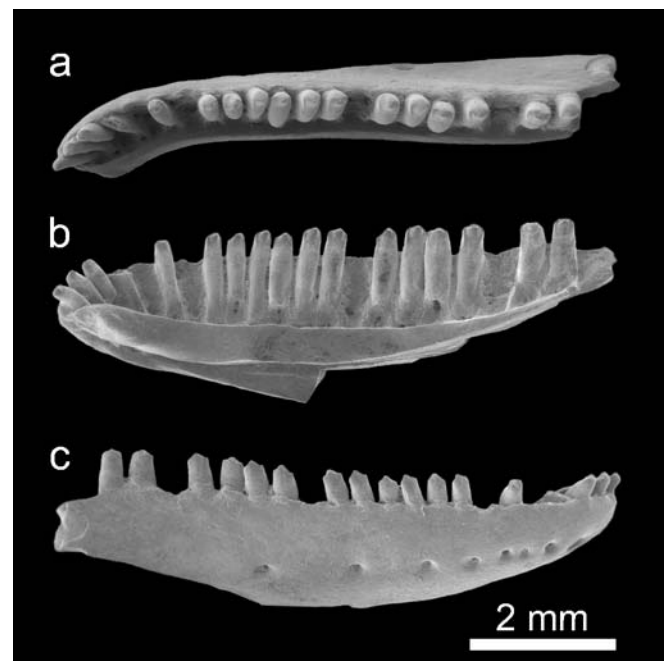
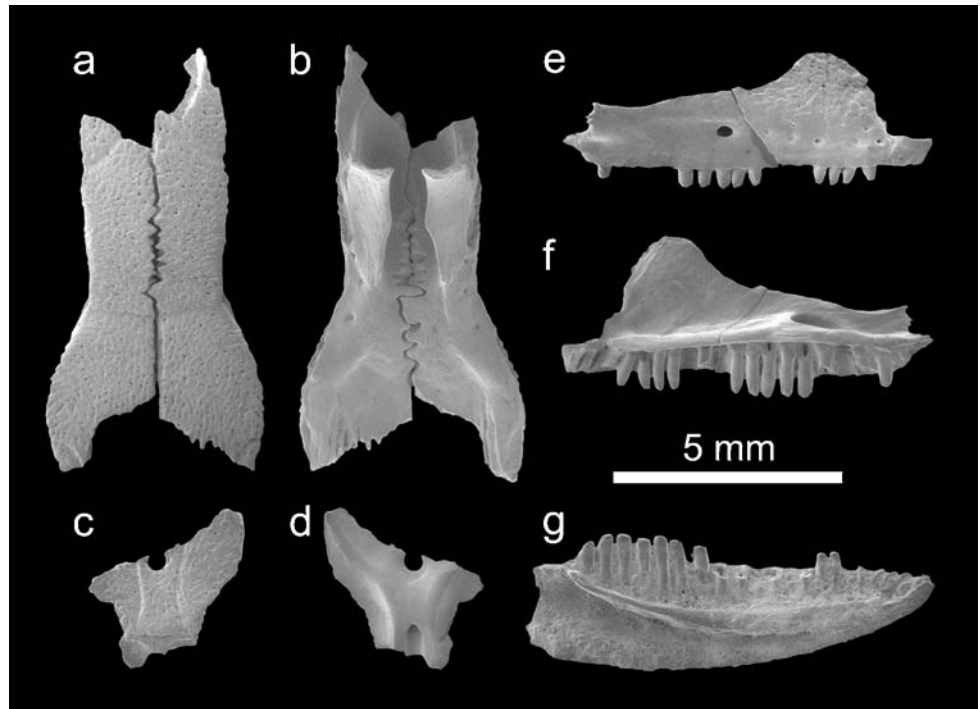


Fig. 1 Holotype dentary of *S. haininensis* gen. et sp. nov. (IRSNB R 219) in a occlusal, b lingual and c labial views

**Fig. 2** *S. haininensis* gen. et sp. nov. **a–b** paired frontals (IRSNB R 228) in dorsal and ventral views. **c–d** parietal (IRSNB R 231) in dorsal and ventral views. **e–f** maxilla (IRSNB R 217) in labial and lingual views. **g** dentary (IRSNB R 221) in lingual view

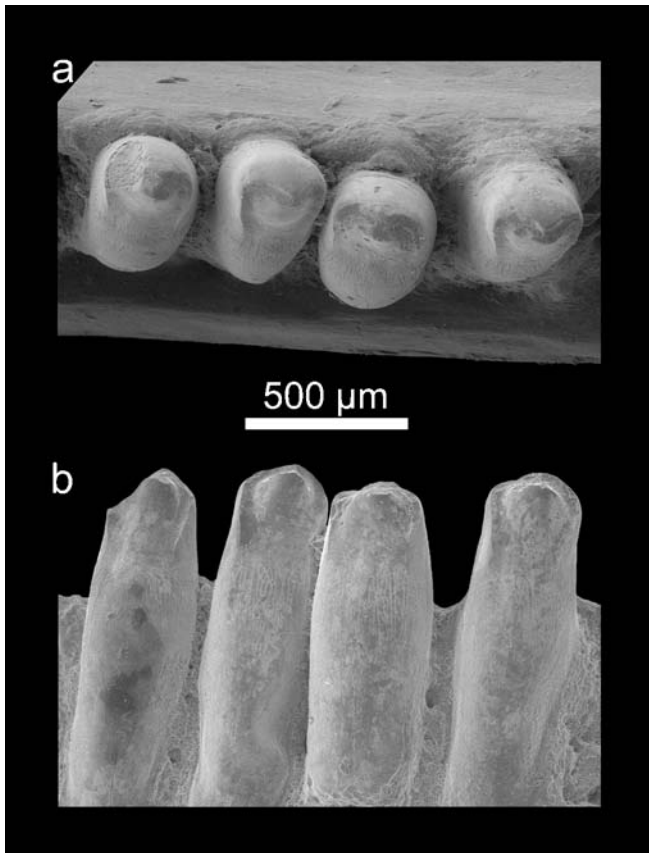


(Fig. 2a). This ornamentation is identical to the one observed on the maxilla (Fig. 2e) and on the parietal (Fig. 2c). Symmetrical, shallow and narrow grooves are well visible in the anterior, medial and postero-lateral parts of the frontals. These grooves correspond to scale marks. Ventrally, the descending processes are strongly developed, but they are not fused together (Fig. 2b).

Only one incomplete thin unpaired parietal is attributed to *S. haininensis* (Fig. 2c,d). Dorsally, the surface presents the same ornamentation as the maxillae and the frontals, and a wide pineal foramen is present. Two medially curved grooves are developed on both sides of the pineal foramen and correspond to scale marks. Ventrally, two flat and shallow ridges are developed, and there are no descending processes (or parietal downgrowth *sensu* [6]).

## Discussion

*S. haininensis* gen. et sp. nov. is attributed to the Scincomorpha by the presence of two synapomorphies: a sulcus dentalis on the dentaries and vermiculate dermal rugosities [11, 5]. This group is classically divided into the Lacertoidea that includes the Lacertidae, Teiidae and Gymnophthalmidae, and the Scincoidea that includes the Cordylidae, Gerrhosauridae and Scincidae [12]. The Xantusiidae and Paramacellodidae are also considered as scincomorphs, but their phylogenetic relationships with the other groups are still debated [6, 12]. *S. haininensis* does not belong to the Lacertoidea or the Xantusiidae by the posterior part of the dentary that overlaps the coronoid, the maxilla without a well-marked lingual carina and a wide posterior part, the presence of paired frontals and a single parietal, the vermiculate ornamentation of the bones



**Fig. 3** Detail of the holotype dentary *S. haininensis* gen. et sp. nov. (IRSNB R 219) showing its dentition in **a** occlusal and **b** lingual views

corresponding to dermal rugosities and the lack of parietal downgrowth [6]. Actually, all these bony characters suggest referral of *S. haininensis* to the Scincoidea and the Paramacellodidae. It does not belong to the Gerrhosauridae because those lack the parietal foramen [13], whereas the parietal foramen is present and wide on *S. haininensis*. It also differs from *Eolacerta* (*Scleroglossa incertae sedis*; see Müller [14, 15]), which shares synapomorphies with Scincomorpha, by the thin parietal with flat and shallow ridges, the bicuspid teeth, the absence of lingual carina and the wide posterior part of the maxilla.

*S. haininensis* is thus close to the Cordylidae, Scincidae and Paramacellodidae. These three families are highly related groups [6]. All the morphologic characters shared by *S. haininensis* and paramacellodids seem to be symplesiomorphic features. Moreover, the presence of a well-developed additional lingual cusp on the teeth and the absence of lingual striae on tips of *S. haininensis* prevent the attribution of the new Belgian taxon to the Mesozoic paramacellodid group [17, 6].

The presence of the parietal downgrowth is a synapomorphy of scincomorphs with reversals in some scincids [5]. As *S. haininensis* do not present these downgrowths, it is close to the Scincidae [6]. However, the presence of vermiculate dermal rugosities on the skull bones, the robust shape of the dentary and the presence of the lingual cusp are more common among the cordylids than the scincids.

*S. haininensis* presents typical mosaic characters of a basal scincoid close to the origin of the Scincidae and the Cordylidae (see S1 for the results of a cladistic analysis).

## Palaeobiogeography

The palaeobiogeographic origins of the Early Palaeogene herpetological faunas of Europe are still not well known. Eocene herpetofaunas of Europe present a multi-palaeogeographic component with numerous genera and families occurring for the first time in Europe at the earliest Eocene (MP7) of Dormaal in Belgium [2, 3]. This is very likely related with the immigration of the first modern mammals in Europe [20]. However, the presence of *S. haininensis* in the Palaeocene of Hainin indicates that the origin of scincoid scincomorphans in Europe is older than the Palaeocene/Eocene boundary.

To assess different paleobiogeographic scenarios for the Palaeocene herpetofaunas of Europe, comparisons were made with the contemporaneous mammalian fauna. The mammals of Hainin have a mixed geographic origin. Some belong to typical European endemic groups such as kogaionid multituberculates [16]. Others, such as proteutherian Pantolestidae and primate-like Plesiadapidae, are related to early Palaeocene taxa of North America [10, 19]. Finally, adapisoriculid insectivores are known from Europe and North Africa [8]. All these groups disappeared at the Palaeocene/Eocene boundary or during the Eocene.

We suggest that some lizard groups such as scincoids were present in Europe from the Palaeocene or maybe even before the Cretaceous/Palaeogene boundary and that they were progressively replaced by modern scincoids such as true scincids and cordylids during the Eocene. This hypothesis is corroborated by the recent description of several complete skeletons of *Ornatocephalus metzleri* from the Middle Eocene of Messel in Germany [21], another basal European scincoid that was contemporaneous with true European scincids.

**Acknowledgements** The authors are very grateful to Alain Herbosch (ULB, Brussels) and Pascal Godefroit (RBINS, Brussels) for accepting to support this research; to Marie-Claire Groessens-Van Dyck (UCL, Louvain-la-Neuve) for giving access to part of the material; to Susan Evans (NHM, London), Randall Nydam (MWU, Glendale, Arizona) and Jean-Claude Rage (MNHN, Paris) for giving access to comparative material and discussions about scincomorphs and Marc Augé and Pieter Missiaen for improving the manuscript and helping for the cladistic analysis. At the RBINS, Julien Cillis produced the SEM photographs. A. Folie is a F.R.I.A. grant holder. This paper is a contribution to projects MO/36/011 financially supported by the Federal Science Policy Office of Belgium.

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