



## Food resources and habitat selection of a diverse vertebrate fauna from the upper lower Campanian of the Kristianstad Basin, southern Sweden

Anne Mehlin Sørensen<sup>a,\*</sup>, Finn Surlyk<sup>a</sup>, Johan Lindgren<sup>b</sup>

<sup>a</sup> Department of Geosciences and Natural Resource Management, University of Copenhagen, Øster Voldgade 10, DK-1350 Copenhagen K, Denmark

<sup>b</sup> Department of Geology, Lund University, Sölvegatan 12, SE-223 62 Lund, Sweden

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### ABSTRACT

During the latest early Campanian, a diverse vertebrate assemblage inhabited the shallow coastal waters of the Kristianstad Basin, southernmost Sweden. The taxon-rich fauna includes numerous species of sharks, rays, chimaeroids, bony fish, mosasaurs, plesiosaurs, aquatic birds, crocodiles, and turtles. Vertebrate fossils have been found at several localities within the basin, representing at least three different environments: near-shore waters around a rocky island, presumably murky, shallow waters adjacent to a river mouth, and more open coastal waters. Many vertebrates in the marine faunal community were high-level predators, others were piscivorous, bottom-dwellers that fed primarily on benthic invertebrates and fish, or omnivores that fed on algae and invertebrates. The fauna thus exploited a wide range of food sources and habitats. Six trophic levels, ranging from primary producers to fifth-level consumers, are recognised, indicating a high loss of energy and reflecting a mixture of shallow coastal and more open water ecosystems. The trophic structure suggests that the basin was a rich palaeoenvironment with high faunal diversity and productivity.

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### 1. Introduction

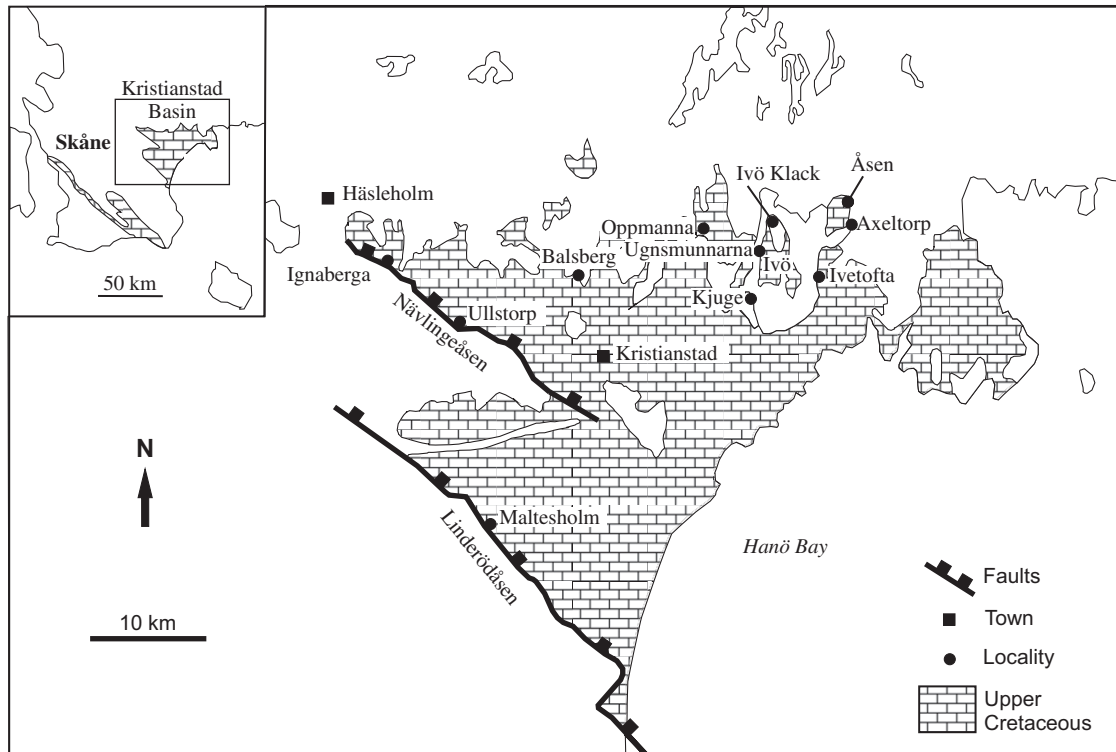
Southern Sweden was transgressed several times during the Late Cretaceous, resulting in a shallow-marine archipelago with numerous low islands and peninsulas (Surlyk and Christensen, 1974; Surlyk and Sørensen, 2010). The sea offered a wide range of habitats for marine vertebrates, including rocky shores, deeper coastal waters, and protected shallow-water settings. The upper lower Campanian deposits of the Kristianstad Basin, northeast Skåne (Fig. 1), have yielded a rich vertebrate fauna, comprising about 40 species of sharks, six species of rays, six species of mosasaurs, six species of plesiosaurs, three species of aquatic birds, one species of crocodile, one taxon of ornithischian dinosaur, and an unknown number of turtle, bony fish and chimaeroid taxa (Tables 1 and 2). Furthermore, the basin has produced one of the finest fossil invertebrate rocky shore faunas known to date (e.g., Sørensen and Surlyk, 2010, 2011; Sørensen et al., 2011, 2012).

Studies of the Cretaceous vertebrate fauna from southern Sweden commenced in 1827 when Nilsson described a few isolated reptilian teeth; he continued his work in 1836 and 1857 with descriptions of an incomplete mosasaur skull erroneously

referred to as a plesiosaur (see Persson, 1959; Lindgren, 2004) and some isolated mosasaur tooth crowns. The material examined by Nilsson (1836) was redescribed by Hisinger (1837). Angelin (1877) and Schröder (1885) described mosasaur remains from the basin. Subsequently, Moberg (1884), Lundgren (1888a,b, 1889), Nathorst (1894), Hennig (1910), and Kuhn (1939) mentioned, listed or redescribed the mosasaur material. Davis (1890) described selachian teeth, chimaeroid teeth and fin spines, plus teeth, vertebrae and scales of bony fishes. Törnebohm and Hennig (1904) noted additional mosasaur fossils from the basin, while a few finds of vertebrates were reported by Voigt (1929) and Lundgren (1934). Studies on the vertebrate fauna continued with Persson's (1954, 1959, 1960, 1962, 1963, 1967, 1990, 1996) papers on skeletal remains of plesiosaurs, mosasaurs, marine turtles, dinosaurs and crocodiles (note that the material described by Persson (1996) is a partial lower jaw of a marine turtle and not a plesiosaur jugal). The mosasaur fauna was listed once again by Russell (1967). More recently, shark teeth have been either listed or described by Bergström and Sundquist (1978), Bergström (1983), Siverson (1992a,b, 1993, 1995) and Rees (1999), while teeth and bones of mosasaurs were described by Lindgren and Siverson (2002, 2004, 2005) and Lindgren (2004, 2005a,b), mosasaur bite marks on a plesiosaur propodial by Einarsson et al. (2010), bones of aquatic birds by Rees and Lindgren (2005), a carapace fragment of a soft-shelled

\* Corresponding author. Tel.: +45 35322448.

E-mail address: [anne@geo.ku.dk](mailto:anne@geo.ku.dk) (A.M. Sørensen).



**Fig. 1.** Simplified geological map of northeast Skåne (southern Sweden), showing the Kristianstad Basin and the location of the Cretaceous localities mentioned in the text. Modified from Norling and Bergström (1987) and Lindgren and Siverson (2002).

turtle by Scheyer et al. (2012), dental and vertebral elements of dinosaurs by Lindgren et al. (2007), and vertebrate coprolites by Eriksson et al. (2011).

The aim of the present contribution is to provide an overview of the vertebrate fauna based on the scattered literature items listed above, and to present a palaeoecological synthesis based on those animals that once inhabited the shallow coastal waters that covered southern Sweden. This work complements recent studies of important invertebrate groups (see Sørensen and Surlyk, 2010, 2011; Sørensen et al., 2011, 2012) and aids in a reconstruction of the higher levels of the trophic structure of this marine Cretaceous ecosystem.

## 2. Geological setting

The Upper Cretaceous marine succession of the Kristianstad Basin was deposited during a number of transgressive events, when the sea level periodically rose up to about 100 m higher than it is today (Sahagian et al., 1996; Kominz et al., 2008). The relatively small-sized basin was situated at the northeastern margin of the epeiric Chalk

Sea, which covered most of northwest Europe during this time interval. The basin was open towards the southeast but may have been closed towards the west, based on present-day topography of Skåne (Surlyk and Sørensen, 2010). The palaeolatitude was about 50°N (Smith et al., 1994) and the climate was warm temperate to subtropical (Surlyk and Christensen, 1974; Surlyk and Sørensen, 2010). The marine Upper Cretaceous succession in the basin is less than 200 m thick, thins towards the north where it onlaps low-relief basement rocks, and consists mainly of skeletal carbonate gravel, sand and silt (Surlyk and Sørensen, 2010). Most outcrops expose strata from the uppermost lower Campanian – lower upper Campanian interval (Christensen, 1975).

## 3. Localities

### 3.1. Ivö Klack (*Blaksudden* in older literature)

This locality is an abandoned and partly overgrown kaolin and limestone quarry located on the northern slope of the Island of Ivö (Fig. 1). The uppermost lower Campanian succession comprises

**Table 1**  
Recorded number of vertebrate species per group from ten localities in the Kristianstad Basin.

Vertebrate groups/sites	Ivö Klack Rocky shore	Ugnsmunnarna Shoreface	Ignaberga Shoreface	Maltesholm Shoreface	Åsen Protected environment	Axeltorp Shoreface	Balsberg Shoreface	Oppmanna	Ivetofta Shoreface	Kjuge Shoreface	Total number of species
Sharks	23	24	28	12	34	–	–	–	–	–	38
Rays	1	1	2	–	5	–	–	–	–	–	6
Mosasaurs	6	3	3	1	6	2	1	Remains	Remains	–	6
Plesiosaurs	4	–	2	1	1	1	–	–	Remains	1	6
Crocodyles	1	–	–	–	–	–	–	–	–	–	1
Turtles	1	Remains	Remains	1	Remains	–	–	–	–	–	1
Aquatic birds	3	–	–	–	–	–	–	–	–	–	3
Dinosaurs	–	–	–	–	1	–	–	–	–	–	1
Total number of species	39	28	35	15	47	3	1	–	–	1	62

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