= Dromaeosauroides =

Dromaeosauroides is a genus of dromaeosaurid theropod dinosaur from the Early Cretaceous of what is now Denmark . It was discovered in the Jydegaard Formation in Robbedale , on the island of Bornholm in the Baltic Sea . This is the only likely place for dinosaur remains to be discovered on Danish territory , since the Mesozoic deposits exposed in the rest of the country are marine . Dromaeosauroides is the first known dinosaur from this location , and the only one which has been scientifically named . It is one of the oldest known dromaeosaurs in the world , and the first known uncontested dromaeosaur from the Early Cretaceous of Europe .

It is known from two teeth , the first of which was found in 2000 and the second in 2008 . Based on the first tooth (the holotype) , the genus and species Dromaeosauroides bornholmensis was named in 2003 . The genus name means " Dromaeosaurus @-@ like " , due to the similarity to the teeth of that genus , and the species name means " from Bornholm " . After this discovery , remains and tracks of more dinosaurs were found in several formations on Bornholm . Some teeth from the United Kingdom that have been referred to the genus Nuthetes may also belong to this animal . Coprolites containing fish remains found in the Jydegaard Formation may belong to Dromaeosauroides .

The holotype tooth is 21 @.@ 7 millimetres (0 @.@ 85 in) long , and the second tooth is 15 millimetres (0 @.@ 59 in) . They are curved and finely serrated . In life , Dromaeosauroides would have been 3 to 4 metres (10 to 10 ft) in length , and weighed about 40 kilograms (88 lb) . As a dromaeosaur it would have been feathered , and had a large sickle claw on its feet like its relatives Dromaeosaurus and Deinonychus . It lived in a coastal lagoon environment with sauropods , as evidenced by a possible titanosaur tooth .

= = Discovery and naming = =

Few dinosaur remains have been found in Scandinavia . The mainland of western Denmark is an unlikely region to find dinosaur remains , since the Mesozoic sediments there are marine Maastrichtian chalk . Fossils of non @-@ dinosaurian marine animals , including mosasaurs and plesiosaurs , have been found in these deposits . Mesozoic deposits in Scania , Sweden , are much richer in fossils , including those of dinosaurs . The Danish island of Bornholm in the Baltic Sea was part of the same land mass as Scania (the Scandinavian @-@ Russian continent) , and has a similar geology . The southwestern part of the island is the only place in Denmark which has yielded dinosaur remains .

During the 1990s , the Fossil Project (disbanded in 2005) was formed by a group of unemployed people who received funding from Denmark and the EEC to maintain geological sites on Bornholm . One of these , " Carl Nielsen 's sandpit " in the Robbedale valley (not to be confused with the Robbedale Formation , where no vertebrate remains have been found) , is part of the Jydegaard Formation . This formation is 140 million years old , dating to the Late Berriasian (or Ryazanian) stage of the Early Cretaceous period . The Fossil Project sifted sand at these sites in cooperation with the NaturBornholm interpretation centre , which exhibited the fossils discovered . In September 2000 , Danish palaeontologists Per Christiansen and Niels Bonde taught a field course at the site , " The Hunt for Danish Dinosaurs " . During the course , geology student Eliza Jarl Estrup found a theropod tooth , the first dinosaur discovered on Danish territory , and the find was recorded by a local television station .

The tooth was presented at the 45th annual meeting of the Palaeontological Association in 2001 , and identified as a dromaeosaur . In 2003 the tooth (MGUH 27218 / DK 315) was made the holotype specimen of Dromaeosauroides bornholmensis ? named and described by Christiansen and Bonde . The genus name combines Dromaeosaurus with the Greek -ides (" in the form of ") , referring to the resemblance between the teeth of the taxa . The specific name refers to Bornholm . Bonde and Christiansen had expected the first Danish dinosaur remains to be teeth of herbivorous dinosaurs such as hypsilophodonts or Iguanodon , and were surprised to find a dromaeosaur tooth instead , since these are rare in Early Cretaceous formations ; herbivores would have been more

abundant than carnivores . Because the dromaeosaur seems to have been large , they expected that resilient bones , such as claws , might be found in the future . The palaeontologists did not expect bones of larger dinosaurs to be discovered in the formation (since these would most likely have been found when the sand was commercially exploited) , but hoped the remains of a Mesozoic mammal would be found . The holotype tooth has been illustrated in several books and research articles . It was certified " Danekræ " (" Danish creature " , according to a 1990 Danish museum law securing important fossils) when its scientific importance was evaluated by the Geological Museum in Copenhagen .

In late summer 2008 , ranger Jens Kofoed found a second dromaeosaurid tooth . This specimen (DK 559) was found in the same location , and later assigned to D. bornholmensis as well . Kofoed explained that the finds were surprising because people had been unsuccessfully searching for dinosaur remains in Denmark for years , and it was like finding a " needle in a haystack " . In a press release , the second dromaeosaur tooth was also certified Danekræ by the Natural History Museum of Denmark , which compared the animal to the raptors in Jurassic Park , noting that the animals , unlike the film 's raptors , would have been feathered .

Since the discovery of Dromaeosauroides , evidence of more dinosaurs has been found on Bornholm . In 2002 , a tooth thought to belong to a juvenile titanosaurian sauropod was found in the Jydegaard Formation . Footprints of a sauropod and a thyreophoran were reported from the Middle Jurassic Bagå Formation in 2005 . Small dromaeosaur and indeterminate maniraptoran teeth from the Early Cretaceous Rabekke Formation were reported in 2008 , and sauropod tracks were also reported from the formation that year . In 2011 , footprints of a sauropod , a thyreophoran and a theropod were reported from the Bagå Formation . Lower Jurassic tracks reported form the Rønne Formation on Bornholm in 2014 are the earliest evidence of dinosaur activity in Denmark . A tooth from the multituberculate Sunnyodon was found in the Rabekke Formation in 2004 , making it the first known Danish and Scandinavian Mesozoic mammal .

In 2012 , Jesper Milàn and colleagues described two coprolites (fossilised faeces) containing fish scales and bones . They were found in the Jydegaard Formation , the first such fossils found in Danish continental Mesozoic deposits . Although the producer of these faeces cannot be identified with certainty , marine turtles and dromaeosaurids such as Dromaeosauroides are the most likely candidates .

= = Description = =

Features used to identify fossil theropod teeth include size , proportion , curvature of the crown and the morphology and number of denticles (serrations) . The holotype of D. bornholmensis is a tooth crown 21 @.@ 7 millimetres (0 @.@ 85 in) long , 9 @.@ 7 millimetres (0 @.@ 38 in) from front to back and 6 @.@ 6 millimetres (0 @.@ 26 in) wide at the base . The front part of the tooth was worn , indicating that it was shed when the animal was alive . It was further affected by taphonomic wear ; the base of the tooth is irregular , so it may have been slightly longer in life . The curvature and length of the holotype tooth and the length of its hindmost cutting edge (carina) indicates it was in the front of the jaw .

The tooth is recurved with a backward bend , and is oval in cross @-@ section . Its front and back cutting edges are finely serrated , extending two @-@ thirds down each edge . There are six denticles per millimeter (0 @.@ 04 in) , and each denticle is square and chiseled . The overall form of the tooth , its width and shape in cross @-@ section and its curvature resemble those in the maxilla (upper jawbone) and mandible of the species Dromaeosaurus albertensis from North America . Blood grooves are indistinct or absent , also similar to Dromaeosaurus , and differing from members of the Velociraptorinae subfamily . Dromaeosauroides differs from Dromaeosaurus in that the cutting edge at the front side is further from the middle of the tooth . Although the tooth is larger and the denticles similar , each denticle was smaller than those of Dromaeosaurus , which had only 13 ? 20 denticles per 5 millimetres (0 @.@ 20 in) , instead of Dromaeosauroides ' 30 . The second known tooth is smaller ? 15 millimetres (0 @.@ 59 in) ? with the same features as the holotype .

The holotype tooth is roughly 25 percent larger than equivalent Dromaeosaurus teeth , from which

a body length of 3 metres (120 in) or more was estimated for Dromaeosauroides ; it may have been as long as 3 to 4 metres (9 @.@ 8 to 13 @.@ 1 ft) . In an interview , Christiansen estimated its skull to be 35 centimetres (14 in) long and the animal 's weight 40 kilograms (88 lb) ; a Bengal tiger of the same length would weigh 150 to 180 kilograms (330 to 400 lb) by comparison . As a dromaeosaur , Dromaeosauroides would have had a large sickle claw on its highly mobile second toe , like its relatives Dromaeosaurus , Velociraptor and Deinonychus . This group is closely related to birds , and the NaturBornholm interpretive centre houses a roughly life @-@ sized sculpture of Dromaeosauroides covered in feathers . Later Chinese finds of well @-@ preserved feathered dromaeosaurs indicate that the sculpture should have more and longer feathers to be accurate . Although some smaller dromaeosaurs may have been able to fly , flight was unlikely for an animal the size of Dromaeosauroides .

= = Classification = =

Several features of the tooth are only known from members of the family Dromaeosauridae of theropod dinosaurs . Dromaeosauroides was classified as a member of the Dromaeosaurinae subfamily within the Dromaeosauridae , due to its similarity to Dromaeosaurus . Despite the resemblance , Dromaeosauroides is not considered part of that genus . It is unlikely that a genus would survive for 60 million years ; Dromaeosauroides lived during the Early Cretaceous , and Dromaeosaurus during the Late Cretaceous . The differences between their denticles also indicate they should be kept separate .

Dromaeosauroides is one of the oldest known dromaeosaurs in the world ; older remains , for the most part , have only tentatively been referred to Dromaeosauridae . Dromaeosauroides was the first definite dromaeosaurid known from the Early Cretaceous of Europe , depending on the identity of Nuthetes from the Middle Purbeck formation of the United Kingdom (which may slightly predate the Jydegaard Formation) . It is uncertain whether the juvenile holotype specimen of Nuthetes has dromaeosaurid characteristics . Large specimens referred to Nuthetes appear to belong to true dromaeosaurs , and may belong to Dromaeosauroides rather than Nuthetes . These specimens measure 15 to 18 millimetres (0 @.@ 59 to 0 @.@ 71 in) .

Dromaeosauroides has been considered an indeterminate dromaeosaur by some scientists . Bonde responded that since the teeth differ from those of other dromaeosaurs from the Early Cretaceous (and later members of the group , including Dromaeosaurus) , it should be considered valid . He also said that these scientists had provided incorrect information about the location , strata and age of the specimen , and that the circumstances of its naming were no different from those of other tooth @-@ based taxa .

= = Palaeoecology = =

Only a corner of the Jydegaard Formation is exposed today ; the remainder is overgrown . Jydegaard is part of the Nyker Group , which includes three formations (Rabekke , Robbedale and Jydegaard) ranging from the Berriasian to the Valanginian ages of the Early Cretaceous . Jydegaard consists of sediments deposited in a fresh @-@ to @-@ brackish lagoon facing a coastal strip . In addition to Dromaeosauroides and a possible titanosaur , remains of hybodont sharks , fish such as Lepidotes and Pleuropholis , turtles , lizards , the crocodile Pholidosaurus and thin bone fragments from birds or pterosaurs have been found in the deposit . The bivalve Neomiodon is found in abundance in the sediments below (the Neomiodon Bed) , indicating mass mortality , perhaps due to dinoflagellate toxins .

The fish and bivalves were found in clay which was probably a lagoon , and the dinosaurs and lizards in sand which probably was land , perhaps a beach ; turtles and crocodiles were found in both . Freshwater snails were found in clay that may have been shallow , drying lakes behind a sandy barrier between lagoon and sea , in a setting perhaps similar to the Florida Keys or the southwestern coast of Jutland . Dinosaurs may have fed there , based on the remains of plants and small land animals , and theropods may have hunted along the shore . Bornholm and Scania appear

to be the only places were remains of the Scandinavian @-@ Russian fauna of the Early Cretaceous can be found . Further investigations there may show whether this fauna has European or Asian affinities .

Based on possible dromaeosaur coprolites from the Jydegaard Formation , which contained scales of the fish Lepidotes , Milàn and colleagues speculated that some dromaeosaurids were able to catch fish with the enlarged sickle claw on the second digit of the foot , similar to the " spear fishing " that has been proposed for the theropod Baryonyx and its enlarged thumb claw . The larger of the two coprolites has evidence of coprophagous organisms .