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THE ULTIMATE 'IFFYOSAUR' – AN UNUSUAL ICHTHYOSAUR COMPOSITE CONTAINING BRITISH AND GERMAN MATERIAL OF DIFFERENT GEOLOGICAL STAGES

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ABSTRACT

Composite fossils can distort our evaluation of the morphology and variation of a species if unrecognised or misidentified. Many Early Jurassic ichthyosaurs collected during the 19th century have been identified as composites, but the problem is not restricted to historic specimens. More recently collected material, including some specimens for sale on the fossil market, are also composites or have been modified. One such specimen (RNHM F5672), said to be from the Lower Lias of Dorset, England, appears to be an almost complete skeleton, but comprises at least three individuals along with a carefully reconstructed and carved skull, and an apparent replica coracoid and forefin. The forefin, if a cast of a genuine specimen, shows a unique set of characters not previously observed in any ichthyosaur. Additionally, various caudal and dorsal vertebrae of indeterminate ichthyosaurs were pieced together to give the appearance of a complete, articulated vertebral column. One authentic block, containing the hindfins, the pelvic girdle and some ribs, can be assigned to *Ichthyosaurus conybeari*, based on characters of the hindfins. It comes from the Lower Jurassic (Sinemurian) of the Charmouth-Lyme Regis area, Dorset. The entire 'skeleton' is set into a large block of matrix which is from the Lower Jurassic (Toarcian) Posidonia Shale of Holzmaden, Germany. Therefore, this fossil represents a composite of material from multiple specimens belonging to perhaps two different genera, collected from two different countries and from two different geological stages.

INTRODUCTION

Ichthyosaurs were the first large extinct reptiles to be described in a modern paleontological study (Home, 1814), based on the discovery of a large ichthyosaur skull and partial skeleton found and collected by Mary and Joseph Anning in Lyme Regis, Dorset (Torrens, 1995). The subsequent description of the first ichthyosaur genus to be formally recognised, *Ichthyosaurus* (De la Beche and Conybeare, 1821), ignited a major interest in paleontology during the early-mid 19th century. However, ichthyosaurs were not necessarily always collected for their scientific significance, but instead for their display potential, and were often mounted in large wooden frames held together by plaster or cement. A forefin, hindfin, tail, or even a skull was sometimes appended to a skeleton to create a more complete specimen for display. This practice resulted in numerous ichthyosaur composites (McGowan, 1990; Buttler and Howe, 2002; Massare and Lomax, 2016b). Most historic composites were not necessarily done for deceptive purposes, but simply for a more display-worthy piece of 'art' (Massare and Lomax, 2016b), unlike today where, unfortunately, the commercial fossil market is populated with countless frauds and forgeries (Mateus et al., 2008).

Lower Jurassic deposits in the UK, notably from the coastal exposures in the Charmouth-Lyme Regis area, Dorset, and from the quarries in Street and surrounding areas in Somerset, have yielded thousands of ichthyosaurs, ranging from isolated bones to complete skeletons. Many nearly complete or complete historic specimens have been found to be composites (McGowan, 1990; Massare and Lomax, 2014, 2016b) or show some form of modification (e.g., reconstruction of the rostrum, Massare and Lomax, 2016; Maxwell and Cortés, 2020). Such examples are sometimes found during conservation, when old plaster filler has begun to crack and break apart (e.g., Buttler and Howe, 2002). Similarly, thousands of ichthyosaurs have been collected from the Posidonia Shale quarries of Holzmaden and surrounding areas in Germany, where many have been found to be composites or have modifications (e.g., see discussion in Maisch, 1998; Maisch, 2008; M. Maisch, pers. comm., DRL 2021). One well-known example even deceived the then partially blind F. v. Huene who described a small individual as a juvenile ichthyosaur (Huene, 1966), which was later shown to be an entirely carved forgery (Wild, 1976; Maisch, 1998).

Recently, there has been an increase in research on ichthyosaurs, with new discoveries made in the field and through the re-examination of historic specimens held in museum collections. However, with so many composite or modified ichthyosaur specimens, this generates a problem (Maisch, 1998). A good composite, "enhanced", or fake specimen can confuse even an experienced researcher, leading to misidentifications and wrong information in the published literature.

In January 2017, the senior author (DRL) visited the collections of the State Museum of Natural History in Stuttgart and examined a replica ichthyosaur forefin and hindfin (SMNS 56841). The associated label stated that the original belonged to a specimen of *Ichthyosaurus*, specifically *Ichthyosaurus* cf. *tenuirostris* (now *Leptonectes tenuirostris*, assigned by McGowan, 1996) from the Lower Lias of Dorset, England, held in the collection of the Reutlingen Natural History Museum. The RNHM donated the replicas to the SMNS in 1990. The forefin is unusual (see below), and so examining the original was of interest.

Initially, a photograph of the specimen (RNHM F5672) was kindly sent to DRL by Dr. Günter Wahlefeld, a curator at the RNHM. However, upon observation, the skull and parts of the axial skeleton looked suspicious, and it was impossible to determine the details of some of the more potentially significant features, such as the forefin. Therefore, in March 2017, DRL and SS visited the RNHM to examine the specimen.

In this study, we describe this unusual composite ichthyosaur (RNHM F5672). It was sold in 1984 to the Reutlingen Natural History Museum (RNHM), Germany, as a genuine, complete ichthyosaur (Figure 1). The specimen is important because the composite/fake portions have been carefully pieced together so that it would be mistaken for a genuine specimen. Our work illustrates how a close examination of a specimen can find evidence of a composite or modified specimen and illustrates that at least portions of such fossils can be scientifically important.

Institutional abbreviations—CAMSM: Sedgwick Museum, Cambridge University, Cambridge, UK; **OUMNH**: Oxford University Museum of Natural History, Oxford, UK; **RNHM**: Naturkundemuseum Reutlingen, Reutlingen, Germany; **SMNS**: Staatliches Museum für Naturkunde, Stuttgart, Germany.

MATRIX AND AGE

There is a distinct difference in color between the matrix containing the hindfins and pelvis and the matrix surrounding the entire specimen. The color of the former is a much lighter, bluish-grey whereas the latter is much darker, almost black. The obvious difference in contrast is best observed at the distal end of the hindfins. This difference, coupled with the identification of the hindfin as *Ichthyosaurus conybeari* (see below), a rare species known almost exclusively from the Lower Jurassic (upper Hettangian to lower Pliensbachian) of Charmouth-Lyme Regis, Dorset (Massare and Lomax, 2016a), confirms the pelvis-hindfin block derives from this location where fossils are typically found in a greyish blue mudstone matrix, similar to that seen here. Most importantly, an ammonite is embedded in the matrix (Figure 2A) adjacent to the pelvis. Based on morphology and preservation, it is likely an *Asteroceras* ammonite form that is known from the Upper Sinemurian Obtusum Chronozone, Stellare Subchronozone (beds 84a-89 of Lang and Spath, 1926) of the Black Ven Marl Member, Charmouth Mudstone Formation at Charmouth, Dorset (P.G. Davis and M. Edmunds, pers. comm., DRL, 2021).

The matrix surrounding the rest of the skeleton is from the Posidonia Shale (Posidonienschiefer) and is thus Toarcian in age. This is based on the identification of an ammonite imbedded in the surrounding darker matrix, immediately posterior to the hindfin block (Figure 2B), as well as our first-hand knowledge of ichthyosaur specimens from the Posidonia Shale. The preservation of the ammonite, along with the surrounding sediment, are typical of Holzmaden specimens (M. Maisch, pers. comm., DRL, 2021). More specifically, this is a small, immature hildoceratid ammonite, perhaps an *Hildaites*-like form or *Harpoceras serpentinum*, which confirms this matrix block is from somewhere in the Middle Posidonia Shale (M. Maisch, pers. comm., DRL, 2021).

A third ammonite is positioned immediately posterior to the skull, but appears to be set into, or at least surrounded by, plaster rather than matrix (Figure 2C). The morphology does not match any of the more typical specimens found at Holzmaden (M. Maisch, pers. comm. DRL, 2021) and again based on morphology and preservation, it is similar to *Caenisites* from Charmouth, which would place it in the Lower Sinemurian Turneri Chronozone (beds 73 – 81 of Lang et al., 1923 and Lang and Spath, 1926) of the Shales with Beef and Black Ven Marl Members, Charmouth Mudstone Formation, Dorset (P.G. Davis, pers. comm. DRL, 2021). In any event, as this ammonite is not in its original matrix, it does not offer any reliable stratigraphic information about the studied specimen. It also contradicts the stratigraphic details of the ammonite found in situ on the hindfin-pelvis block.

DESCRIPTION AND COMPARISON

RNHM F5672 comprises a real hindfin and pelvic material collected from the Charmouth-Lyme Regis area, Dorset (specifically Sinemurian in age), real caudal and dorsal vertebrae from an indeterminate location (including some caudal vertebrae which have been placed as dorsal vertebrae), an apparent replica forefin and coracoid from an unknown specimen (and age), and a forged skull with some real teeth and set in a rock matrix (Figure 1). Together, this material gives the appearance of a 'complete skeleton', which is set entirely into a matrix block of Posidonia Shale (Toarcian age) from Holzmaden (or surrounding area), Germany. To clarify the description, the specimen is discussed in sub-sections below.

Skull (Forgery)—The skull is entirely fake and carved from plaster (Figure 3A). However, detail in the carving of some elements appears realistic and

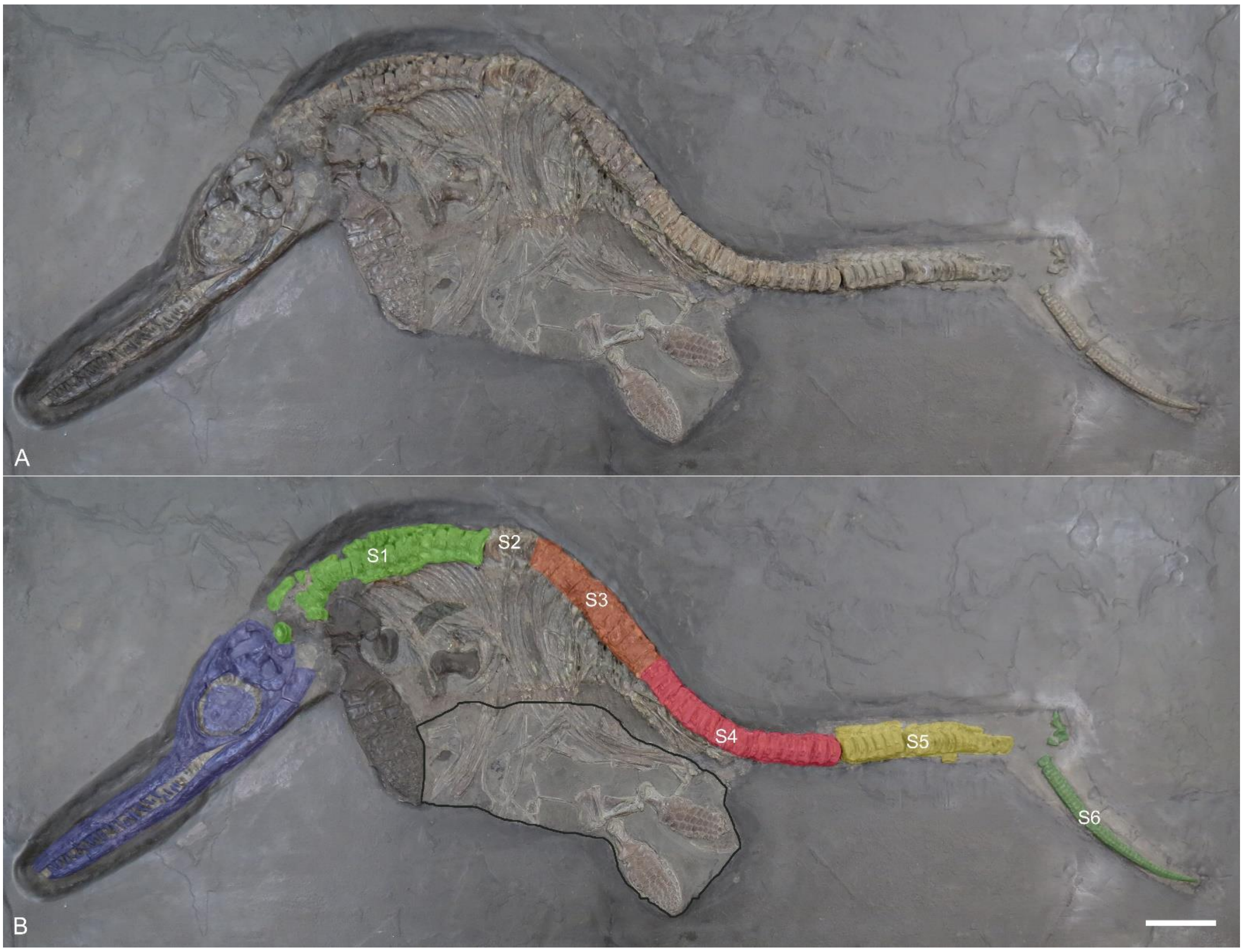

FIGURE 1: RNHM F5672, a composite ichthyosaur skeleton set into a large block of Posidonia Shale matrix from the Holzmaden area, Germany. (A) Unaltered photo, (B) illustration of the individual sections labelled as segments (S1-S6). The skull (blue) is a forgery, but includes some poorly preserved real teeth. The vertebral column is largely genuine and composed of various sections from different individuals. Color coding of the vertebral column (from left to right) bright green (S1): caudals belonging to one individual; no color (S2); four associated centra that are connected with ribs and appear embedded in matrix, but might belong to the previous set of vertebrae; orange (S3): mix of dorsal and caudal vertebrae with a supposed transition from dorsals to caudals, probably from two individuals; red (S4): block showing the transition from dorsals to caudals from one individual; yellow (S5): set of caudal vertebrae; dark green (S6): string of distal caudals probably belonging to one individual. The forefin and pectoral girdle (dark grey) are made of plaster. The encircled block contains the authentic hindfins, pelvic elements and some ribs belonging to *Ichthyosaurus conybeari* from the Upper Sinemurian (Lower Jurassic) of Lyme Regis-Charmouth, England. Scale bar = 10 cm.

shows that time and effort was put into constructing the skull fairly accurately. Portions of the skull have multiple scalpel lines extending across it, which may have been intentional to provide 'detail' in the surface of the 'bones', but which do not match what is expected for an authentic specimen. The shape and structure of the skull suggest it was probably based on an original ichthyosaur skull, as the large eye and long snout are somewhat reminiscent of the Lower Jurassic genus *Leptonectes* (McGowan, 1989; 1996), known primarily from Dorset and Somerset, England, and which would match the initial identification written on the label of the SMNS replica.

The orbital region is particularly well done. Some of the 'bones' appear discernible, including the lacrimal, prefrontal, jugal with an almost 90-degree bend in the dorsal ramus, and postfrontal that occupies almost all of the dorsal margin of the orbit. The sclerotic plates are also shaped appropriately. The 'bones' in the post-orbital region of the skull, however, are not as well defined. There are two openings that are surrounded by 'bone', one of which apparently indicates the upper temporal fenestra, but the other is a mystery and clearly a mistake. A circular 'blob' of plaster is probably meant to indicate the basioccipital condyle, but there is no detail or structure. Portions of the skull and mandible show cracks that expose the internal structure of the plaster, although care has been taken to follow the anatomy of the lower jaw, which includes a distinct groove (representing the surangular foramen). Notably, there is a clear difference in 'bone' color approximately 10 cm posterior from the tip of the snout, which might suggest that different paint had been used. Alternatively, it is possible that the creator was (unknowingly?) emulating other modified specimens

FIGURE 2: Ammonites associated with RNHM F5672. (A) A juvenile *Asteroceras* from the Upper Sinemurian Charmouth Mudstone Formation, Charmouth, Dorset. (B) An immature hildoceratid ammonite whose preservation and morphology are consistent with typical Holzmaden ammonites. (C) A probable *Caenisites* from the Lower Sinemurian Charmouth Mudstone Formation, Charmouth, Dorset. See text for more specific details on stratigraphy. Note, A and B are in *situ* whereas C is surrounded by plaster, into which it appears to be set. Scale bars = 1 cm.

in which the anterior portion of the snout had been added, thus showing a darker or different colored section. This type of modification is often found in restored specimens (e.g., *Hauffiopteryx*, Maxwell and Cortés, 2020, fig 9D; *Ichthyosaurus*, Massare and Lomax, 2016a, fig 2). Almost all of the teeth, except for a few poorly preserved original teeth under the ‘maxilla’, are made of plaster. The detail appears somewhat anatomically accurate, which might indicate that some are copies of real teeth positioned at different angles.

Forefin and Coracoid (Possible Cast)—The forefin and coracoid (Figures 3B-C) are made of plaster and might be replicas of real specimens. The forefin morphology is unusual and would probably represent something new if found to be from an actual specimen. Admittedly, the possibility remains that the forefin may have been modified, carved, cast, or simply pieced together from other bones prior to it being replicated and added to this specimen, thus making the forefin morphology even more unreliable (Figure 3B). Another possibility is that the fin was entirely fabricated based on comparisons with the morphology of the authentic hindfins, which it closely resembles (i.e., the creator simply sculpted a larger version of the hindfin to use as a forefin). Nevertheless, a brief description is included below.

The forefin is presented as a left in dorsal view, but there is no prominent dorsal process in the humerus. The proximal end is not robust, the shaft is very narrow, and the distal end is much wider than the proximal end. This shape, especially in being much more slender and with a smaller proximal region, is somewhat femur-like, which could suggest this is a femur set in the place of a humerus (the reverse has been observed in a composite specimen of *Ichthyosaurus* from the Lower Jurassic of Lyme Regis, Dorset, DRL pers. obs. OUMNH J.13800) or an entire hindfin set in place of a forefin; however, the latter is unlikely due to the morphology of the other elements in the forefin.

The forefin has three primary digits (II, III, and IV) and three elements are present in the distal carpal (third) row. Similar morphology is seen in other Lower Jurassic taxa, such as *Temnodontosaurus*, *Excalibosaurus* and *Protoichthyosaurus* (Motani, 1999; McGowan and Motani, 2003; Lomax et al., 2017). However, in the former two taxa, the number of elements in the third row indicate the fixed number of primary digits in the forefin. In the studied specimen, however, there is a very small anterior bifurcation from distal carpal 2 in the metacarpal (fourth) row, thus bringing the total digit count to four. The only ichthyosaur having three elements in the third row with a bifurcation of distal carpal 2 is *Protoichthyosaurus* (Appleby, 1979; Lomax et al. 2017). In *Protoichthyosaurus*, however, the first element of the bifurcation is always proximodistally long, hexagonal and is always positioned between distal carpal 2 and distal carpal 3 where it almost separates them. This is not the same condition as in the studied specimen. There is also a distal bifurcation in the forefin of *Protoichthyosaurus*, leading to a total of five digits (including the two bifurcated digits), whereas there appears to be no distal bifurcation in the studied specimen. A posterior accessory digit is also located at the level of the distal carpal row. A posterior accessory digit is always present in *Protoichthyosaurus* and occasionally in specimens of *Ichthyosaurus* (Lomax et al., 2017). Similarly, specimens of *Stenopterygius* occasionally have a posterior accessory digit, which may provide further evidence for modification or ‘fancification’ of the forefin beyond a standard morphology.

The radius, radiale, and distal carpal 2 are all notched. A notched radius occurs in several taxa such as *Leptonectes tenuirostris* and *Stenopterygius* spp. (Motani, 1999; McGowan and Motani, 2003; Maxwell, 2012). Notching of other elements in the forefin occurs in other Lower Jurassic genera too, such as *Temnodontosaurus*, *Ichthyosaurus*, and *Stenopterygius* (Motani, 1999; Massare and Lomax,

FIGURE 3: RNHM F5672, close-ups of the faked or modelled elements. (A). Skull. (B) Forefin, note the notched 'radius'. As discussed in the text, the forefin might be a cast of an original specimen but it seems unlikely. (C) Coracoid. Scale bars = 5 cm.

2018; Maxwell, 2012). One element of the bifurcated digit at the third phalangeal row may be a natural notch or could be damaged. It should also be noted that the morphology of the forefin, with three elements in the third row and the presence of an anterior bifurcation, is a morphology observed in the hindfin of some species of *Ichthyosaurus*, but the bifurcation is never reduced to a small digit as in this specimen (Massare and Lomax, 2019). The unusual forefin structure might suggest something new, or that the entire forefin has been reconstructed. The latter seems most likely.

The coracoid (Figure 3C) has both a well-defined anterior and posterior notch which is similar to *Ichthyosaurus* and *Protoichthyosaurus* (Massare and Lomax, 2018; Lomax et al. 2017). However, the posterior notch is much smaller and more enclosed than the anterior, a morphology somewhat similar to the coracoid of CAMSM J35183, an example of *Ichthyosaurus* (DRL pers. obs.).

Vertebral Column (Real, but Composite)— The vertebral column is mainly composed of caudal vertebrae of an unknown number of individuals and taxa (Figure 4). Given the lack of data for the specimen, and the lack of any obvious defining characteristics of the vertebrae, we are unsure about their provenance or specific identification. However, considering that the matrix block the skeleton has been purposely set into comes from the Holzmaden area (Posidonia Shale), and given that *Stenopterygius* is common at Holzmaden and the color of the vertebrae matches other bones from Holzmaden, it appears likely that they are from multiple individuals of *Stenopterygius* from this location. However, we cannot entirely exclude the possibility that they might derive from another ichthyosaur and locality. None of the vertebrae are part of the underlying matrix block; all seem to be set into the block of matrix.

We included a color coding in Figure 1 to illustrate the mix of vertebrae found on the specimen. The isolated centrum posterior to the skull probably does not belong to the rest of the vertebrae highlighted in green (Figure 1, S1), and it is sitting in plaster. The first string of vertebrae immediately posterior to the skull (Figure 1, S1, indicated in green) are caudals belonging to one individual (Figure 4A). At least four associated centra follow this string (Figure 1, S2, not color coded) might belong with the previous vertebrae, but some are associated with ribs and appear partly embedded in matrix or plaster, so they might be another set of centra from another individual. The next set of vertebrae (Figure 1, S3, indicated in orange) is a jumbled mix of dorsal and caudal vertebrae that show an apparent transition from double-headed ribs to single-headed ribs (i.e. from dorsals to caudals), perhaps composed of elements from two individuals, considering the mix of caudals and dorsals and the change in size. However, the following set of vertebrae (Figure 1, S4, indicated in red) are yet another block showing the transition from dorsals to caudals, this time possibly from a single individual (Figure 4B). The next set of vertebrae (Figure 1, S5, colored in yellow) form part of the proximal portion of the tail, once again representing a set of caudal vertebrae. The remaining distal caudals (Figure 1, S6, indicated in dark green, Figure 4C), could belong to the same specimen as the preceding caudals (in yellow), although this cannot be confirmed with certainty.

Hindfins and Pelvis (Real)—The hindfins and pelvis (Figure 5) are authentic and appear mostly complete. Whether they belong together might be questionable, based solely on the composite nature of the rest of the specimen. However, the proximity and contact of the pelvic bones with the hindfins suggest that they are from the same individual. The left hindfin (left on specimen) is in dorsal view and is the more complete of the two.

The femur is long and narrow with a slightly expanded proximal end and widely expanded distal end which is noticeably much wider than the proximal. There are three primary digits (II, III, and IV) and a proximal and distal bifurcation which results in a total of five digits, a morphology that is unique to *Ichthyosaurus* (Massare and Lomax, 2019). The left hindfin has four elements in the third row, resulting from the anterior digital bifurcation, but the right fin (right on specimen) has three elements in the third row and a bifurcation in the fourth row. This bifurcation, however, probably occurred in the third row because a circular space for a phalanx is present in the matrix and suggests the element has since been lost. Four elements in the third row is a morphology found in all species of *Ichthyosaurus* (but see discussion of hindfin morphotypes in Massare and Lomax, 2019). A posterior accessory digit is also present on both hindfins at the level of the fourth row.

The tibia and tarsal 2 are notched. In *Ichthyosaurus*, a notched tibia is only found in one species, *Ichthyosaurus conybeari*, where it is considered a unique character (Massare and Lomax, 2016a, 2018, 2019). The metatarsal is unnotched, but the next two distal elements appear to be notched on both fins, although this could be due to damage or overpreparation. In addition, the fibula is both proximodistally and anteroposteriorly larger than the tibia, which is also unique to *I. conybeari* (Massare and Lomax, 2016a, 2019). Based on the morphology discussed here, we assign the hindfins to *I. conybeari*.

Articulated pubes, ischia and part of one ilium are preserved. As in all species of *Ichthyosaurus*, the pubis and ischium are not fused (Massare and Lomax, 2018). The pubis is marginally shorter than the ischium and the proximal end and shaft are narrow, but the distal end is flared and somewhat 'fan' shaped. The ischium is long and narrow with a slightly robust proximal and distal end. The morphology of both elements is typical of *Ichthyosaurus* (Massare and Lomax, 2018).

However, if the pelvis definitely belongs with the hindfins, then this may have wider implications. Massare and Lomax (2016a) revised the species *I. conybeari* with the description of new material. This included the first identification of a pelvis in *I. conybeari*, in which the ischium is much shorter than the pubis, a condition that is not present in the studied specimen. This suggests that the unusual morphology reported by Massare and Lomax (2016a) could be related to sexual dimorphism, ontogeny, pathology, or simply that the pelvis of the specimen studied herein has been added to the hindfins. The latter seems unlikely due to the similar preservation and the proximity of the pelvis to the hindfins. However, a crack in the matrix extends along the posterior edge of the left femur, fibula, and calcaneum. A similar crack occurs along the anterior edge of the right hindfin.

FIGURE 4: RNHM F5672, close-ups of the axial skeleton. (A) Set of caudal vertebrae placed immediately after the skull. (B) Mixed vertebrae, from left to right, showing the transition from dorsals (with diapophysis and parapophysis for rib attachment) to caudals (showing single headed rib facet) and then from caudals to dorsals in reverse. (C) Distal-most caudals. All vertebrae are genuine and possibly from ichthyosaur specimens from Holzmaden (Germany). See text for more details. Scale bars = 5 cm.

FIGURE 5: RNHM F5672, hindfin and pelvic elements of *Ichthyosaurus conybeari* from the Lower Jurassic (Sinemurian) of Lyme Regis-Charmouth, Dorset, England. Abbreviations: fe –femur, fi –fibula, il –ilium, is –ischium, ti –tibia, pu –pubis. Scale bar = 5 cm.

This could suggest the hindfins have been reset into the matrix.

DISCUSSION

Making composite fossils is not a new practice, as fossil collectors, sellers, and museums have produced composites for centuries (Corbacho and Sendino, 2012). The distinction between a composite and a fake lies in transparency of context. Where a museum may explicitly state that a mounted specimen is a combination of elements from several individuals of the same species, it would never unknowingly display a composite with the intention of passing it off as a genuine fossil.

For those who seek only profit, it is to the benefit of the seller to provide potential buyers with specimens that appear complete. As fossils are rare and finite resources, the more complete a specimen appears, the more a potential buyer is willing to pay for it. Over the past several decades, there has been an apparent increase in the commercialization of fossils, perhaps driven in part by the high-dollar auctions of specimens of *Tyrannosaurus rex* ('SUE', which sold for $8.36 million in 1997; and more recently 'Stan', which sold for $31.8 million in 2020; Vogel, 2020), or by the ease of listing fossils for sale on the internet. Of course, the sale of fossils is nothing new (Corbacho and Sendino, 2012). If best practices are followed and scientifically significant fossils are legally excavated and sold to an institution so that they can be studied in perpetuity, then science benefits. Unfortunately, there will always be unscrupulous individuals that create, misrepresent, and sell fakes and 'enhanced' specimens to make a bigger profit. For example, a seemingly 'complete' ichthyosaur like that described herein will always sell for more money than a single authentic fin (Maisch, 1998).

Fossil forgery can sometimes be extremely difficult to distinguish, even to the trained eye. Credible institutions and researchers have unwittingly purchased forgeries or included them in their data sets (Rowe et al., 2001). Perhaps the most infamous fossil fake in recent years is "Archaeoraptor liaoningensis", a supposed "missing link" that purportedly revealed new insight into the evolutionary history between dinosaurs and modern birds. The "Archaeoraptor" forgery was created by layering pieces of fine-grained shale with authentic elements from at least two different species. Additionally, the two specimens were each also new species, but were combined in favor of higher commercial value. Both were nearly lost to science as a result (Rowe et al., 2001). Although "Archaeoraptor" caused confusion and controversy at the time, today it provides a prime example of the importance of verifying the authenticity of potentially significant fossils.

To uncover any further details of the studied specimen (RNHM F5672), DRL tracked down and reached out to the original seller, who will remain anonymous. The seller confirmed that the fossil had been reconstructed but stated that "…we have annihilated the Reutlingen papers ca. 2 years ago" (pers. comm., DRL, 2018). Unfortunately, this means important details about the reconstruction process and exactly when and where the various skeletal elements were found are now lost.

As illustrated by Massare and Lomax (2016b), not all ichthyosaur composites should be discounted as "bad" or scientifically unusable. With a careful assessment using appropriate methods, valid information can be obtained from the authentic portions of composite specimens. Even though RNHM F5672 is a composite that was largely faked, the rare *Ichthyosaurus conybeari* block (comprising the hindfins, pelvis and some ribs) provides useful information.

Now that the components of RNHM F5672 are understood, it can serve as a valuable teaching specimen. Thus far, it has contributed to our knowledge of fossil fakery techniques. If placed on exhibit in a museum, such a specimen could help educate the public about the ethical issues of fossil forgery and commercial collecting, as well as the techniques used to better detect fakes. We hope that with proper analysis and documentation of fossil specimens, museum professionals and visiting researchers will not be deceived by fakes or disguised composites, and that this 'Frankenstein' ichthyosaur will help educate the public about the world of fossil fakes and forgeries.

CONCLUSIONS

The specimen described herein (RNHM F5672) is unique for several reasons. It is, to our knowledge, the first ichthyosaur composite comprised of material from two different countries: Charmouth-Lyme Regis, Dorset, England, and Holzmaden, Germany. It is also the first documented composite ichthyosaur to be made up of specimens from two different geological stages: the Dorset specimen is from the Sinemurian whereas the German material is Toarcian. The skull is entirely carved from plaster, although parts might be based upon real specimens. Likewise, the forefin and coracoid are possibly replicas of an original specimen.

The only scientifically significant portion of the skeleton is the block containing the hindfins and pelvic bones, which comes from the Charmouth-Lyme Regis area in Dorset, England and can be readily assigned to *Ichthyosaurus*. Within the genus *Ichthyosaurus*, the presence of a notched tibia, along with a fibula that is both proximodistally and anteroposteriorly longer than the tibia, are characters found only in *Ichthyosaurus conybeari*, a rare species known from just six confirmed specimens (Massare and Lomax, 2016a, 2019), although three others might belong to this species (see discussion in Massare and Lomax, 2019).

The ability to identify fake from real fossils in a single specimen is an important but sometimes difficult task. It is important to research the history of the specimen (if it exists) before describing unique morphological features or new geological information. In order for researchers to minimize future difficulties over publishing on 'Frankenstein' specimens, we recommend a healthy dose of scepticism and research into the history of a specimen prior to study. Overlooking the details and completeness of a specimen can lead to issues of credibility of researchers, institutions, and even of paleontology in general. Besides experience, new and improved non-destructive technologies, such as chemical analyses, X-ray or CT-scanning, and the analysis of fossils under UV light (e.g., Eklund et al., 2018), enable researchers to distinguish skeletal elements and the surrounding matrix as added, sculpted, or carved more easily than ever before.

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