sciendo
Austrian Journal of Earth Sciences | Vienna | 2025 | Volume 118 | 141–155 | DOI: 10.17738/ajes.2025.0008

A new nothosaurid taxon from the Middle Triassic of Carinthia, Austria

Nicole Klein[1*], Heinz Furrer[2], Claudia Dojen[3], Alexander Lukeneder[4] and Torsten M. Scheyer[2]

1) Staatliches Museum für Naturkunde, Stuttgart, Rosenstein 1, 70191 Stuttgart, Deutschland
2) Universität Zürich, Paläontologisches Institut, Karl-Schmid-Strasse 4, 8006 Zürich, Schweiz
3) Landesmuseum Kärnten Sammlungs- und Wissenschaftszentrum, Liberogasse 6, 9020 Klagenfurt, Austria
4) Naturhistorisches Museum Wien, Abteilung für Geologie und Paläontologie, Austria, A 1010 Wien, Austria
*) Corresponding author: nklein@posteo.de

Keywords: Austroalpine Drau Range, Jadersdorf, Fellbach Limestone, Eosauropterygia, new taxon, postcranial morphology

Abstract

Two recently excavated specimens of a medium-sized (up to 115 cm long) new nothosaurid taxon are described from a Middle Triassic locality in the Gailtal Alps (Austroalpine Drau Range) of Carinthia. The holotype is a complete and articulated specimen exposed in dorsal view. The referred specimen, also prepared in dorsal view, lacks the skull and is slightly smaller in overall body size. The new taxon shows an exclusive combination of morphological characters. It shares with nothosaurs the large upper temporal openings and anterolaterally expanded corners of the clavicle. Lariosaur affinities are the large number of carpalia and the configuration of the sacral region. Similarities with ceresiosaurs are the increased height of neural spines in the posterior neck and anterior trunk region, pending additionally the distinctiveness of ceresiosaurs and lariosaurs. Further on, its skull morphology, as far as sutures are discernible, shows a rectangular prefrontal that extends from the anteromedial orbital margin to the posterolateral margin of the external naris, which is a rather rare shape in nothosaurids. The morphology of the humerus and ulna as well as limb ratios are considered as autapomorphies, and a new taxon, *Carinthiasaurus kandutschi* gen. et sp. nov. is erected. Its phylogenetic relationships are however not tested due to the unclear status of *Ceresiosaurus* and the general ambiguous phylogenetic relationships within Nothosauridae, both awaiting a thorough revision.

1. Introduction

Sauropterygia is a diverse group of Mesozoic, secondary aquatic, marine reptiles. The main radiation of Triassic Sauropterygia was during the Middle Triassic in the western and eastern Tethys (Rieppel, 2000; Benton et al., 2014; Laboury et al., 2023). Both realms have yielded a diverse marine reptile fauna, which is partially connected to each other by some established phylogenetic relationships whereas others are unique for the respective region. In both realms, numerous specimens had been found and consist to a large degree of complete individuals (e.g., Meyer, 1847–55; Benton et al., 2014; Rieppel, 2019; Voeten et al., 2019; Klug et al., 2024). The western Tethyan realm is divided into two main sedimentary areas: the Germanic Basin, which represents an occasionally enclosed shallow epicontinental sea and the Alpine Triassic, of which the sediments are interpreted as a wide shallow marine platform with several small intraplatform basins, connected to the open sea (e.g., Furrer, 2004, 2019; Ziegler, 2005; Walter, 2007; Feist-Burkhardt et al., 2008; Klein et al., 2022a). Sauropterygia had been described from the Germanic Basin since the mid-19th century (e.g., Meyer, 1847–55) and from the Alpine Triassic since the 30ties of the 20th century (summarized in Klug et al., 2024). The classical division of Sauropterygia into variously armoured and durophagous Placodontia, and three groups with an elongated body form classically forming the Eosauropterygia (pachypleurosaurs, nothosaurs, pistosaurs) is largely based on material from the western Tethyan realm (summarized in Rieppel, 2000). The eastern Tethys has mainly in the last three decades produced a number of new eosauropterygian taxa (summarized in e.g., Hu et al., 2024). Some of these new descriptions show a mixture of pachypleurosaur and nothosaur features questioning the traditional classification of Rieppel (2000) (e.g., Liu et al., 2014; Li and Liu, 2020; Wang et al., 2022; Wolniewicz et al., 2023). In addition, new material from the western Tethys (e.g., Wachtler, 2018) has been unearthed and new taxa had been recently described (e.g., Renesto et al., 2014; Klein et al., 2022a). Some of these have recently been included for the first time in a revised and emended phylogenetic analysis (Hu et al., 2024). Although Hu et al. (2024) recovered the traditional classification with a monophyletic Pachypleurosauria and Nothosauroidea, taxonomy and phylogenetic relationships of taxa belonging formerly to Nothosauridae are still ambiguous.

1.1. The problematic status of Lariosaurus-Ceresiosaurus-Nothosaurus

The monophyly of the classically recognized Nothosauridae (*Nothosaurus* spp. and *Lariosaurus* spp.; sensu Rieppel, 2000) is in some of the newer phylogenetic analyses no longer supported (e.g., Liu et al., 2014; Hu et al., 2024). Additionally problematic is the status of *Lariosaurus balsami*, the type species of *Lariosaurus*, and the most common and most widespread taxon within *Lariosaurus* (Curioni, 1847; Rieppel, 1994). According to Rieppel (2000, p. 74) this "is the only one of all lariosaur species which lacks uniquely derived autapomorphies, and it has therefore to be considered a metaspecies sensu Gauthier et al. (1988; see also Archibald, 1994)". Further on, the status of the lariosaurid genus *Ceresiosaurus* Peyer (1931) is also not clear. According to Hänni (2004), *Ceresiosaurus* is valid containing two species, *C. calcagnii* and *C. lanzi*, whereas Rieppel (1998, 2000, 2007) found *Ceresiosaurus* to represent a junior synonym of *Lariosaurus*. In either case, the Nothosauridae clade is in need of revision, which is however beyond the scope of the current contribution.

1.2. Eosauropterygian remains from Carinthia

Nothosauroid remains from Carinthia have so far been identified as belonging to *Lariosaurus*, with the first fossil from this area having been originally named *Proneusticosaurus carinthiacus* by Arthaber (1924). This specimen consists of the posterior trunk and sacral region (Arthaber 1924, Fig. 34) and was later assigned to '*Lariosaurus* cf. *balsami* CURIONI' by Zapfe and König (1980, p.78). Two further specimens of *Lariosaurus* had been described and mentioned by Warch (1966, 1979, 1984). Zapfe and König (1980) mentioned specimen LMK5410 as '*Lariosaurus* (?) sp.', while Rieppel (1994) revised it as *Lariosaurus balsami*. Besides these lariosaur specimens, the pachypleurosaur *Neusticosaurus toeplitschi* (Nopsca, 1928; Rieppel, 1993; Tichy, 1998) had been described from Carinthia based on some incomplete specimens. In addition, Wachtler (2018) mentioned several newer specimens of pachypleurosaurs, coming from the same locality (i.e., Jadersdorf) as the here described nothosaurid.

Besides these finds from Carinthia, Middle Triassic (Ladinian) remains of another possible lariosaurid skeleton from Plattenbach of Bürserberg near Bludenz (Vorarlberg, Austria) had been originally described as *Rhaeticonia rothpletzi* by Broili (1927). This specimen is today considered lost (Rieppel, 2000). *Partanosaurus zitteli* Skuphos, 1893 was described from the Partnach Schichten (Ladinian) of Dalaas (Vorarlberg, Austria) but was later identified by Rieppel (1996) as junior synonym of *Simosaurus gaillardoti* Meyer, 1842.

Here we describe two specimens of Eosauropterygia, recently found in a locality north of the village Jadersdorf (see below). These two new specimens stand out due to their size from the lariosaur and pachypleurosaur material so far described from Carinthia, and we erect a new taxon for them.

2. Geology and stratigraphy

The here described specimens were excavated at the Schwarzwandgraben below the Großboden north to the village of Jadersdorf in the Gitschtal close to Hermagor (Carinthia, Austria) (referred to in the following as "Jadersdorf") (Fig. 1). The site belongs to the Gailtal Alps and the fossils have been found in Middle Triassic marine deposits of the Drau Range, classified as an Austroalpine tectonic unit of the Eastern Alps, situated today south of the Northern Calcareous Alps and north of the Southern Alps (Fig. 2). The Permian to Upper Triassic sediments of the Gailtal Alps/Drau Range are similar to both areas, but the names of the lithostratigraphic units were traditionally compared to the series of the Northern Calcareous Alps (Bechstädt, 1978).

The vertebrate remains from Jadersdorf, which include marine reptiles and bony fish fossils (e.g., Sieber, 1955; Bachmayer and Warch, 1959; Zapfe and König, 1980; Wachtler, 2018) have been collected in dark, finely laminated limestones, called "Partnach-Plattenkalk, Ladin" in the geological maps of Weissbriach and Hermagor (1:50 000, Geologische Bundesanstalt/GeoSphere; (https://www.geologie.ac.at/onlineshop/karten/geologische-karte-der-republik-oesterreich-150000). The last detailed analysis of the Triassic in the Gailtal Alps, with its stratigraphy, facies and palaeogeography was published by Bechstädt (1978), introducing also the lithostratigraphic name "Fellbacher Kalk" for the well-bedded Ladinian limestones, previously referred to as "Plattenkalk" or "Partnachkalk" (Bechstädt and Mostler, 1974, Fig. 2). As mentioned above, fossil reptile remains are known from several localities in the Gailtal Alps, all assigned to the "Partnach-Plattenkalk", i.e., Fellbach Limestone. The Fellbach Limestone is considered Ladinian in age in accordance with Bechstädt (1978), Warch (1984), and Tichy (1998). The Austrian Stratigraphic Chart 2004 (Sedimentary Successions) suggest "Fellbach-Formation" for the Ladinian sediments of the Lienzer Dolomiten (western Drau Range), however still use in the central Drau Range the term "Partnach-Schichten" for late Ladinian-early Carnian strata interbedded in the "Reifling-Formation", better known from the Northern Calcareous Alps. As there are strong differences to the definition of the Partnach Formation in the Northern Calcareous Alps (e.g., Tollmann, 1976), we use the name Fellbach Limestone here. A detailed geological description of the locality will be provided in a forthcoming publication.

3. Material and Methods

3.1. Material

One nearly complete and fully articulated specimen (designated holotype, repository number Nockalm 7030v), and one postcranial skeleton lacking the skull and the anterior cervicals as well as some distalmost phalanges (referred specimen, repository number Nockalm 7030n) are described. Both specimens are stored in the museum "Kärntens versteinerte Welten", Nockalmhof at the Nockalmstrasse, Carinthia, Austria) (referred to in the following as "Nockalm"). The Nockalm is accessible only during summer months due to weather conditions. A digital 3D model as well as a print of both specimens is available at the Landesmuseum für Kärnten, Klagenfurt, Österreich.

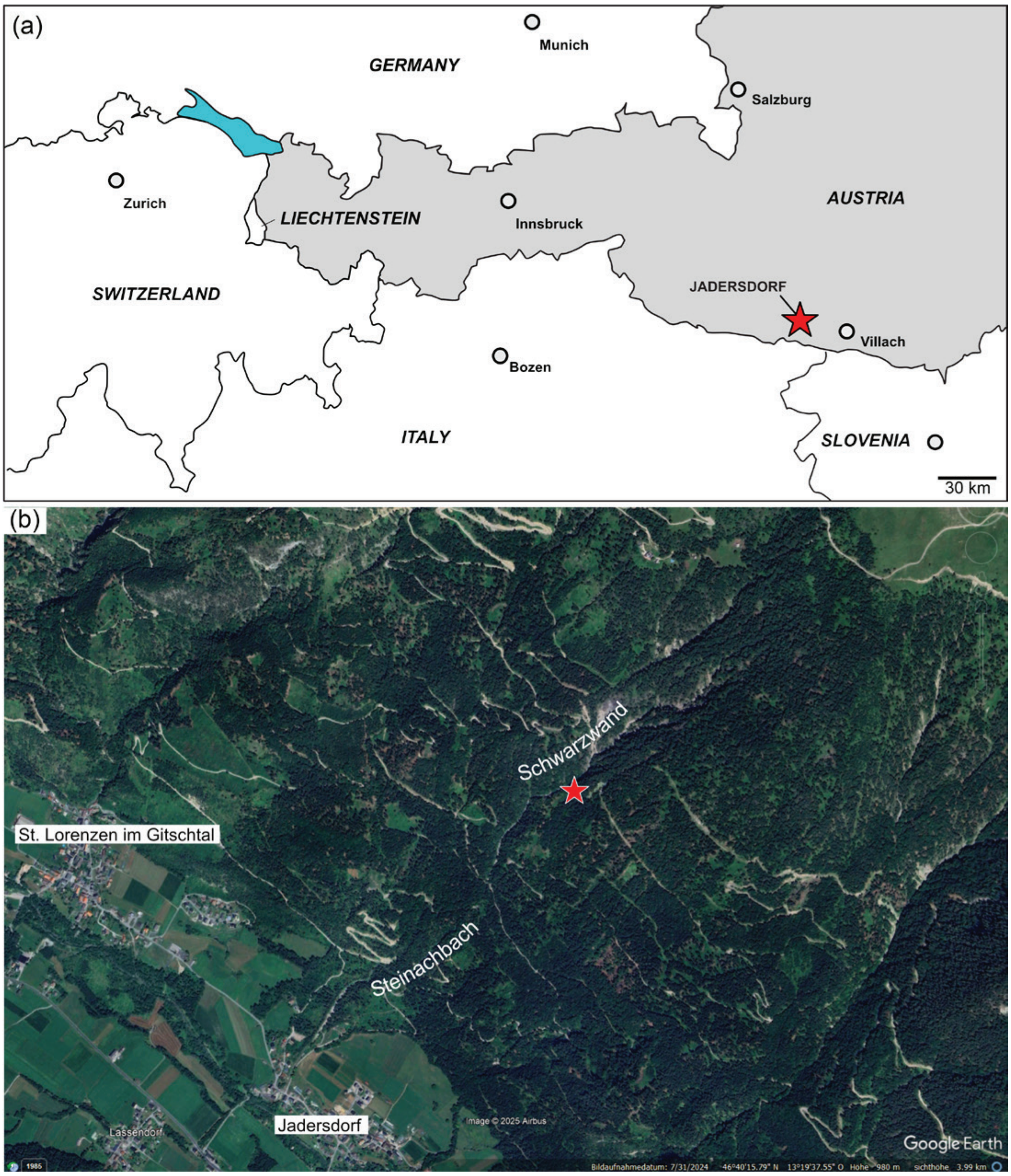

Figure 1: Geographical position of the locality Schwarzwandgraben north of Jadersdorf (Carinthia, Austria). **(a)** Map depicting the locality in a larger geographical context. **(b)** 3D landscape image of Jadersdorf area [downloaded from Google Earth Pro on February 11th 2025; imagery © 2025 Airbus.

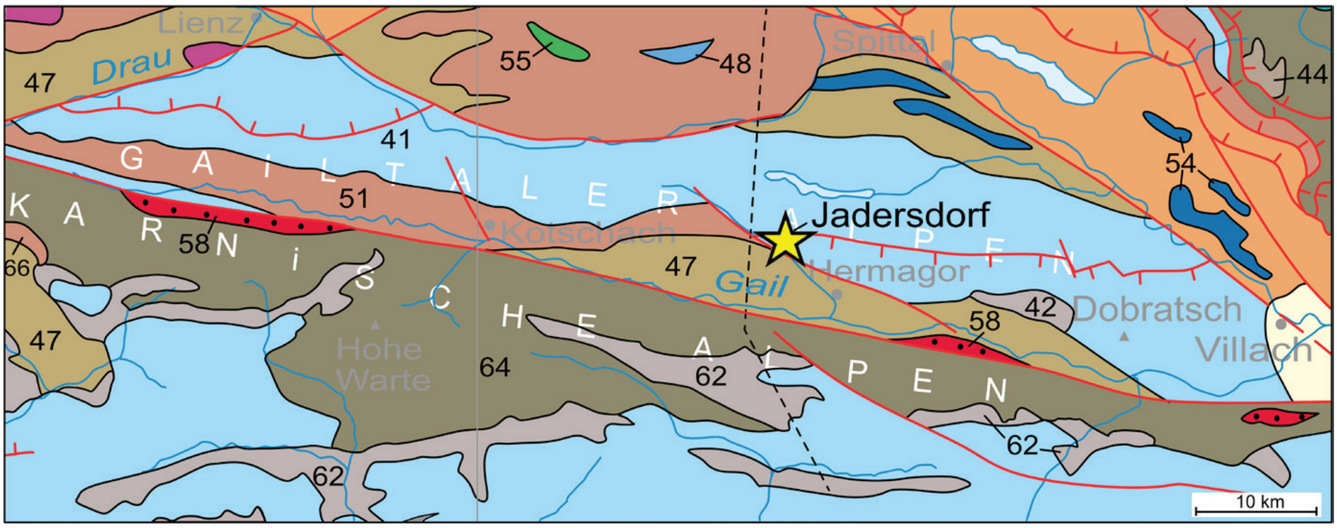

Figure 2: Geological overview of the Gailtal Alps in the Drau Range (41 in blue color: Permian - Mesozoic sediments), and the locality Jadersdorf (modified from Geologische Übersichtskarte der Republik Österreich 1:1 500 000, © GeoSphere Austria 1999).

Specimen Nockalm 7030v was found and excavated in 2022 by Georg Kandutsch, Werner Hofmann, and Harald Stonig and specimen Nockalm 7030n was found and excavated 2018 by Georg Kandutsch. Both specimens come from the locality Schwarzwandgraben below the Großboden north to the village of Jadersdorf in the Gitschtal near Hermagor (Carinthia, Austria) (Figs. 1, 2). The exact stratigraphically provenance of the two fossils is pending further work of better dating of the sedimentary succession. Both specimens were mechanically prepared by Georg Kandutsch and Harald Stonig.

3.2. Methods

A photogrammetry model of both specimens was made by Christian Seifried (rnk.studio, Wien) in May 2024. Measurements are taken by NK from the photogrammetry models in Meshlab. Procedure and identification of the specimens as new taxon are described in detail below.

In a first attempt we analysed the phylogenetic interrelationships of the new specimens from Jadersdorf within Nothosauroidea. For this purpose, we used the data matrix derived from Hinz et al. (2019), which is based on Lin et al. (2017) and Liu et al. (2014), respectively. The phylogenetic analysis resulting of this data matrix focuses to test the relationships within Nothosauroidea. We further added the new taxon from Austria to the data matrix of Hu et al. (2024), which have recently included many more (i.e., new) eosauropterygian taxa in a revised phylogenetic analysis. However, the above-mentioned problematic related to the *Lariosaurus-Ceresiosaurus-Nothosaurus* complex is in both of these phylogenetic analyses not taken into account. Further on, the character coding of the new specimens was difficult because some of the included characters in both matrices do not fit to the new material from Austria and creating a new data matrix or reworking an existing one was beyond the scope of this paper. The results of these preliminary runs showed that the new find from Austria is a nothosaurid or nothosauroid, respectively but were otherwise ambiguous. When using the Hinz et al. (2019) data matrix, their published topology collapsed and the new taxon was found in a polytomy with (some) lariosaurs or (some) nothosaurs. When using the Hu et al. (2024) analysis, the published topology was kept and the new taxon from Austria was revealed as the sister taxon to *Nothosaurus jagisteus* in a clade consisting of (*Ceresiosaurus* (*Germanosaurus*, *Simosaurus*)(*N. jagisteus, C. kandutschi gen. et sp. nov.*)). Besides this questionable topology that had not been discussed further in Hu et al. (2024), *Nothosaurus jagisteus* was lately considered to maybe represent a juvenile individual of *Nothosaurus mirabilis* (Klein et al. 2022b). Because of these ambiguous results and the problematic discussed before, we decided to omit a phylogenetic analysis for now and to erect a new genus and species for the new Carinthian material on the basis of a differential diagnosis.

3.3. Abbreviations

LMK, Landesmuseum für Kärnten, Klagenfurt, Österreich

NMW, Naturhistorisches Museum Wien, Österreich

Nockalmhof, "Kärntens versteinerte Welten" an der Nockalmstrasse, Kärnten, Österreich

4. Systematic Paleontology

Sauropterygia Owen, 1860 sensu Rieppel, 2000
Eosauropterygia Rieppel, 1994
Nothosauroidea Baur, 1889
Nothosauridae Baur, 1889

Carinthiasaurus kandutschi gen. et sp. nov.

Figures 3–6; Table 1

Holotype: Nockalm specimen 7030v

Referred specimen: Nockalm specimen 7030n

Locality and Horizon: Schwarzwandgraben below the Großboden north of Jadersdorf in the Gitschtal close to Hermagor, Carinthia, Austria; Fellbach Limestone (“Partnach-Plattenkalk”); Ladinian, Middle Triassic.

Etymology: The genus is named after Carinthia, the southernmost federate state of Austria and the Greek term sauros for lizard. The species name is in honor of the finder and initiator of this study, Georg Kandutsch (Arriach/Hinterwinkl, Austria).

Differential diagnosis: Medium-sized nothosaurid with a known maximal body length of 112.8 cm, diagnosed by the following unique combination of characters: rectangular prefrontal that extends from the anteromedial orbital margin to the posterolateral margin of the external naris, humerus slender, only slightly curved, proximal head flat and not protruding, with a clear deltopectoral crest, latissimus dorsi insertion, and ectepicondylar groove, shaft minimally constricted; humerus longer than femur; ulna proximally broader than distally, with a smoothly convex proximal head, a straight postaxial and a concavely curved preaxial margin; high neural spines in the posterior neck and anterior trunk region; long dorsal process of ilium; no pachyostosis. The morphology of the humerus and ulna as well as limb ratios are considered as autapomorphic for the new taxon.

Information on registration of genus and species in ZooBank

This published work and the nomenclatural act it contains have been registered in ZooBank, the proposed online registration system for the International Code of Zoological Nomenclature (ICZN). The ZooBank LSIDs (Life Science Identifiers) can be resolved and the associated information viewed through any standard web browser by appending the LSID to the prefix ‘http://zoobank.org/’. The LSID for this publication is: urn:lsid:zoobank.org:pub:163CC025-A16E-4020-BF62-31CD51B74760.

Holotype **(Nockalm 7030v)**			
skull length	11.5 cm	humerus re/li	7.5/7.75
neck length	28.4	radius re/li	4.1/3.85
trunk length	32,5	ulna re/li	+3.5/3.9
tail length	40.4	manus re/li	5.85/+5.4
total length	112,8		
number of cervicals	**24** (23-24)	femur re/li	7/6.7
number of dorsals	**22** (22-23)	tibia re/li	3.5/3.5
number of sacrals	5	fibula re/li	3.5/3.6
number of caudals	57	pes re/li	+6/7.8
presacral vertebrae	46		
number of carpalia	6/6		
number of tarsalia	3/3		
manus	2-3-3-2+-3 ?-4-2+-2+-2	pes	2-2-3-5-5 2-2-4-4+-3
ratio skull length /longi upper temp length	2.6	longi upper temp length/orbit longi length	2
Referred specimen **(Nockalm 7030n)**			
skull length	not preserved	humerus re/li	7.8/8.1
neck length	>10.5	radius re/li	4.2/3.9
trunk length	34	ulna re/li	3.9/4.1
tail length	>30.8	manus re/li	nm/5.5
total length	>75.3		
number of cervicals	>8	femur re/li	6/6
number of dorsals	22	tibia re/li	3.2/3.2

Table 1: Measurements (in centimetres) of both specimens of *Carinthiasaurus kandutschi* nov. gen. et sp. from Jadersdorf.

4.1. Morphological description

4.1.1. Overall description

Both specimens were found lying on their back and were prepared from field down side in dorsal view. The holotype (Nockalm 7030v) is, except for some disarticulation and loss of distalmost autopodial elements, complete and fully articulated (Figs. 3a, b). The second specimen lacks the skull, the anterior cervicals and shows some disarticulation and loss of elements in the autopodials (Fig. 3c). Its right half of the sacrum is slightly disarticulated but complete. The referred specimen is otherwise also complete and articulated. Both skeletons show the typical relaxed pose of a water carcass. The skull, neck, trunk, and tail, i.e., the articulated vertebral column, is in a nearly straight line. The forelimbs are arranged parallel to the trunk whereas the femora are perpendicular to the vertebral column and the zeugopodial and autopodial elements (as far as preserved) are again oriented parallel to the vertebral column. Sutures between skull elements are not easily to be discerned due to manifold cracks and breaks (Fig. 4a). Further on, the skull is slightly dorsoventrally flattened, whereas the postcranial skeleton is not compressed given the well exposed and high neural spines (Fig. 3b). At the height of the external naris the snout is evenly narrowing but not distinctly constricted as in other nothosaurid taxa, giving the snout an isosceles triangular shape. In front of the external nares, the teeth of the anterior lower and upper jaw are resem-

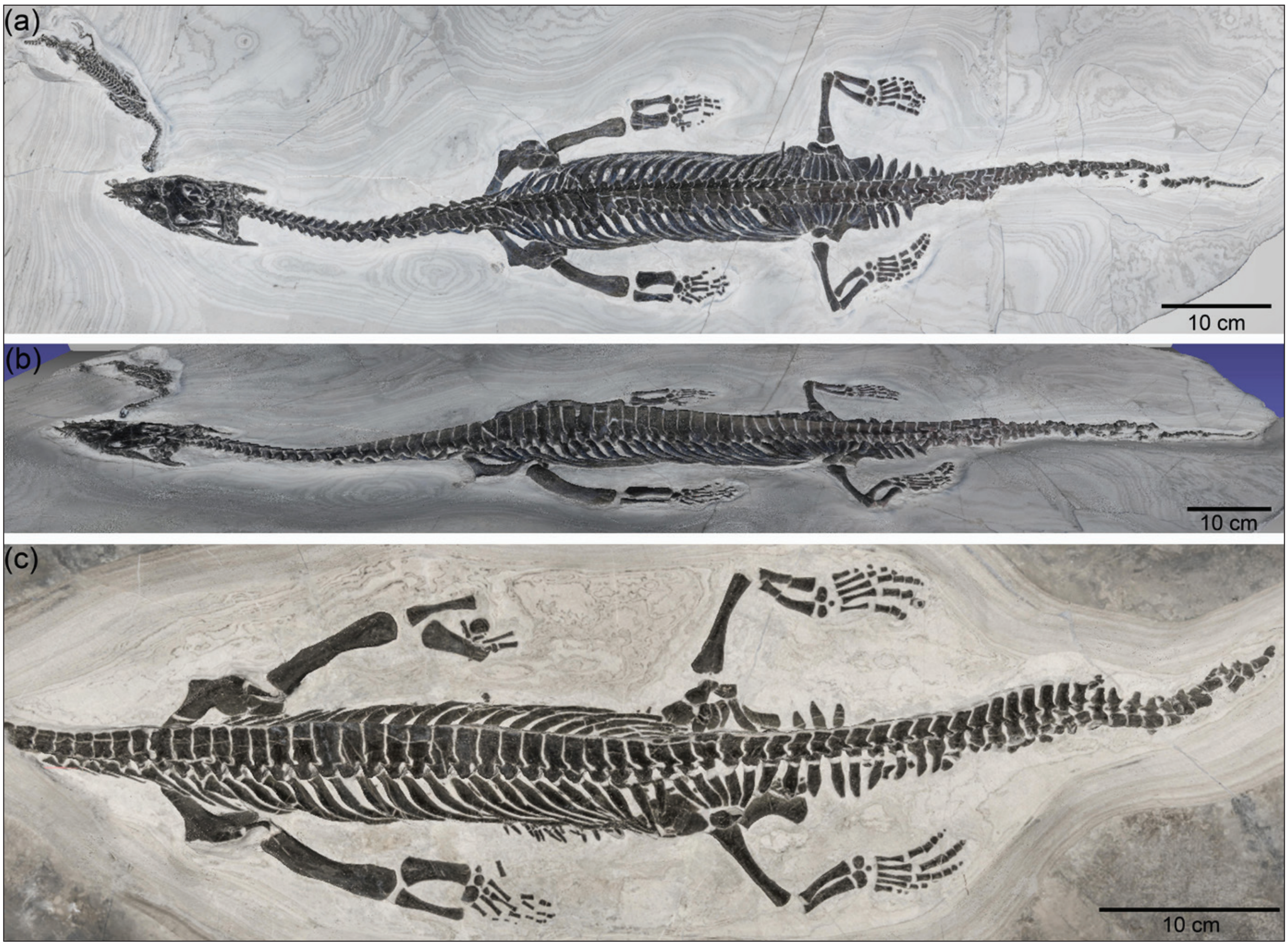

Figure 3: Holotype (Nockalm 3070v) and referred (Nockalm 3070n) specimen of *Carinthiasaurus kandutschi* nov. gen. et sp. **(a)** The holotype in dorsal view. Close to its snout lies a small yet undescribed pachypleurosaur. **(b)** The holotype in angled dorsolateral view exposing the high neural arches in the posterior neck and anterior trunk region. **(c)** The referred specimen in dorsal view. Note the high neural spines in the anterior tail region.

bling a fish trap. External nares and orbits are oval with their longest axis pointing laterally but are now compressed/crushed in a general anteroposteriorly direction. The upper temporal openings are kidney-shaped. In comparison to other nothosaurids, the external nares and orbits are large whereas the upper temporal openings are medium-sized, although still distinctly larger (> twice) than the orbits (Tab. 1). The skull is widest at the postorbital bridge. It is slightly constricted behind the mid-level of the upper temporal openings were also the parietal foramen is located. This part is crushed but a slight constriction is nevertheless obvious. Through the large openings, parts of the palate, braincase, and posterior lower jaws are visible. The left side of the skull is better preserved, i.e., less compressed than its right half. Judged from the complete specimen, the neck appears elongated and the tail is relatively short in relation to the trunk region (Fig. 3a, b). However, measurements reveal that the complete and only slightly disarticulated tail is longer than the neck (Tab. 1). The anterior tail region is massive as indicated by strong tail ribs likely functioning for muscle attachments for a sculling tail (Fig. 3). The forelimb is longer (~17.5 cm; Tab. 1) and more massive than the hindlimb (~14 cm; Tab. 1) (Fig. 3). However, the pes is longer than the manus (Figs. 3, 5; Tab. 1).

4.1.2 Detailed element by element description

The skull is well ossified, which additionally to the cracks and breaks extending over it, obscures identification of most sutures between elements. Only on the dorsal snout some sutures are well visible. This is the skull midline and the posterior processes of the premaxillae, which extend to the height of the posterior end of the external naris (Fig. 4). They each end in a pointed tip and did not contribute to the mid- or posterior margin of the external naris, excluded by an anterior process of the nasals.

The nasals encompass the entire medial margin of the external naris. They are posteriorly broad, contacting each other here and then continue each in separated anterior process, divided by the posterior process of the premaxilla (Fig. 4c). They contact the frontals posteriorly but are excluded from the maxilla by the prefrontals (Fig. 4). The prefrontal is rectangular and spans the dis-

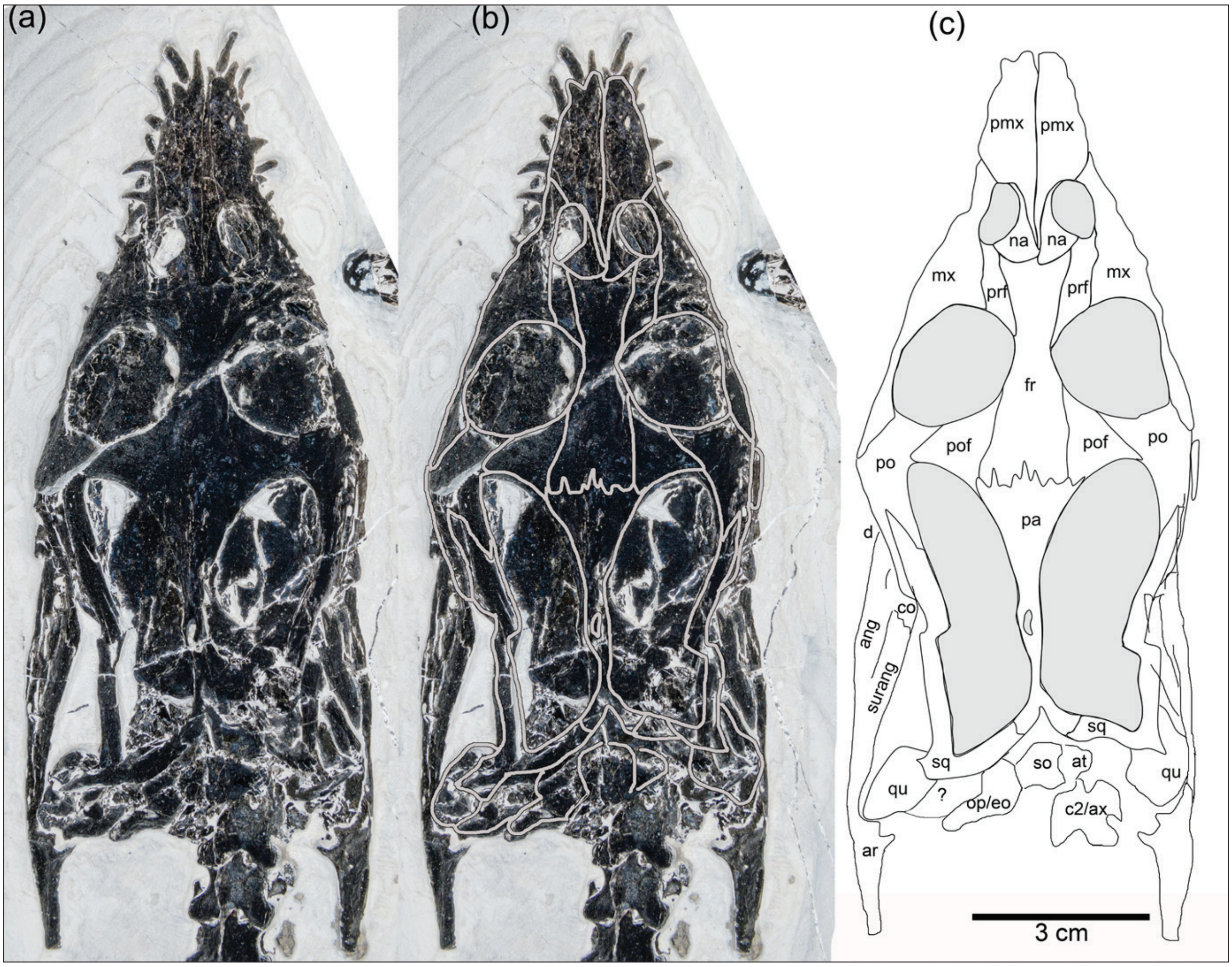

Figure 4: Details of the skull of the holotype (Nockalm 3070v) of *Carinthiasaurus kandutschi* nov. gen. et sp. from Jadersdorf. **(a)** Skull in dorsal view. Note the relatively large upper temporal opening and the unconstricted snout. **(b)** Skull with sutures. **(c)** Interpretative outline sketch of the skull with sutures. Abbreviations: ar, articulare; ang, angulare; at, atlas; ax, axis; c, cervical vertebra; co, coronoid; d, dentary; eo, exoccipital; fr, frontal; mx, maxilla; na, nasal; op, opisthotic; pa, parietal; pmx, premaxilla; po, postorbital; pof, postfrontal; prf, prefrontal; qu, quadratum; so, supraoccipital; sq, squamosal; surang, surangulare.

tance between the anteromedial orbital margin and the anterolateral margin of the external naris (Fig. 4). The fused frontals limit the medial orbital margin and contact posteriorly the parietal in an interdigitating suture. Pre- and postfrontal are separated by the frontal from each other. The postfrontal are triangular. Anteriorly they form the posteromedial orbital margin and posteriorly the anteromedial margin of the upper temporal openings (Fig. 4). The fused parietals are anteriorly broad. They taper distinctively and behind the large parietal foramen, they form only a thin bridge before they divide each into a posterior process that each contacts the squamosal. The medial posterior skull is slit-like due to the split posterior processes of the parietals (Fig. 4). The parietals border the entire antero- to posteromedial margin of the upper temporal openings. The parietal foramen is displaced posteriorly in relation to the middle of the upper temporal opening.

The maxilla form most of the laterodorsal part of the preorbital region. Its posterior process extends until the height of the anterior upper temporal opening (Fig. 4). If a jugal is present or if the slender and elongated piece of bone still belongs to the maxilla cannot be clarified (Fig. 4). The postorbital is a massive element forming most of the postorbital bridge. It limits the posterolateral orbital margin and forms most of the anterolateral margin of the upper temporal opening. A ventroposterior postorbital process extends close to the middle of the upper temporal opening. However, this process does not contribute to the lateral margin of the upper temporal opening but is excluded from this margin by a long anterior process of the squamosal (Fig. 4). The squamosal forms the posterior and 2/3 of the lateral margin of the upper temporal opening. It further has a ventrally extending process to the quadrate. The occipital region is highly damaged due to compression. Discernable are the flat supraoccipital, flanked by broad roundish exoccipitals and boomerang shaped opistothic (Fig. 4)

Only the posterior parts of the lower jaws are preserved, exposing the complete articular and surangular in dorsal view (Fig. 4a, b). The retroarticular process is pronounced. The surangular has anterodorsally a clear suture to the dentary at the middle of the upper temporal opening. Laterally to the surangular, the angular is visible which connects anterolaterally to the dentary. The coronoid region is visible and slightly bulged. The jaw is very gracile and slender. Teeth are best preserved (or prepared) at the left skull side. Anterior to the external naris five premaxillary fangs are visible, interdigitating with fangs from the dentary. These are all highly procumbent, forming a fish trap. Between the posterior external naris and the anterior orbital margin, three maxillary teeth are visible, of which one also represents a fang. Posterior to the postorbital part, two tiny dentary teeth are visible. The posteriormost part of the dentary is toothless.

The holotype and complete specimen (Nockalm 7030v) has 46 presacral (24 cervicals; 22 dorsals), 5 sacral, and 57 (partially disarticulated but complete sequence) caudal vertebrae preserved. The referred specimen (Nockalm 7030n) has >8 cervical, 22 dorsal, 5 sacral, and only 28 caudal vertebrae preserved. The anterior neck and the posterior tail are in this specimen incomplete (Fig. 3c). The vertebral column is in both specimens firmly articulated, mainly exposed in dorsal view and thus, only the neural arches and neural spines are visible. In the presacral region, no centra are exposed. The tail region is partially disarticulated in both specimens and here some centra are visible as well as some neural arches and spines are preserved in lateral view. Pre- and postzygapophyses are horizontally oriented and of a similar width all along the vertebral column.

Atlas and axis are displaced into the occipital region and not much can be said about their morphology. The neural arch of the atlas is smaller and asymmetrical when compared to the following neural arches. Posteriorly from the 3rd cervical, the neural arches are very symmetrical and typical butterfly-shaped with a deep constriction between pre- and postzygapophyses. In the middle of the neck this constriction becomes less deep and the postzygapophyses are less roundish but more pointed. The neural arches of the cervicals are roughly as long as wide. The neural arches of the trunk region are wider than long. The neural arches of the dorsals all have a distinct transversal process that is wider than/protrudes from the zygapophyses. Until the 14th cervical, the neural spines are very low but then the height of the neural spines increases continuously until the 32rd vertebra in the complete specimen. The 32rd vertebra is the highest. Vertebrae 33 to 37 are equally high, and from the 38th vertebra posteriorly, the height decreases and in the sacral region, the neural spines are low again (Fig. 3b). The neural spines form thus an arch mainly in the posterior neck and anterior trunk. The referred specimen shows a similar pattern of height increase in the neural spines (Fig. 3c). Further on, the neural spines of the tail of this specimen are also high (Fig. 3c). They are not as high as in the posterior neck and anterior trunk and not as high as in *Ceresiosaurus calcagnii* (Hänni, 2004) but higher than in the complete specimen. The neural spines are in lateral view always rectangular, i.e., have straight margins of similar lengths, except for the posterior tail where they are triangular.

The sacral vertebrae as exposed are not distinguishable from the other vertebrae. Their rib facets are large and round oval but this is also the case in the last dorsals and first caudals. The number of sacrals is deduced from the number of sacral ribs (see below). The centra exposed in the tail of the referred specimen are slightly amphicoelous, longer than high and not constricted. The anterior ones are roundish whereas the posterior ones show ventrally two parallel, lateral ridges.

Cervical ribs are visible from the 15th cervical backwards (Fig. 3a, b). However, more anterior ones are likely lost due to preservation or preparation. The cervical ribs are short and stout but bear a distinct free-ending anterior process. All dorsal ribs are preserved and associated to their respective vertebrae. The proximal part of the ribs is not constricted in the holotype (Nockalm 3070v) and they are evenly and gently curved. In the second specimen the proximal part of the ribs is slightly constricted.

In the holotype, four ribs contact the ilium at each side plus one posterior one that is too short and does not contact the ilium but also points towards the ilium (Fig. 3b). In the referred specimen, sacral ribs are only on the left side articulated but clearly five ribs contact here the ilium (Fig. 3c). The 3rd sacral rib points straight laterally whereas the first two sacral ribs point posteriorly and the last two sacral ribs point anteriorly. The first caudal rib is short and stout and points also anteriorly. The following three caudal ribs are of a similar size and point laterally to posteriorly. The next pair of caudal ribs (58th vertebra) is distinctly smaller. Caudals posterior the 60th vertebra do not have caudal ribs. The referred specimen has one more pair of caudal ribs. However, it cannot exactly be determined how far the caudal ribs reach (in terms of vertebrae number) because the tail is disarticulated in both specimens. Chevron bones/hemal arches are not unequivocally identified in the holotype but in the referred specimen. Here the tail shifted somewhat to the right and it is exposed in left dorsolateral view. Thus, the left side of several chevrons is visible. These are short and stout (Fig. 3).

Gastralia are only well visible in form of distal-most pointed ends in the posterior trunk region at the left side of the referred specimen. Likely the gastral apparatus is completely preserved but it is in both specimens overlain by the dorsal ribs and still covered with sediment. In the holotype, the gastral apparatus is visible through the gaps between the dorsal rib or at their distalmost end (Fig. 3c).

Because the specimens are prepared from their dorsal sides most of the girdle element are still covered

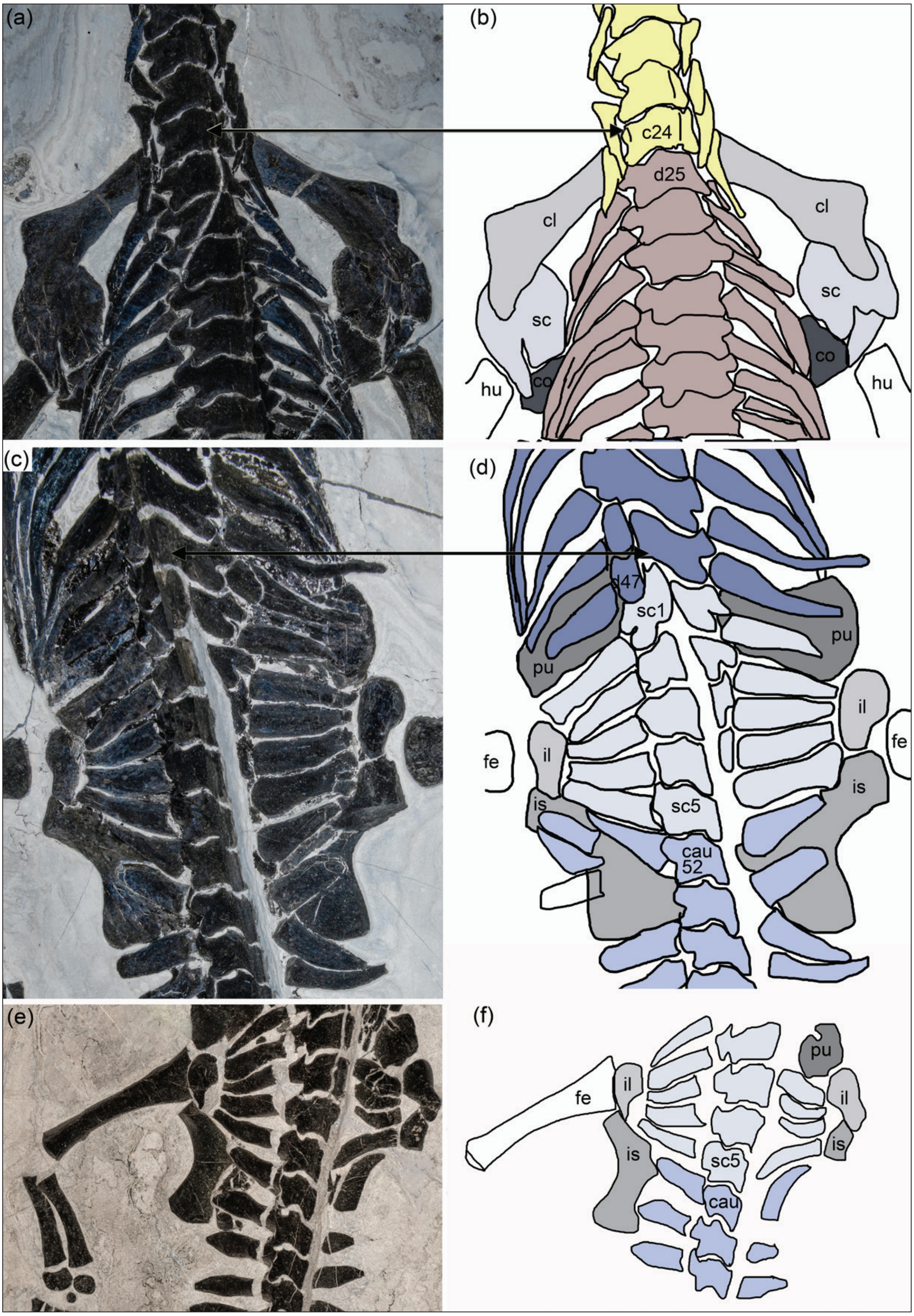

Figure 5: Details of girdle elements and sacral region of *Carinthiasaurus kandutschi* nov. gen. et sp. from Jadersdorf. (a-d) holotype (Nockalm 3070v). **(a)** photograph of pectoral region and **(b)** outline sketch. **(c)** photograph of pelvic and sacral region and **(d)** outline sketch. (e-f) pelvic and sacral region of the referred specimen (Nockalm 3070n). **(e)** photograph and **(f)** outline sketch. Abbreviations: c = cervical vertebra; cl = clavicle; co = coracoid; cau = caudal vertebra; d = dorsal vertebrae; fe = femur; hu = humerus; il = ilium; is = ischium; pu = pubis; sc = scapula; sv = sacral vertebra.

with sediment. Only parts of the anterior margin of the coracoid contributing to the glenoid are visible on both sides of the holotype (Figs. 5a, b). The clavicles however are well exposed due to their lateral position. They have pronounced anterolateral expanded edges (Figs. 3, 5a, b). The posterolateral process has a blunt end and articulates along the dorsal process of the scapula (Figs. 3, 5a, b). The scapulae are largely covered by this process with their ventral portion pointing medially and being partially still covered by sediment.

The dorsal part of the small ilium is in both specimens well visible (Figs. 5c-f). It is anteriorly broader than posteriorly, giving it a kidney-shaped form in this view. Looking from laterally, the posterior part is formed by the dorsal process of the ilium, which ends in a pointed tip that contacts the anterolateral ischium. The posterolateral half of the ischia is visible in both specimens (Figs. 3, 5c–f). Their posterior margin is deeply concave and the medial part fan-shaped but asymmetrical, because the anterior margin appears rather straight (as far as visible). The lateral process is relatively long but massive. Parts of both pubes are visible (Figs. 3, 5c–f) but their exact shape is not discernible. The right pubis of the referred specimen shows a slit-like obturator foramen (Figs. 3c, 5E). The limb elements are in both specimens well preserved except for some disarticulation and loss of the distalmost phalanges (Fig. 6). The zeugopodial and autopodial elements appear much more massive in the holotype when compared to the referred specimen (Fig. 6). The humerus is in the preserved views rather straight, which differs from the humeral shape of *Lariosaurus*. It has an angled proximal half with a deltopectoral crest and a latissimus dorsi insertion (indicating muscle attachments representing plesiomorphic morphology). The proximal head is flat and not protruding. The rather straight shaft is minimally constricted due to a slight concavity of the medial margin. The distal end is flattened and broad and has a round distal margin. An ectepicondylar groove is present. The holotype also shows an entepicondylar foramen. The radius has a broad proximal head that is in relation to the shaft angled. The shaft is constricted and medially slightly curved. The distal end broadens again.

The ulna has a very broad proximal head with a smoothly convex (bulged) anterior margin. The shaft is as broad as the distal end. It is slightly curved due to a minimal concave lateral margin whereas the medial margin is straight (Figs. 6a, b, d, e).

Both manus of the holotype have six carpalia. In the left manus, the first element is a large semilunar-shaped intermedium, articulating to the lateral part of the distal ulna (Figs. 6a, b, d, e). Aligned in a curved row posteriorly to the intermedium and from medially to laterally decreasing in size are five more round carpal ossifications. The medial and largest one in this row is the ulnare, laterally followed by the subsequent size-decreasing distal carpalia 5, 4, 3 and 2. At the right manus, the number of carpalia is the same, but the configuration differs: intermedium and ulnare are in one row. Posterior to these two carpalia is distal carpal 5 (in between intermedium and ulnare) and after a short gap the distal carpalia 4 to 2 (Figs. 6a, b) are located. The left manus of the referred specimen has only four carpalia (the large semilunar-shaped intermedium, the somewhat smaller round ulnare, and two much smaller elements) preserved. Intermedium, ulnare and one small distal carpal are in a row below the zeugopodial bones and one more is posteriorly in between the intermedium and ulnare. The right manus is disarticulated and rather incomplete (Fig. 6f).

The, in general, slender appearing femur is also very straight with a slightly broader proximal than distal end and a minimally constricted shaft (Fig. 6). The tibia is rectangular, whereas the fibula is slightly curved laterally. Both elements are of similar dimensions, but the fibula is tendentially slightly longer (Fig. 6; Tab. 1). Both specimens show three tarsalia each in both hindlimbs (Fig. 6). The largest element is the astragalus which is semilunar/kidney-shaped, sitting posterior to the tibia (Fig. 6). Posterior to the fibula is the round and much smaller calcaneus. Posterior and between the calcaneus and astragalus is a third roundish tarsal that is again smaller than the calcaneus (Fig. 6).

The metacarpalia, metatarsalia, and phalanges show the typical slender, elongated hourglass-shaped morphology of eosauropterygians. Partially, also the terminal phalanges are preserved. Although incomplete, there is no indication for hyperphalangy (Fig. 6; Table 1 for phalangeal formula).

4.2. Differences between the holotype and the referred specimen

The holotype (Nockalm 7030v) and the referred specimen (Nockalm 3030n) differ in their body size, with the holotype being larger (total length 112.8 cm) than the referred specimen (body length ~/> 100 cm). The observed difference in the higher number of carpalia in the holotype (6 vs 4 in the referred specimen) might also be related to the larger size and maybe a result of an older ontogenetic age or represent individual variation. In addition to the high neural spines in the posterior neck and anterior trunk region that are observed in both specimens, the referred specimen shows also high neural spines in the anterior tail region. As described above, increased height of neural spines is observed in the referred specimen in the area posterior to the caudals carrying large tail ribs (posterior to caudal vertebra number 9; Fig. 3c). This area is in the holotype not very well, and in a different angle, preserved (Figs. 3a, b), but the neural spines in the respective area (posterior caudal vertebra 9 or vertebrae number 59) are in the holotype lower when compared to the preceding ones. This feature might be related to individual variation as well or might represent a sexual dimorphism.

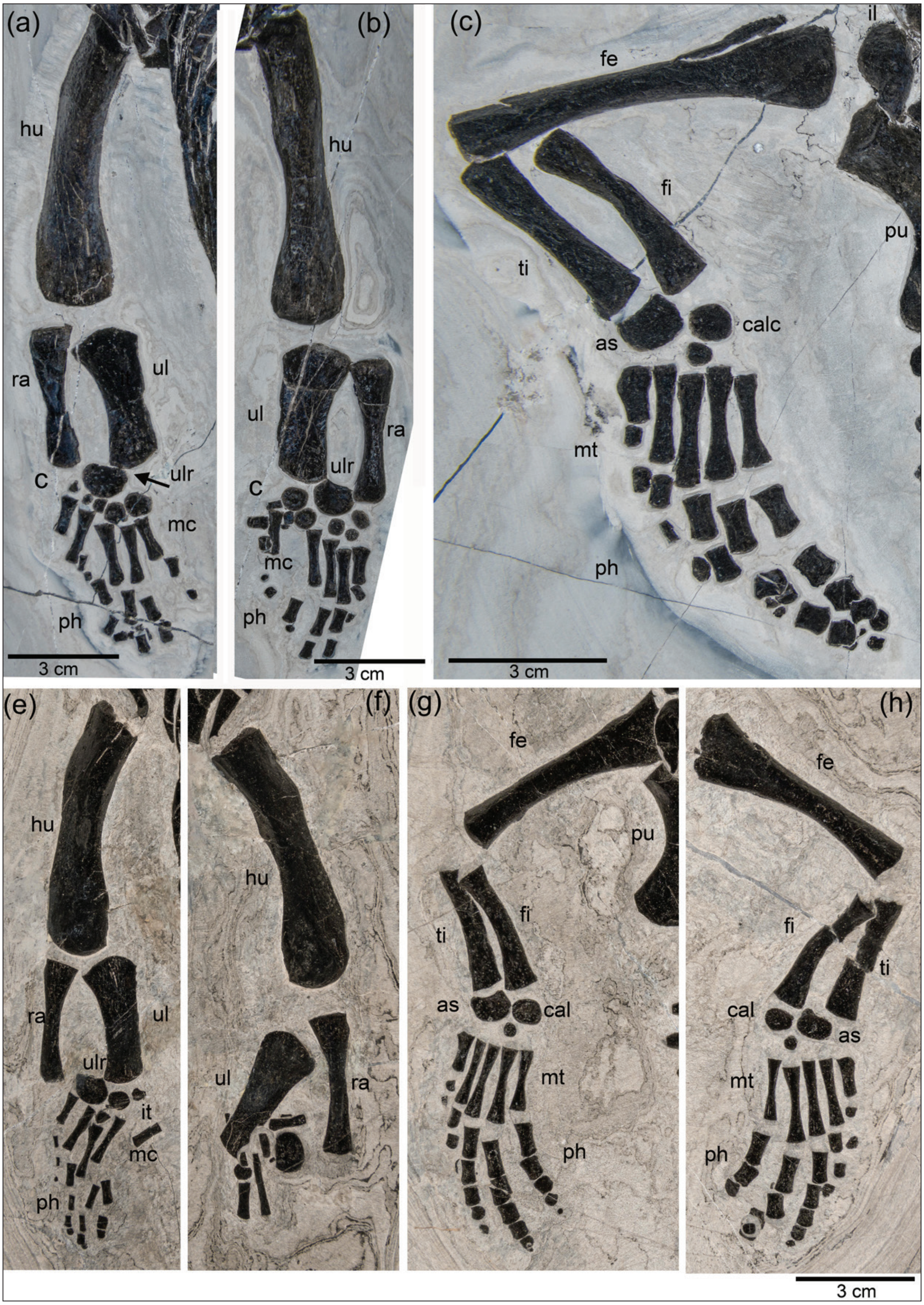

Figure 6: Details of limb bones of both specimens of *Carinthiasaurus kandutschi* nov. gen. et sp. from Jadersdorf. **(a)** left and **(b)** right forelimb of the holotype (Nockalm 3070v). **(c)** left and **(d)** right forelimb of the referred specimen (Nockalm 3070n). **(e)** left and right **(f)** hindlimb of the holotype (Nockalm 3070v). **(g)** left and **(h)** right hindlimb of the referred specimen (Nockalm 3070n). Abbreviations: as = astragalus; ca = calcaneus; car = carpalia; fe = femur; fi = fibula; hu = humerus; it = intermedium; mc = metacarpalia; mt = metatarsalia; ph = phalanges; ra = radius; ta = tarsalia; ti = tibia; ul = ulna; ulr = ulnare.

5. Morphological comparison

5.1. Comparison with nothosaurids

For *Lariosaurus* and *Nothosaurus* we follow the definition of Rieppel (2000 and reference therein) and for *Ceresiosaurus* that of Hänni (2004) (but see also Rieppel, 1998, 2000, 2007). Only the holotype has a skull preserved, which is strongly ossified and additionally damaged by multiple cracks. Thus, sutures are hard to identify and comparison with skulls of Nothosauroidea is limited. However, a rectangular prefrontal extends from the anteromedial orbital margin to the posterolateral margin of the external naris, which is to our knowledge unique among Nothosauroidea, except for the second specimen of *L. valceresii* (Renesto et al., 2004). Both here described specimens share with *Nothosaurus* (Rieppel, 1999, 2000) and *Ceresiosaurus* (Hänni, 2004) a relatively long upper temporal opening with a ratio of the longitudinal diameter of the upper temporal opening to the orbit of 2 or even 2.1. This ratio is for *Lariosaurus* <2 (usually between 1.4 and 1.8) (Lin et al., 2017), except for *L. valceresii* where it is 1.93 (Tintori and Renesto, 1991). Nockalm 3017n and Nockalm 3070v share with *Nothosaurus* (Rieppel and Wild, 1996) and *Ceresiosaurus* (Hänni, 2004) anterolaterally expanded corners of the clavicles. In lariosaurs these corners are usually not anterolaterally expanded (Rieppel, 1998).

The neural spines along the vertebral column are in general low in most taxa of nothosaurs (except for *Nothosaurus mirabilis*, Klein et al., 2022a and *Simosaurus gaillardoti* Rieppel, 1994) and in lariosaurs (Rieppel, 1998). The height of the neural spines of the posterior cervical and anterior trunk region is increased in *Ceresiosaurus* as is the case in the specimens from Jadersdorf. *Ceresiosaurus calcagnii* also has increased neural spines in the anterior tail (Hänni, 2004). The differences in the height of the neural spines in the anterior tail region might be related to swimming capabilities (environment) or to individual or sexual variability but it is unlikely to represent an ontogenetic feature.

Humeri are slightly longer than the corresponding femora in both specimens from Jadersdorf (Tab. 1). In many lariosaur specimen, the humerus is distinctly shorter than the femur (Rieppel, 1998), or slightly shorter in *L. valceresii* (Tintori and Renesto, 1991; Renesto et al., 2004). In *Ceresiosaurus*, the humerus is tendentially longer than the femur (but not in all individuals; see measurements in Hänni, 2004). In *Ceresiosaurus calcagnii*, the forelimbs are much larger than the hindlimbs, which is also observed in *L. valceresii* (Rieppel, 1998) and the two specimens from Jadersdorf. However, the morphology of the humerus and ulna as well as the proportion of the zeugopodials from the hindlimb are very different between the Jadersdorf specimens and *Ceresiosaurus*, which has very stout and short tibiae and fibulae (Hänni, 2004). In addition, the specimens from Jadersdorf do not show a tendency for hyperphalangy in the manus as it is described for lariosaurs (Rieppel, 1998) and for *Ceresiosaurus* (Hänni, 2004).

The number of sacral vertebrae of the two new specimens from Jadersdorf is five, which is typical for *Lariosaurus* (Rieppel, 1998; Lin et al., 2017) and *Ceresiosaurus* (Hänni, 2004; please note that Hänni (2004) mentioned only four sacral ribs for *Ceresiosaurus* but the configuration with a fifth short sacral rib is similar to other lariosaurs and to the two new specimens from Jadersdorf) but higher when compared to nothosaurs which usually have three sacral ribs (Rieppel and Wild, 1996). The number of presacral vertebrae as well as the number of carpalia and tarsalia is often used as a phylogenetic character but both seems to be highly variable (summarized in Rieppel, 2000; Lin et al., 2017; Klein et al., 2022a) and likely depends on other than taxonomical reasons. The presence of pachyostosis was also often used as a phylogenetic character but was already pointed out by Rieppel (1998) that this is very variable among lariosaurs. The presence of pachyostosis is likely related to environment (Ricqlès and Buffrénil, 2001). *Lariosaurus* (Rieppel, 1998) and *Ceresiosaurus* (Hänni, 2004) usually show pachyostosis in humeri, vertebrae, and ribs (except for *L. valceresii* (Rieppel, 1998)) but nothosaurs do not. Pachyostosis is not observed in the two specimens from Jadersdorf. The two here described specimens from Jadersdorf differ from all other eosauropterygian taxa in the shape and morphology of their humerus and ulna.

5.2. Comparison to lariosaur finds from Carinthia

The three finds of lariosaurs from Carinthia are difficult to compare because those specimens are very incomplete and in parts poorly preserved. Two specimens consist of the posterior neck and anterior trunk regions (Zapfe and König, 1980) that are undiagnostic, and the third one has only the posterior trunk and sacral region preserved (Arthaber, 1924). All three specimens are distinctly smaller when compared to the two new finds from Jadersdorf and show pachyostosis (Arthaber, 1924; Zapfe and König, 1980; Rieppel, 1994). Their humeri are much broader and more curved and the ulnae have a saddle-shaped proximal head. However, the best-preserved specimen shows six carpalia (Rieppel, 1994) as does the larger specimen from Jadersdorf. The configuration of the sacral region in the specimen originally described by Arthaber (1924) resembles that of the two larger specimens from Jadersdorf. It has four ribs contacting the ilium and a shorter fifth rib pointing towards but likely not contacting the ilium (Arthaber, 1924, Fig.34). However, among lariosaurs this is a very common configuration (Rieppel, 1998; Hänni, 2004; Lin et al., 2017). It can thus not be clarified if the new and the historical finds belong to the same taxon.

6. Discussion

6.1. Taxonomical assignment

As discussed under 5.1, the two new specimens from Jadersdorf show few nothosaur affinities (i.e., large upper temporal opening; anterolaterally expanded corners of the clavicle). They further share some features with lariosaurs (i.e., number of carpalia; configuration of the sacral region) and ceresiosaurs (i.e., increased height of neural spines in the posterior neck and anterior trunk region) but differ mainly in the shape and morphology of the limbs and their ratios. In addition, the shape and course of the prefrontal is special and differs from all other Nothosauridae (except for the second specimen of *L. valceresii*).

The two new specimens from Jadersdorf thus show a combination of morphological characters that are so far unique, which justifies the erection of a new taxon named *Carinthiasaurus kandutschi* nov. gen. et sp. Until a comprehensive revision of Nothosauridae from the western and eastern Tethys (including a revised and emended data matrix) will be conducted, the exact phylogenetic position and relationships of the new taxon remains unresolved.

6.2. Locality and fauna

The fauna of the Gailtal Alps (Austroalpine Drau Range) includes thus at least three eosauropterygian taxa: *Neusticosaurus toeplitschi*, *Lariosaurus* sp./*balsami* and the here described *Carinthiasaurus kandutschi* nov. gen. et sp. If the numerous finds of pachypleurosaurs (Wachtler, 2018; personal obs. of the authors) can be assigned to *N. toeplitschi*, represent a new or another pachypleurosaur taxon or even contain different species is the topic of a future study.

In any case, the Middle Triassic of the Gailtal Alps show the typical marine reptile faunal composition of other, paleogeographically and stratigraphically close localities such as the Ducan-Landwasser area (Scheyer et al., 2017; Klein et al., 2022b) and Monte San Giorgio (summarized in Klug et al., 2024). Further on, the Triassic sequence of the Drau Range has good facies analogies to the Triassic of Monte San Giorgio in the western Southern Alps and the Ducan-Landwasser area in the western upper Austroalpine units, where restricted basins with diameters of several tens of kilometres existed in the Middle Triassic carbonate platform. There are more differences in the stratigraphy, facies and fossil content of the Middle Triassic in the eastern Southern Alps and in the Northern Calcareous Alps. However, all these depositional areas originally deposited at the northwestern rim of the Palaeotethys. Interestingly, the new taxon *Carinthiasaurus kandutschi* nov. gen. et sp., seems to show a mixture of characters otherwise typical of taxa from the eastern Tethyan realm but this needs to be confirmed in a comprehensive phylogenetic study.

7. Conclusion

- On the basis of two newly found and fairly complete and articulated specimens a new eosauropterygian taxon, *Carinthiasaurus kandutschi* nov. gen. et sp. is described.
- The new taxon shows besides few unique features, an interesting combination of nothosaur, lariosaur and ceresiosaur morphology.
- The phylogeny of Nothosauridae as well as the status of *Ceresiosaurus* and *Lariosaurus balsami* needs to be revised in a comprehensive analysis including taxa from the eastern and western Tethys.

Acknowledgements

We are thankful to Werner Hofmann (Spittal an der Drau), Georg Kandutsch (Arriach/Hinterwinkl), Harald Stonig (Spittal an der Drau), and Karl Weiss (Berg im Drautal) who guided us to the locality close to Jadersdorf and for their hospitality during visits. We are grateful for their efforts in excavating and skilfully preparing specimens from Jadersdorf. Thanks also to the owners of the locality – especially to Ministerialrat i. R. Dr. Rudolf Philippitsch and the neighbourhood of Jadersdorf – Lassendorf. Christian Seifried (rnk.studio, Wien) is acknowledged for the photogrammetry models and for an introduction to Meshlab. We further would like to thank the "Naturwissenschaftlicher Verein für Kärnten" for the funding of the photogrammetry models. TMS acknowledges support by the Swiss National Science Foundation (grant no. 10001433). Finally, we would like to thank Silvio Renesto (Università degli Studi dell'Insubria, Italy) and an anonymous reviewer, as well as the editors for their various efforts and help to improve the previous versions of this article.

References

Archibald J.D., 1994. Metataxon concepts and assessing possible ancestry using phylogenetic systematics. Systematic Biology, 43, 27–40. https://doi.org/10.1093/sysbio/43.1.27.

Arthaber G.V., 1924. Die Phylogenie der Nothosaurier. Acta Zoologica, Stockholm, 5, 439–516.

Austrian Stratigraphic Commission (ed.) 2004. The Austrian Stratigraphic Chart 2004 (Sedimentary Successions).

Bachmayer H., Warch A., 1959. Ein bemerkenswerter Fischfund in den Partnachschichten (Trias) südlich von Feistritz an der Drau (Kärnten). Carinthia II, 69, 42–43.

Bechstädt T., 1978. Faziesanalyse permischer und triadischer Sedimente des Drauzuges als Hinweis auf eine großräumige Lateralverschiebung innerhalb des Ostalpins. Jahrbuch der Geologischen Bundes-Anstalt, 121, 1–121.

Bechtstädt T., Mostler H., 1974. Fossillagerstätten im mitteltriadischen Plattenkalk der Gailtaler Alpen (Kärnten, Österreich). Schriften der erdwissenschaftlichen Kommission der Österreichischen Akademie der Wissenschaften, 2, 45–55.

Benton M.J., Zhang Q., Hu S., Chen Z.-Q., Wen W., Liu J., Huang J., Zhou C., Xie T., Tong J., Choo B., 2014. Exceptional vertebrate biotas from the Triassic of China, and the expansion of marine ecosystems after the Permo-Triassic mass extinction. Earth Science Reviews, 125, 199–243. https://doi.org/10.1016/j.earscirev.2013.05.014

Broili F., 1927. Ein Sauropterygier aus den Arlbergschichten. Sitzungsberichte der Bayerischen Akademie der Wissenschaften, mathematisch-naturwissenschaftliche Abteilung, 1927, 205–228.

Baur G., 1889. Palaeohatteria Credner, and the Proganosauria. American Journal of Science, 3, 37, 310–313.

Curioni G., 1847. Cenni sopra un nuovo sauro fossile dei monti di Perledo sul Lario e sul terreno che lo racchiude. Giornale del Reale Istituto Lombardo di Scienze, Lettere ed Arti, 16, 159–170.

Feist-Burkhardt S., Götz A.E. Szulc J., Borkhataria R., Geluk M., Haas J., Hornung J., Jordan P., Kempf O., Michalík J., Nawrocki J., Reinhardt L., Ricken W., Röhling H.-G., Rüffer T., Török Á., Zühlke R., 2008. Triassic. In: McCann T. (ed.), The Geology of Central Europe, Vol. 2: Mesozoic and Cenozoic. The Geological Society. 749–821.

Furrer H., 2004. Der Monte San Giorgio im Südtessin – vom Berg der Saurier zur Fossil-Lagerstätte internationaler Bedeutung. Neujahrsblatt der Naturforschenden Gesellschaft in Zürich, 206, 1–64.

Furrer H., 2019. Fische und Saurier aus dem Hochgebirge. Fossilien aus der mittleren Trias bei Davos. Neujahrsblatt der Naturforschenden Gesellschaft in Zürich, 221, 1–112.

Furrer H., Schaltegger U., Ovtcharova M., Meister P., 2008. U-Pb zircon age of volcanic layers in Middle Triassic platform carbonates of the Austroalpine Silvretta nappe (Switzerland). Swiss Journal of Geosciences, 101, 595–603. https://doi.org/10.1007/s00015-008-1295-8

Gauthier L.R., DeQueiroz Estes K., 1988. A phylogenetic analysis of Lepidosauromorpha. In: Estes R., Pregrill G. (eds.), Phylogenetic Relationships of the Lizard Families. Stanford University Press, Stanford CA. 15–98.

Hänni K., 2004. Die Gattung *Ceresiosaurus*. *Ceresiosaurus calgagnii* Peyer und *Ceresiosaurus lanzi* n.sp. (Lariosauridae, Sauropterygia). 146 pp. vdf Hochschulverlag AG, Zürich.

Hinz J.K., Matzke A.T., Pfretzschner H.-U., 2019. A new nothosaur (Sauropterygia) from the Ladinian of Vellberg-Eschenau, southern Germany. Journal of Vertebrate Paleontology, 39/2, 7142, e1585364. https://doi.org/10.1080/02724634.2019.1585364

Hu Y.W., Li Q. Liu J., 2024. A new pachypleurosaur (Reptilia: Sauropterygia) from the Middle Triassic of southwestern China and its phylogenetic and biogeographic implications. Swiss Journal of Palaeontology, 143, 1. https://doi.org/10.1186/s13358-023-00292-4

Huene v.F., 1958. Aus den Lechtaler Alpen ein neuer *Anarosaurus*. Jahrbuch für Geologie und Paläontologie, Monatshefte, 1958/8–9, 382–384.

Klein N., Furrer H., Ehrbar I., Torres Ladeira M., Richter H., Scheyer, T.M., 2022a. A new pachypleurosaur from the Early Ladinian Prosanto Formation in the Eastern Alps of Switzerland. Swiss Journal of Palaeontology, 141, 12 (2022). https://doi.org/10.1186/s13358-022-00254-2

Klein N., Eggmaier S., Hagdorn H., 2022b. The redescription of the holotype of *Nothosaurus mirabilis* (Diapsida, Eosauropterygia) – a historical skeleton from the Muschelkalk (Middle Triassic, Anisian) near Bayreuth (southern Germany) PeerJ, 10:e13818. https://doi.org/10.7717/peerj.13818

Klug C., Scheyer T.M., Klein N., Liu J., Albisetti D., Furrer H., Stockar R., 2024. Special Issue: 100 years of scientific excavations at UNESCO World Heritage Site Monte San Giorgio and global research on Triassic marine Lagerstätten. Swiss Journal of Palaeontology, 143, 37. https://doi.org/10.1186/s13358-024-00328-3

Laboury A., Scheyer T.M., Klein N., Stubbs T.L., Fischer V., 2023. High phenotypic plasticity at the dawn of the eosauropterygian radiation. PeerJ 11, https://doi.org/10.7717/peerj.15776

Li Q., Liu J., 2020. An Early Triassic sauropterygian and associated fauna from South China provide insights into Triassic ecosystem health. Communications Biology, 3, 63. https://doi.org/10.1038/s42003-020-0778-7

Lin W.-B., Jiang D.-Y., Rieppel O., Motani R., Ji C., Tintori A., Sun Z.-Y., Zhou M., 2017. A new specimen of *Lariosaurus xingyiensis* (Reptilia, Sauropterygia) from the Ladinian (Middle Triassic) Zhuganpo Member, Falang Formation, Guizhou, China. Journal of Vertebrate Paleontology, e1278703. https://doi.org/10.1080/02724634.2017.1278703

Liu J., Hu S.-x., Rieppel O., Jiang D.-y., Benton M.J., Kelley N.P., Aitchison J.C., Zhou C.-y., Wen W., Huang J.-y., Xie T., Lv T., 2014. A gigantic nothosaur (Reptilia: Sauropterygia) from the Middle Triassic of SW China and its implication for the Triassic biotic recovery. Scientific Reports, 4, 7142. https://doi.org/10.1038/srep07142

Meyer H., 1842. *Simosaurus*, die Stumpfschnauze, ein Saurier aus dem Muschelkalke von Lunéville. Neues Jahrbuch für Mineralogie, Geognosie, Geologie und Petrefaktenkunde, 1842, 147–197.

Meyer H. v., 1847–1855. Zur Fauna der Vorwelt. Die Saurier des Muschelkalkes mit Rücksicht auf die Saurier aus buntem Sandstein und Keuper. Heinrich Keller, Frankfurt a.M.

Nopsca F., 1928. Palaeontological notes on reptiles. Geologica Hungaria, Ser. Palaeontologica, 1, 3–84.

Owen R., 1860. Palaeontology; or, a systematic summary of extinct animals and their geologic remains. Adam and Charles Black, Edinburgh.

Peyer B., 1931. Die Triasfauna der Tessiner Kalkalpen. IV. *Ceresiosaurus calcagnii* nov. gen. nov. spec. Schweizerische Paläontologische Abhandlungen, 62, 1–87.

Renesto S., 2010. A new specimen of *Nothosaurus* from the Anisian (Middle Triassic) Besano Formation (Grenzbitumenzone) of Italy. Rivista Italiana di Paleontologia e Stratigrafia, 116, 145–160. https://doi.org/10.13130/2039-4942/5946

Renesto S., Pareo M., Lombardo C., 2004. A new specimen of the sauropterygian reptile *Lariosaurus* from the Kalkschieferzone (uppermost Ladinian) of Valceresio (Varese, N. Italy). Neues Jahrbuch für Geologie und Paläontologie, Monatshefte, 6, 361–369. https://doi.org/10.1127/njgpm/2004/2004/351

Renesto S., Binelli G., Hagdorn H., 2014. A new pachypleurosaur from the Middle Triassic Besano Formation of Northern Italy. Neues Jahrbuch für Geologie und Paläontologie, Abhandlungen, 271, 151–168. https://doi.org/10.1127/0077-7749/2014/0382

Rieppel O., 1993. Status of the pachypleurosauroid *Psilotrachelosaurus toeplitschi* Nopcsa (Reptilia, Sauropterygia), from the Middle Triassic of Austria. Fieldiana (Geology), n.s. 27, 1–17.

Rieppel O., 1994. *Lariosaurus balsami* Curioni (Reptilia, Sauropterygia) aus den Gailtaler Alpen. Carinthia II, 104, 345–356.

Rieppel O., 1996. The status of the sauropterygian reptile *Partanosaurus zitteli* Skuphos from the Middle Triassic of the Austrian Alps, with comments on *Microleptosaurus schlosseri* Skuphos. Paläontologische Zeitschrift, 70, 657–577. https://doi.org/10.1007/BF02988093

Rieppel O., 1998. The status of the sauropterygian reptile genera *Ceresiosaurus*, *Lariosaurus*, and *Silvestrosaurus* from the Middle Triassic of Europe. Fieldiana (Geology), New Series 38, 1–46.

Rieppel O., 1999. Phylogeny and paleobiogeography of Triassic Sauropterygia: problems solved and unresolved. Palaeogeography, Palaeoclimatology, Palaeoecology, 153, 1–15. https://doi.org/10.1016/S0031-0182(99)00067-X

Rieppel, O., 2000. Sauropterygia I – Placodontia, Pachypleurosauria, Nothosauroidea, Pistosauroidea. Handbuch der Paläoherpetologie [Handbook of Paleoherpetology] Part 12A, 1–134.

Rieppel O., 2007. On the nothosaurian genera *Ceresiosaurus* and *Lariosaurus*. Geologia Insubrica, 10, 1–4.

Rieppel O., 2019. Mesozoic Sea Dragons: Triassic Marine Life from the Ancient Tropical Lagoon of Monte San Giorgio. 256 pp. Indiana University Press, Bloomington.

Rieppel O., Wild R., 1996. A revision of the genus *Nothosaurus* (Reptilia, Sauropterygia) from the Germanic Triassic, with comments on the status of *Conchiosaurus clavatus*. Fieldiana (Geology), n.s. 34, 1–82.

Ricqlès A.de., Buffrénil V.de., 2001. Bone histology, heterochronies and the return of tetrapods to life in water: where are we?; In: Mazin J.-M., Buffrénil V.de. (eds.), SecondaryAdaptations of Tetrapods to Life in Water. Verlag Dr. Friedrich Pfeil, München. pp. 289–310.

Scheyer T.M., Neenan J. M., Bodogan T., Furrer H., Obrist C., Plamondon M., 2017. A new, exceptionally preserved juvenile specimen of Eusaurosphargis dalsassoi (Diapsida) and implications for Mesozoic marine diapsid phylogeny. Scientific Reports, 7, 4406. https://doi.org/10.1038/s41598-017-04514-x

Sieber R., 1955. Ein bemerkenswerter Fischfund aus der Mitteltrias Kärntens. Carinthia II, 65, 91–96.

Stockar R., Baumgartner P.O., Condon D., 2012. Integrated Ladinian Bio-Chronostratigraphy and Geochrononology of Monte San Giorgio (Southern Alps, Switzerland). Swiss Journal of Geosciences, 105, 85–108. https://doi.org/10.1007/s00015-012-0093-5

Skuphos T., 1893. *Partanosaurus zitteli*. Zoologischer Anzeiger, 16, 96.

Sun Z., Jiang D.-Yy., Ji Ch., Hao W., 2016. Integrated biochronology for Triassic marine vertebrate faunas of Guizhou Province, South China. Journal of Asian Earth Sciences, 118, 101–110. https://doi.org/10.1016/j.jseaes.2016.01.004

Tichy G., 1998. Ein Neufund von *Neusticosaurus toeplitschi* (Nopcsa, 1928) (Reptilia, Sauropterygia) aus den Partnachschichten der Gailtaler Alpen, Karnten. Carinthia II, 108, 519–530

Tintori A., Renesto S., 1991. A new *Lariosaurus* from the Kalkschieferzone (Uppermost Ladinian) of Valceresio (Varese, N. Italy). Bolletino della Società Paleontologica Italiana, 29, 309–319.

Tollman A., 1976. Analyse des klassischen nordalpinen Mesozoikums. 580 pp. Franz Deuticke Wien.

Wachtler M., 2018. The marine reptile *Neusticosaurus* from the Eastern Alps. In: Perner T., Wachtler M., (eds.), Some new and exciting Triassic Archosauria from the Dolomites (Northern Italy). DOLOMYTHOS-Museum, Oregon Institute of Geological Research [ISBN 9978-88-908815-0-3], Innichen. 47–57.

Walter R., 2007. Geologie von Mitteleuropa. 7. Auflage. 511 pp. Schweizerbart, Stuttgart.

Wang W., Shang Q., Cheng L., Wu X.-C., Li C., 2022. Ancestral body plan and adaptive radiation of sauropterygian marine reptiles. iScience, 25/12, 105635. https://doi.org/10.1016/j.isci.2022.105635

Warch A., 1966. Weitere triassische Tuffe und Tuffite in den zentralen Gailtaler Alpen. Carinthia II, 76, 141–157.

Warch A., 1979. Perm und Trias der nördlichen Gailtaler Alpen. Carinthia II, Sonderhefte 35, 1–111.

Warch A., 1984. Saurier-Fossilfunde in den Gailtaler Alpen. Carinthia II, 174/94., 79–90.

Wolniewicz A., Shen Y., Li Q., Sun Y., Qiao Y., Chen Y., Hu Y.-W., Liu J., 2023. An armoured marine reptile from the Early Triassic of South China and its phylogenetic and evolutionary implications. eLife 12:e83163. https://doi.org/10.7554/eLife.83163

Zapfe H., König H., 1980. Neue Reptilienfunde aus der Mitteltrias der Gailtaler Alpen (Kärnten, Österreich). Sitzungsberichte der Österreichischen Akademie der Wissenschaften, mathematisch-naturwissenschaftliche Klasse, Abt. I, 189, 65–82.

Ziegler P.A., 2005. Europe: Permian to Recent Evolution. In: Selley R.C., Cocks L.R.M., Plimer I. R., (eds.), The Encyclopedia of Geology. Elsevier, Amsterdam. 102–125.

Received: 14.2.2025
Accepted: 22.5.2025
Editorial Handling: Gerald Auer

Zeitschrift/Journal: Austrian Journal of Earth Sciences

Jahr/Year: 2025

Band/Volume: 118

Autor(en)/Author(s): Klein Nicole, Furrer H., Dojen Claudia, Lukeneder Alexander, Scheyer Thorsten

Artikel/Article: A new nothosaurid taxon from the Middle Triassic of Carinthia, Austria 141-155