1 # Reappraisal of sauropod dinosaur diversity in the

2 # Upper Cretaceous Winton Formation of Queensland,

3 # Australia, through 3D digitisation and description of

4 # new specimens

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6 Samantha L. Beeston[1,2,3], Stephen F. Poropat[4], Philip D. Mannion[1], Adele H. Pentland[3,4],

7 Mackenzie J. Enchelmaier[3], Trish Sloan[3], David A. Elliott[3]

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9 [1]Department of Earth Sciences, University College London, London, United Kingdom

10 [2]Faculty of Science, Engineering and Technology, Swinburne University of Technology,

11 Hawthorn, Victoria, Australia

12 [3]Australian Age of Dinosaurs Museum of Natural History, Winton, Queensland, Australia

13 [4]Western Australian Organic and Isotope Geochemistry Centre, School of Earth and

14 Planetary Science, Curtin University, Bentley, Western Australia, Australia

15

16 Corresponding author:

17 Samantha L. Beeston

18 E-mail: samanthalbeeston@gmail.com

Abstract

Skeletal remains of sauropod dinosaurs have been known from Australia for over 100 years. Unfortunately, the classification of the majority of these specimens to species level has historically been impeded by their incompleteness. This has begun to change in the last 15 years, primarily through the discovery and description of several partial skeletons from the Cenomanian–lower Turonian (lower Upper Cretaceous) Winton Formation in central Queensland, with four species erected to date: *Australotitan cooperensis*, *Diamantinasaurus matildae*, *Savannasaurus elliottorum*, and *Wintonotitan wattsi*. The first three of these appear to form a clade (Diamantinasauria) of early diverging titanosaurs (or close relatives of titanosaurs), whereas *Wintonotitan wattsi* is typically recovered as a distantly related non-titanosaurian somphospondylan. Through the use of 3D scanning, we digitised numerous specimens of Winton Formation sauropods, facilitating enhanced comparison between type and referred specimens, and heretofore undescribed specimens. We present new anatomical information on the holotype specimen of *Diamantinasaurus matildae*, and describe new remains pertaining to twelve sauropod individuals. Firsthand observations and digital analysis enabled previously proposed autapomorphic features of all four named Winton Formation sauropod species to be identified in the newly described specimens, with some specimens exhibiting putative autapomorphies of more than one species, prompting a reassessment of their taxonomic validity. Supported by a specimen-level phylogenetic analysis, we suggest that *Australotitan cooperensis* is probably a junior synonym of *Diamantinasaurus matildae*, but conservatively regard it herein as an indeterminate diamantinasaurian, meaning that the Winton Formation sauropod fauna now comprises three (rather than four) valid diamantinasaurian species: *Diamantinasaurus matildae*, *Savannasaurus elliottorum*, and *Wintonotitan wattsi*, with the latter robustly supported as a member of the clade for the first

43 time. We refer some of the newly described specimens to these three species and provide

44 revised diagnoses, with some previously proposed autapomorphies now regarded as

45 diamantinasaurian synapomorphies. Our newly presented anatomical data and critical

46 reappraisal of the Winton Formation sauropods facilitates a more comprehensive

47 understanding of the mid-Cretaceous sauropod palaeobiota of central Queensland.

48

49 **Keywords** Sauropoda, Cretaceous, Australia, Gondwana, Winton Formation, 3D digitisation

50

Introduction

52   Within Australia, sauropod body fossils have been discovered in Cretaceous units

53 hosted within the Eromanga and Surat basins in Queensland (Longman, 1933; Coombs and

54 Molnar, 1981; Molnar 2001, 2010, 2011a, 2011b; Molnar and Salisbury, 2005; Hocknull et

55 al., 2009, 2021; Poropat et al., 2015a, 2015b, 2016, 2017, 2020, 2021, 2022, 2023; Rigby et

56 al., 2022) and northern New South Wales (Molnar and Salisbury, 2005; Bell et al., 2019;

57 Frauenfelder et al., 2021). The most productive unit by far is the Cenomanian–lowermost

58 Turonian (lower Upper Cretaceous) Winton Formation, which blankets vast swathes of

59 western Queensland, and produces abundant sauropod remains near the towns of Winton and

60 Eromanga, in particular (Table 1; Table S1). Continual rotation, deepening, and erosion of

61 the clay-rich topsoil layer across the region is the mechanism by which many sauropod

62 specimens are brought to the surface (Jell, 2013). Unfortunately, as a direct consequence of

63 this, the fossils found at the surface are often weathered and fragmented, thereby hindering

64 taxonomic identification. Despite this, several associated partial sauropod skeletons —

65 including rare articulated specimens — have been discovered in Winton and Eromanga, and

66 four species have been erected based on these remains: *Australotitan cooperensis* (Hocknull

67   et al., 2021), *Diamantinasaurus matildae* (Hocknull et al., 2009), *Savannasaurus elliottorum*

68   (Poropat et al., 2016), and *Wintonotitan wattsi* (Hocknull et al., 2009). With the exception of

69   *Savannasaurus*, these taxa all have additional specimens referred to them (Hocknull et al.,

70   2009, 2021; Poropat et al., 2015a, 2016, 2021, 2023; Rigby et al., 2022). Whereas

71   *Australotitan*, *Diamantinasaurus*, and *Savannasaurus* appear to form a clade

72   (Diamantinasauria) of early diverging titanosaurs or close relatives to titanosaurs (Poropat et

73   al., 2016, 2021, 2023; Hocknull et al., 2021), *Wintonotitan* is typically recovered as a

74   distantly related, non-titanosaurian somphospondylan (e.g. Hocknull et al., 2009; Carballido

75   et al., 2011; Mannion et al., 2013; Poropat et al., 2016). A recent study suggested that

76   *Wintonotitan* might also belong to Diamantinasauria (Hocknull et al., 2021), but the validity

77   of the analyses supporting this assignment was questioned by Poropat et al. (2023).

78   The holotype and referred specimens of *Diamantinasaurus matildae* and

79   *Savannasaurus elliottorum* are held in Winton at the Australian Age of Dinosaurs Museum of

80   Natural History (AAOD). Both the holotype and referred specimens of *Wintonotitan wattsi*

81   are housed in Brisbane at the Queensland Museum (QM), and all specimens of *Australotitan*

82   *cooperensis* are reposited in Eromanga at the Eromanga Natural History Museum (ENHM).

83   The physical magnitude of these specimens, coupled with the significant geographical

84   distance between these institutions, impedes direct comparison between many of the

85   specimens. Furthermore, these institutions house a plethora of undescribed sauropod

86   specimens, ranging from single elements to partial skeletons. The described specimens of the

87   named sauropod species from the Winton Formation are all incomplete, making it difficult to

88   assign new, similarly incomplete specimens to existing taxa based on shared autapomorphies.

89   Consequently, a significant portion of each of these three museums' collections remains

90   undescribed: the combination of large size, fragility, and incompleteness of the material has

91   impeded comparison between specimens, as does the frequent lack of anatomical overlap

92   between new specimens and holotypes (e.g. *Savannasaurus* preserves only the astragalus and

93   a metatarsal from the hind limb, making it impossible at present to assign isolated femora,

94   tibiae, or fibulae to this taxon). However, skeletal incompleteness does not necessarily

95   diminish scientific importance (Mannion and Upchurch, 2010; Cashmore et al., 2020):

96   significant insights into the composition of Winton's sauropod fauna, and into the anatomy of

97   each sauropod taxon therein, could be made if these undescribed specimens were identified to

98   species level.

99   In this contribution, we digitise and describe materials representing twelve previously

100   undescribed sauropod individuals from the Winton Formation, and compare them with the

101   four named Winton sauropod species. We also present new anatomical information on the

102   holotype individual of *Diamantinsaurus* and referred specimens of *Australotitan*. We use this

103   as the basis for a taxonomic and phylogenetic reappraisal of the Winton Formation sauropods

104   (Table 1).

105

106   Institutional abbreviations. AAOD, Australian Age of Dinosaurs Museum of Natural History

107   (Winton, Australia); AODF, Australian Age of Dinosaurs Fossil; AODL, Australian Age of

108   Dinosaurs Locality; EMF, Eromanga Natural History Museum Fossil (Eromanga, Australia);

109   EML, Eromanga Natural History Museum Locality; MTQ, Museum of Tropical Queensland

110   (Townsville, Australia); QM, Queensland Museum (Brisbane, Australia); QM F, Queensland

111   Museum Fossil; QM L, Queensland Museum Locality.

112

113   Anatomical abbreviations. PCDL, posterior centrodiapophyseal lamina; PCPL, posterior

114   centroparapophyseal lamina; POSL, postspinal lamina; PRSL, prespinal lamina; SPOF,

115   spinopostzygapophyseal fossa; SPOL, spinopostzygapophyseal lamina; SPRF,

116   spinoprezygapophyseal fossa; SPRL, spinoprezygapophyseal lamina; TPOL,

117   interpostzygapophyseal lamina; TPRL, interprezygapophyseal lamina.

118

Methods

120   All newly described specimens were collected by the AAOD and were excavated with

121   a front-end loader, a small excavator, geological picks, crowbars, screwdrivers, and brushes.

122   The AAOD specimens described herein were surface scanned using an Artec Space Spider

123   handheld scanner (www.artec3d.com/portable-3d-scanners/artec-spider-v2), and the

124   subsequent three-dimensional meshes were aligned in Artec Studio 15 Professional

125   (www.artec3d.com/3d-software/artec-studio) to create three-dimensional models. Figures

126   were assembled in Adobe Photoshop 2022, and annotated in Adobe Illustrator 2022. The

127   terminology used to describe the vertebral laminae and fossae follows Wilson (1999) and

128   Wilson et al. (2011). We use the term 'local autapomorphy' (*sensu* Clarke and Chiappe 2001;

129   Benson and Radley 2009; Mannion and Otero 2012) to define an apomorphy that is uniquely

130   present in one taxon within a region of the tree, but that is also convergently present in a

131   phylogenetically distant taxon (or taxa) within the same higher level clade. Data of 3D

132   models is available at Morphosource (see Supplementary Data for individual ARK numbers).

133

Dataset

135   Based on new and re-evaluated anatomical information, we revised scores for the

136   *Diamantinasaurus* (holotype individual only) and *Wintonotitan* operational taxonomic units

137   (OTUs) in the phylogenetic data matrix of Poropat et al. (2023) (see Appendix for score

138   changes). We also scored *Australotitan* for this data matrix based on the information

139   presented in Hocknull et al. (2021) and herein, as well as from personal observations of the

140 type material (S.L.B and S.F.P). In addition to *Savannasaurus*, the Poropat et al. (2023)

141 version of the data matrix already includes OTUs for two individual skeletons previously

142 assigned to *Diamantinasaurus* (AODF 0836 and AODF 0906). We incorporated four of our

143 newly described specimens comprising partial skeletons into this data matrix as additional

144 OTUs, namely AODF 0032, AODF 0590, AODF 0665, and AODF 2296. Previous iterations

145 of this data matrix focused on the Winton sauropods had already included putative

146 autapomorphies as characters to link unnamed OTUs with named species (Poropat et al.,

147 2016, 2021, 2023). Here, we continue to utilize this approach to conducting a specimen-level

148 phylogenetic analysis (see also Tschopp et al. 2015 for a diplodocid-focused example),

149 modifying one character (176) and adding four new characters to the end of the character list

150 (Appendix). The version of the data matrix presented herein comprises 131 OTUs scored for

151 560 characters.

152

153 ***Analytical protocol***

154   Phylogenetic analyses under Maximum Parsimony were run in TNT v.1.6 (Goloboff

155 and Morales 2023). Following the protocol of analysis of previous iterations of this data

156 matrix, eighteen characters were treated as ordered (11, 14, 15, 27, 40, 51, 104, 122, 147,

157 148, 195, 205, 259, 297, 426, 435, 472, 510) and eight unstable taxa were excluded *a priori*

158 (*Astrophocaudia slaughteri*, *Australodocus bohetii*, *Brontomerus mcintoshi*, *Fukuititan*

159 *nipponensis*, *Fusuisaurus zhaoi*, *Liubangosaurus hei*, *Malarguesaurus florenciae*,

160 *Mongolosaurus haplodon*). Using the 'New Technology Search', we applied the 'Stabilize

161 Consensus' option with sectorial searches, drift and tree fusing. After five rounds of

162 consensus stabilizing, the resultant trees were used as the starting topologies for a

163 'Traditional Search', which used tree bisection–reconnection. Two versions of the analysis

164 were run: one with equal character weighting, and the other with extended implied weighting

7

165 and a *k*-value of 9, for which we also applied the option to 'downweight characters with

166 missing entries faster'. Following Poropat et al. (2021, 2023), two further unstable taxa (the

167 'Cloverly titanosauriform' and *Ruyangosaurus giganteus*) were excluded *a priori* from

168 analyses applying equal character weighting; these taxa were retained in the extended implied

169 weighting analysis.

170

Geological setting

172   The Winton Formation is the stratigraphically youngest Mesozoic stratum

173 outcropping in the Eromanga Basin, and covers most of central Queensland, extending into

174 northern New South Wales, north-eastern South Australia and eastern Northern Territory

175 (Cook et al., 2013). The Winton Formation largely comprises sandstones, mudstones,

176 siltstones, claystones and coal (Senior et al., 1978). Most of these sediments are thought to

177 have been sourced from the Whitsunday Volcanic Province to the east (Bryan et al., 2012;

178 Greentree, 2011). Sedimentation took place in a terrestrial floodplain environment, with

179 alluvial, fluvial and lacustrine deposits all recognised at various localities throughout the

180 Eromanga Basin (Fletcher et al., 2018; Senior et al., 1978).

181   During the mid-Cretaceous, the Winton area lay at ~50°S (Van Hinsbergen et al.,

182 2015) and had a warm and temperate climate, with annual average temperatures of 15°–16° C

183 based on analyses of fossil leaves and wood (Fletcher et al., 2013, 2014, 2015). Fossil flora

184 includes conifers, bennettitales, cycads, ferns, horsetails, ginkgoes and angiosperms (Clifford

185 and Dettmann, 2005; Dettmann et al., 1992, 2009, 2012; McLoughlin et al., 1995, 2010).

186 These floras flourished alongside meandering rivers and channels, with periodic flooding

187 replenishing oxbow lakes and swamps (Fletcher et al., 2018; Tucker et al., 2017). Lakes are

188 thought to have been seasonal and susceptible to periods of drought and flooding (Senior et

189 al., 1978).

190

Description and comparisons

AODF 0603, *Diamantinasaurus matildae* holotype

193

Several additional elements of the *Diamantinasaurus matildae* holotype individual
(AODF 0603) have been prepared since it was originally described by Hocknull et al. (2009)
and redescribed by Poropat et al. (2015b). These are described below, along with
reinterpretations of some anatomical features discussed by these authors.

198

Scapula

The right scapula was initially described by Hocknull et al. (2009) and redescribed by
Poropat et al. (2015b). Since that time, the blade of the left scapula has been prepared, and is
described below. The left scapula of AODF 0603 (Fig. 1A–D) preserves the distal-most
portion of the acromion and the scapular blade. As is also the case with the right scapula, the
left scapular blade appears to have suffered some post-mortem crushing (Hocknull et al.,
2009; Poropat et al., 2015b). The scapula is described with the blade held horizontally.
Measurements for this element are in Table S2.

The lateral surface of the preserved portion of the acromion is proximally concave
and distally convex, dorsoventrally. Medially, it is proximally convex and distally concave
dorsoventrally. The scapular blade is proximodistally elongate and mediolaterally narrow.
Proximally, the scapular blade is 'D'-shaped in cross-section. The dorsal and ventral margins
remain effectively parallel proximodistally, although the dorsal margin is slightly concave

212   along its length. However, the ventral and distal margins are not completely preserved. The

213   lateral surface is dorsoventrally convex along its proximal two-thirds. This convexity is a

214   result of a lateral ridge that is situated at about the mid-height of the blade proximally, but is

215   tilted slightly distoventrally until it fades out just proximal to the distal end. Dorsal to the

216   lateral ridge, on the distal-third of the lateral surface, the blade is shallowly concave. The

217   lateral surface does not host the accessory longitudinal ridge or the fossa that were identified

218   as autapomorphic for *Diamantinasaurus* by Poropat et al. (2015b) for the right scapula. This

219   feature is also absent in the scapula of an immature individual referred to *Diamantinasaurus*

220   (AODF 0663), although its absence was interpreted as ontogenetic (Rigby et al., 2022). Here,

221   we propose that this feature is in fact a taphonomic artefact of the right scapula of the

222   holotype and is not autapomorphic for *Diamantinasaurus* (see below).

223   The medial surface of the scapular blade appears to have undergone more significant

224   post-mortem distortion than the lateral one, resulting in the surface being more strongly

225   dorsoventrally concave than it likely would have been in life. The proximal half of the medial

226   surface is concave, and the distal half is mostly flat. A tuberosity is located at about one-third

227   of the length of the blade from the proximal end. This tuberosity is also present on the right

228   scapular blade, and in AODF 0663, and we follow Rigby et al. (2022) in regarding this

229   character as locally autapomorphic for *Diamantinasaurus*.

230

231   ***Coracoid***

232   The right coracoid of AODF 0603 (Fig. 1Q–S) was initially described by Poropat et

233   al. (2015b). As interpreted by those authors, the coracoid is preserved as four fragments, only

234   three of which are definitively associated. The fourth fragment, which had been previously

235   described and figured by Hocknull et al. (2009) as a nearly complete left sternal plate, was

236   reinterpreted by Poropat et al. (2015b) as the anterodorsal portion of the right coracoid. The

237   subsequent discovery of additional sauropod coracoids from the Winton Formation (e.g.

238   *Savannasaurus*, AODF 0844, AODF 0888, AODF 2296; Fig. 1) implies that the fourth

239   fragment is not part of a coracoid. It is possible that it represents the postacetabular lobe of

240   the left ilium, but this cannot be demonstrated unequivocally. The fourth fragment is

241   therefore excluded from the coracoid, but the description of the main body of this element

242   (comprising three associated fragments) provided by Poropat et al. (2015b) is otherwise

243   unchanged. Measurements for this element are in Table S3.

244

245   ***Sternal plate***

246   The sternal plate of the *Diamantinasaurus* holotype was found in association with the

247   complete right manus. The manus was prepared out of its field plaster jacket, but the

248   remaining sternal plate was rejacketed at the onset of COVID-19 in 2020. It awaits further

249   preparation, but appears to be D-shaped, with a straight lateral margin (S.L.B., S.F.P., *pers.*

250   *obs.* 2019). A comparable morphology characterizes the sternal plate of *Savannasaurus*

251   (Poropat et al. 2016, 2020), the only other Winton sauropod for which this element has

252   previously been described.

253

254   ***Ulna***

255   Hocknull et al. (2009) and Poropat et al. (2015b) both described the right ulna of

256   AODF 0603. Since that time, the left ulna of AODF 0603 has been prepared. The description

257   of the ulna of *Diamantinasaurus* made by Poropat et al. (2015b) is broadly followed, with

258   notes of any differences between the left and right elements made below (Fig. 2A–L; Table

259   S4).

260   The anteromedial process of the left ulna is longer than the anterolateral process, as in

261   the right ulna, but the anteromedial process extends further anteriorly in the left ulna; it is

262   also not as broad as the equivalent process of the right element. Unlike the flat posterolateral

263   face of the right ulna, that of the left ulna is markedly concave along the proximal-third of the

264   element. As is the case in the right ulna, the posteromedial face of the left ulna is concave,

265   but it possesses a deep concavity close to the proximoposterior margin of the olecranon. The

266   proximal-most anterior surface of the left ulna possesses three distinct foramina that are not

267   present in the right ulna (Fig. 2B).

268   A prominent interosseous ridge is present on the distal half of the anterior surface of

269   the left ulna (Fig. 2B), curving slightly proximolaterally–distomedially. The presence of this

270   interosseous ridge causes the distal half of the anterior surface to be convex. Remnants of an

271   interosseous ridge are evident on the right ulna (Fig. 2H), although neither Hocknull et al.

272   (2009) nor Poropat et al. (2015b) recognised it as such because of the incomplete

273   preservation of this section. Hocknull et al. (2021) identified the presence of an interosseous

274   ridge as an autapomorphy of *Australotitan*, stating that *Diamantinasaurus* and *Wintonotitan*

275   do not possess an interosseous ridge; however, Poropat et al. (2015a) identified an

276   interosseous ridge in *Wintonotitan* (albeit not by name), and it is clearly present in the

277   *Diamantinasaurus* holotype as well.

278

279   ***Metacarpals***

280   All previous descriptions of Winton Formation sauropod metacarpals, with the

281   exception of those presented by Poropat et al. (2020) for *Savannasaurus*, were undertaken

282   before a sauropod specimen preserving both complete metacarpi had been identified from this

283   stratigraphic unit. Consequently, these descriptions now require revision.

284   The holotype skeletons of *Wintonotitan* and *Diamantinasaurus* were initially

285   described by Hocknull et al. (2009). Those authors stated that *Wintonotitan* preserves an

286   incomplete right metacarpal I and almost complete right metacarpals II–V, whereas

287   *Diamantinasaurus* preserves a complete left metacarpal I and complete right metacarpals II–

288   V (Hocknull et al., 2009). When redescribing *Wintonotitan*, Poropat et al. (2015a)

289   reinterpreted the metacarpals to all be from the left side, and switched the positions of

290   metacarpals IV and V *sensu* Hocknull et al. (2009). When redescribing *Diamantinasaurus*,

291   Poropat et al. (2015b) followed the interpretations of Hocknull et al. (2009). However, in

292   fully describing *Savannasaurus*, Poropat et al. (2020) reinterpreted all five previously

293   described metacarpals of *Diamantinasaurus* as being from the left side, but did not redescribe

294   them. Poropat et al. (2020, 2021) mentioned that the holotype individual of

295   *Diamantinasaurus* was then known to preserve complete left and right metacarpi, and this is

296   indeed the case; however, before 2019, the right metacarpals had not been prepared out of the

297   rock in which they were preserved.

298   The holotype of *Savannasaurus* was first described by Poropat et al. (2016), who

299   regarded the preserved metacarpals to represent right metacarpals I–V (all complete) and left

300   metacarpal IV (represented only by the proximal end). Subsequently, Poropat et al. (2020)

301   published a full description of the holotype of *Savannasaurus*, reinterpreting the five

302   complete metacarpals as left metacarpals I–V, and the partial metacarpal as a partial right

303   metacarpal IV. Herein, the metacarpals of *Diamantinasaurus* (Fig. 3; Table S5) are

304   redescribed, using the revised descriptions of *Wintonotitan* (Poropat et al., 2015a) and

305   *Savannasaurus* (Fig. 4A–AJ; Poropat et al., 2020) as the basis for the comparisons. Left

306   metacarpals II–V are redescribed in their correct positions, with information from the right

307   metacarpals incorporated into this description for the first time. Left metacarpal I is not

308   redescribed because it was correctly interpreted by Hocknull et al. (2009) and Poropat et al.

309   (2015b).

310   The *Diamantinasaurus* type individual also preserves a manual ungual I-2 and seven

311   manual phalanges (Fig. 5). Hocknull et al. (2009) did not specify whether the manual ungual

13

312   derived from the left or the right foot. Poropat et al. (2015b: fig. 14) labelled the element as a

313   right manual ungual, but described it as a left manual ungual. Rigby et al. (2022)

314   reinterpreted the element to be a right manual ungual, which is followed here. Poropat et al.

315   (2015b) described four right manual phalanges (II-1–V-1) from *Diamantinasaurus*. The order

316   of the phalanges is followed, but the elements are reinterpreted as deriving from the left foot,

317   meaning that the left manus is represented by metacarpals I–V and manual phalanges II-1–V-

318   1. Since their description by Poropat et al. (2015b), an additional three phalanges from the

319   right foot have been prepared (Fig. 5AD–AU; Table S6) and are described below. The right

320   manus is now represented by metacarpals I–V, manual ungual I-2, and manual phalanges II-

321   1–IV-1. Below, the metacarpals are described with the proximal surface facing dorsally, the

322   long axis of the shaft oriented vertically, and the external surface of the metacarpals regarded

323   as facing anteriorly.

324

325   *Metacarpal I*

326   The description of Poropat et al. (2015b) is largely followed, with comments where

327   there are differences between the described left metacarpal I (Fig. 3A–F) and the previously

328   undescribed right metacarpal I (Fig. 3AE–AJ).

329   In anterior view, the proximal and distal ends are slightly more expanded than the

330   shaft, with the medial articular surface more expanded than the lateral non-articular one,

331   causing the medial margin of the shaft to be more concave than the lateral one. The proximal

332   surface of the right metacarpal I is angled proximolaterally–distomedially in anterior view —

333   likely as a result of crushing — contrasting with the essentially horizontal proximal surface of

334   the left metacarpal I. The proximal surface is mostly flat but hosts an anteroposteriorly

335   elongate concavity close to the medial margin (Fig. 3AE). In the left metacarpal I, a similar

336   concavity is present (Fig. 3A), but this is closer to the central lateral margin and is not as

14

337   deep. The anterior and medial margins of the proximal surface form a lip; this is unlike the

338   convex anterior and medial margins of the left metacarpal I.

339   The bulge described by Poropat et al. (2015b) on the proximal quarter of the posterior

340   surface of the left metacarpal I is part of a more extensive, crushed posterior ridge that is

341   better preserved on the right metacarpal I. This posterior ridge extends distolaterally from the

342   posteromedial-most projection of the proximal surface until it fades out just proximal to the

343   mid-shaft, and it does not extend to the lateral margin. The proximal half of the posterior

344   ridge forms the distomedial limit of the articulation point for metacarpal II.

345   In medial view, the proximal and distal articular ends are expanded relative to the

346   mid-shaft, with this expansion being more prominent posteriorly. The proximal articular end

347   is more posteriorly expanded than the distal articular end, owing to the aforementioned

348   longitudinal ridge. In distal view, the lateral condyle is anteroposteriorly taller than the

349   medial condyle.

350

351   *Metacarpal II*

352   The right metacarpal II (Fig. 3AK–AP) of AODF 0603 is less well-preserved than its

353   left counterpart (Fig. 3G–L). The proximal half of the right element has suffered from

354   crushing, whereas the distal half has not undergone any change. The following description is

355   largely based on the better-preserved left metacarpal II, with differences noted between the

356   left and right elements.

357   In anterior view, the proximal and distal articular ends are slightly mediolaterally

358   expanded relative to the mid-shaft. The proximal surface of the left metacarpal II is

359   subtriangular, with rounded corners, whereas it is triangular in the right metacarpal II. This

360   difference could be attributed to incomplete preservation and crushing of the latter element.

361   The corners of the 'triangle' are located anteromedially, anterolaterally and posteromedially,

362   with the anteromedial process extending further anteriorly than the anterolateral process, and

363   the anteromedial and posteromedial processes connected by a straight, posteriorly oriented

364   margin. The proximal surface is sufficiently convex that it can be seen in anterior, medial,

365   and lateral views. Rounded anteromedial and posterolateral margins define the rugose

366   proximal surface, whereas the proximal anterolateral margin is separated from the

367   anterolateral surface by a lip that is exaggerated by incomplete preservation of the right

368   metacarpal II.

369   Ridges extend distally from the anteromedial, anterolateral and posteromedial corners.

370   From the proximal surface, the anteromedial ridge curves distomedially and slightly

371   posterodistally to form the anterior margin of the distal anteromedial articular face, becoming

372   slightly less pronounced the further distally it projects. The anterolateral ridge is sharper than

373   the anteromedial ridge and projects posterodistally for the proximal quarter of the shaft;

374   distally, it runs proximodistally, fading out just proximal to the distal anterolateral articular

375   face. The posteromedial ridge is the sharpest of the ridges and projects slightly distolaterally

376   until mid-height where it fades out. Distal to the posteromedial ridge the posterior surface is

377   flat, with a tuberosity located on the posteromedial margin, at about three-quarters of the

378   height of the shaft (Fig. 3J and Fig. 3AN).

379   The proximal half of the anterior surface, lateral to the anteromedial ridge, is flat and

380   becomes mediolaterally convex as the anteromedial ridge extends further distomedially,

381   whereas the proximal one-third of the medial surface is anteroposteriorly convex. There are

382   two proximodistally elongated foramina on the proximal medial surface of the left metacarpal

383   II (Fig. 3L). Presumably, these foramina represent attachment points between metacarpals I

384   and II, or nutrient foramina. The proximal posterolateral surface is anteroposteriorly concave

385   until the distal-most projection of the posteromedial ridge, where the posterior surface

386   becomes flat and merges with the medial surface. In medial view, the proximal anterior

16

387 surface extends slightly further anteriorly than the distal anterior surface, whereas the

388 posterior articular surfaces extend as far posteriorly as each other. The posterior articular

389 surfaces are more expanded than the anterior articular surfaces, such that the posterior shaft is

390 concave, and the anterior shaft is almost straight.

391   The distal articular surface is bevelled, rounding onto the anterior and posterior

392 surfaces, such that the distal surface is visible in anterior and posterior views. It has an oval

393 outline and the heavily rugose surface is flat centrally with convex edges. The distal posterior

394 margin is slightly pinched in centrally, causing the medial and lateral condyles to be

395 somewhat separated.

396

397 *Metacarpal III*

398   As with metacarpal II, the left metacarpal III (Fig. 3M–R) is better preserved than its

399 right counterpart (Fig. 3AQ–AV). The proximal half of the right metacarpal III has suffered

400 from more crushing than the distal half, but the distal articular surface is well preserved. The

401 following description is based on the left metacarpal III unless otherwise stated.

402   In anterior view, the metacarpal III has an hourglass shape, with the lateral margin

403 more strongly concave than the medial one. The distal surface is slightly mediolaterally wider

404 than the proximal surface; such a feature was considered autapomorphic for *Wintonotitan* by

405 Poropat et al. (2015a). The proximal articular surface is gently convex and strongly rugose.

406 This convexity means that the proximal surface is visible in medial and lateral views. The

407 proximal end is triangular, with corners located anteromedially, anterolaterally and

408 posteromedially. The anteromedial and anterolateral corners are connected by a convex

409 anterior margin, whereas the posteromedial projection is connected to the anteromedial and

410 anterolateral projections by a straight margin. Extending distally from the proximal

411 projections are sharp ridges. In medial view, the anteromedial ridge is concave, projecting

412 posterodistally to the mid-shaft, and then anteriorly until it meets the distal anteromedial

413 articular surface. The anterolateral ridge projects posterodistally until it meets the distal

414 posteromedial surface, and the posteromedial ridge projects distally two-thirds the length of

415 the posterior shaft until it fades out. Distal to the posteromedial ridge, the posterior surface is

416 concave. On the right metacarpal III, there is a subtle tuberosity located close to the

417 posteromedial margin (Fig. 3AT), just distomedial of the posteromedial ridge. The presence

418 of this tuberosity on the left metacarpal III cannot be assessed owing to underpreparation of

419 the element in this area.

420   The anterior surface of the left metacarpal III is mediolaterally convex, with three

421 small foramina located close to the anteroproximal surface (Fig. 3N). The proximal half of

422 the anterior surface of the right metacarpal III is mediolaterally concave and the distal surface

423 of both elements are concave. Wheras the medial surface of the left metacarpal III is flat, the

424 proximal medial surface of the right metacarpal III is concave, but the latter likely reflects

425 taphonomic distortion. The lateral surface is flat to shallowly concave anteroposteriorly. In

426 medial view, the proximal and distal articular surfaces are similarly anteroposteriorly

427 expanded, with the anterior margin slightly concave and the posterior margin almost straight.

428   In distal view, the metacarpal is oval-shaped and the distal articular surface is

429 shallowly mediolaterally concave and flat centrally, with rounded edges. The distal end is

430 divided centrally, forming two condyles, and pinched in along its posterior margin. The

431 medial distal condyle is slightly longer anteroposteriorly than the lateral condyle. In anterior

432 view, the distal surface is proximally bevelled such that it extends onto the anterior surface

433 and is visible in anterior view.

434

435 *Metacarpal IV*

The left and right metacarpal IV (Fig. 3S–X and Fig. 3AW–BB, respectively) are both well-preserved and display a similar morphology. The following description is based on both elements, with any differences noted.

In anterior view, only the distal articular end is notably mediolaterally expanded, with the proximal articular end only slightly more mediolaterally expanded than the shaft. In medial view, the anterior margin is shallowly concave, with the proximal and distal articular surfaces expanded anteriorly to a similar degree. The proximal posterior margin is more expanded posteriorly than the shaft and distal end.

The proximal articular surface of metacarpal IV is rugose and comma-shaped, tapering to form a distolateral ridge that wraps around metacarpal V. The proximal surface is flat centrally, with convex margins, and it is partially visible in anterior and medial views. Ridges extend distally from the proximal anteromedial, anterolateral, and posterior margins. The anterolateral and anteromedial ridges are connected by a convex margin, whereas the anteromedial and posterior ridges are connected by a straight margin, and the posterior and anterolateral ridges are connected by a concave one.

The anterolateral ridge of the left metacarpal IV extends posterodistally until it meets the distal anterolateral surface. By contrast, in the right metacarpal IV, it extends posterodistally until the mid-shaft, then distally until it meets the distal posterolateral surface. The anteromedial ridge extends posterodistally until it meets the distal posteromedial surface. It is intercepted by the distomedially projecting ridge just distal to the proximal half of the element. Because of the distomedially projecting posterior ridge, the concave lateral surface is more visible than the concave medial surface in posterior view.

The anterior surface is mediolaterally convex. The proximal lateral surface of the right metacarpal IV hosts a fossa that is bounded proximally by the proximolateral margin and distally by a horizontal ridge that is offset slightly anterodistally–posteroproximally (Fig.

461 3AY). It is bound anteriorly and posteriorly by the anterolateral and posterior ridge,

462 respectively. The left metacarpal IV does not possess a proximolateral fossa or horizontal

463 ridge. The posterior surface, distal to the posterior ridge, is flat in the left metacarpal IV, and

464 shallowly mediolaterally concave in the right metacarpal IV.

465   The distal articular surface is mediolaterally expanded and anteroposteriorly

466 compressed, with an oval outline. The posterodistal surface of the distal end is slightly

467 pinched in along the middle. The distal articular surface is rugose and concave centrally, with

468 convex edges. It bevels up onto the anterior and posterior surfaces, such that the distal surface

469 is visible in anterior and posterior view.

470

471 *Metacarpal V*

472   The left and right metacarpal V (Fig. 3Y–AD and Fig. 3BC–BH, respectively) are

473 well-preserved, and the following description is based on both elements, with any differences

474 noted. The anterior and posterior surfaces of metacarpal V, as described by Poropat et al.

475 (2015b), are reinterpreted here as the posterior and anterior surfaces, respectively.

476   In anterior view, the proximal articular surface is mediolaterally narrower than the

477 shaft and distal articular surface. As the shaft descends from the proximal surface distally, it

478 becomes mediolaterally wider. In medial view, the proximal articular surface is slightly

479 anteroposteriorly wider than the distal articular surface, and both are anteroposteriorly wider

480 than the shaft. The proximal and distal anterior faces extend as far anteriorly as each other,

481 but the proximal posterior face extends slightly further posteriorly than the distal posterior

482 face.

483   In proximal view, the metacarpal is sub-triangular, with points anteromedially,

484 anterolaterally and posteromedially. The proximal articular surface is concave and not as

485 rugose as in metacarpals II–IV. It bevels onto the medial surface and is visible in medial

20

view. The anterolateral ridge extends distally from one-third the length of the shaft until it

meets the distal posterolateral surface. The anteromedial ridge descends from the proximal

surface posterodistally until it meets the distal anteromedial surface. This curvature causes

the distomedial surface to be visible in posterior view only. The posteromedial ridge extends

distally, where it fades out at about the mid-height of the shaft. Distal to this posteromedial

ridge, the posterior surface is flat.

The anterior surface is flat to shallowly convex and the proximolateral surface is flat.

The medial surface is flat, with the exception of a concavity about two-thirds the length of the

shaft on the right metacarpal V (Fig. 3BH). However, this concavity might represent an

artefactual characteristic, given that it is not present on the left metacarpal V. The distal

articular surface is sub-rectangular and heavily rugose. It is flat, other than the medial margin,

which extends further distally than the rest of the distal surface. The distal surface bevels onto

the anterior and posterior surfaces.

Manual phalanx I-2

Only the right manual ungual I-2 is preserved (Fig. 5Y–AC). In lateral view, it

possesses a convex dorsal margin, a straight proximal margin that is offset slightly

proximodorsally–distoventrally, and a concave ventral margin. The dorsal and ventral

margins taper towards the distal tip, which is situated closer to the ventral margin than the

dorsal one. The ungual is dorsoventrally compressed and proximodistally elongate. The

proximal articular surface is subtriangular, with corners pointing dorsomedially,

ventromedially and laterally. It is mediolaterally convex and laterally bevelled, such that the

proximal surface is visible in lateral view. The ungual is dorsoventrally taller than it is

mediolaterally wide, with a proximal height to length ratio of 0.4, as identified by Poropat et

510 al. (2015b), and recognised in a second specimen of *Diamantinasaurus* (AODF 0663; Rigby

511 et al., 2022).

512 In dorsal view, the ungual is almost straight, with a slight lateral curve of the entire

513 element toward the distal tip. This newly described lateral curve differs to that which Poropat

514 et al. (2015b) described as a lateral curve on the dorsal margin; the latter refers to a faint

515 dorsal ridge that projects slightly distomedially. The medial and lateral surfaces are convex,

516 with the medial surface being more strongly convex proximodistally than the lateral surface,

517 but the lateral surface is more strongly convex dorsoventrally than the medial surface. The

518 lateral surface possesses a dorsolateral groove that extends vertically just distal to the

519 proximal articular margin, and likely extended close to the distal tip. However, because of

520 poor preservation, this can only be tentatively inferred. The ventral margin is convex with a

521 medially bevelled surface.

522

523 *Manual phalanx II-1*

524 The left and right manual phalanx II-1 are of similar size and morphology (Fig. 5A–F,

525 5AD–AI). The left phalanx is slightly longer along its medial margin than its lateral margin,

526 and both elements are mediolaterally wider than proximodistally long, with a sub-trapezoidal

527 outline in dorsal view. The proximal surface is mediolaterally wider than the distal surface. In

528 the left manual phalanx II-1, the medial margin is concave toward the proximal surface and

529 convex toward the distal surface, and the lateral margin is shallowly convex. In the right

530 manual phalanx II-1, the proximal, distal and medial surfaces are flat, whereas the lateral

531 surface is slightly concave. In lateral view, the proximal margin extends further dorsally and

532 ventrally than the distal one, and the element appears subtriangular with corners

533 proximodorsally, proximoventrally and distally. In proximal view, the manual phalanx II-1 is

534 oval, being dorsoventrally compressed and mediolaterally expanded, and the proximal

535 articular surface is flat centrally, with concave edges. The distal surface is similarly expanded

536 medially and laterally, whereas the ventral surface is flat.

537

538 *Manual phalanx III-1*

539   The left and right manual phalanx II-1 are similarly well preserved and display a

540 broadly consistent morphology (Fig. 5G–L, 5AJ–AO). The description of the left element by

541 Poropat et al. (2015b) is followed, and the anatomical information presented herein is based

542 on the right element. In dorsal view, the element is sub-trapezoidal, mediolaterally wider than

543 it is proximodistally long, and has a mediolaterally wider proximal margin relative to the

544 distal margin. The proximal and medial margins are flat, whereas the lateral and distal

545 margins are concave. A longitudinal ridge extends across the dorsal surface, closer to the

546 proximal margin than the distal margin. In lateral view, the element is sub-triangular, with

547 points proximodorsally, proximoventrally and distally. The proximal margin extends further

548 dorsally and ventrally than the distal surface and is straight and slightly offset

549 proximodorsally–distoventrally. The dorsal surface is flat, whereas the distal surface is

550 shallowly convex, and the ventral surface is concave. The proximal articular surface is flat

551 and has a rhomboidal outline, with points dorsally, ventrally, medially and laterally. In distal

552 view, the metacarpal is mediolaterally expanded and dorsoventrally compressed. The ventral

553 surface is flat centrally and concave proximodistally.

554

555 *Manual phalanx IV-1*

556   The right manual phalanx IV-1 (Fig. 5AP–AU) is better preserved than the left

557 manual phalanx IV-1 (Fig. 5M–R), and appears to be complete. The description of the left

558 element by Poropat et al. (2015b) is followed, and the following description is based on the

559 right element. In dorsal view, it is sub-trapezoidal and mediolaterally wider than it is

23

560   proximodistally long, with a straight proximal surface that is offset distomedially–

561   proximolaterally. The medial and lateral margins are concave, whereas the distal margin is

562   convex. The proximal margin is mediolaterally wider than the distal surface, but to a lesser

563   degree than the expansion seen on right manual phalanges II-1 and III-1. In lateral view, the

564   dorsal surface is concave, the distal surface is convex, and the proximal and ventral surfaces

565   are flat, with the proximal surface offset distodorsally–proximoventrally. The proximal end is

566   mediolaterally wider than it is dorsoventrally tall and extends further dorsally than the distal

567   surface. The proximal surface is rugose and flat. In distal view, the metacarpal is

568   dorsoventrally compressed with a slightly dorsoventrally expanded lateral end. The ventral

569   surface is shallowly convex and slightly dorsally bevelled such that it is visible in distal view.

570

571   *Manual phalanx V-1*

572   The description of this element by Poropat et al. (2015b) is followed, and no

573   amendments are made (Fig. 5S–X).

574

575   **AODF 2854, AODL 0001**

576

577   The AODL 0001 site, along with AODL 0126 ('Kylie's Corner') and AODL 0127

578   ('Alex'), is a subsection of QM L1333 ('Elliot'). The geological setting of AODL 0127 was

579   discussed by Poropat et al. (2021), and that of QM L1333 was more broadly covered by

580   Pentland et al. (2022). Numerous isolated and size-incongruent sauropod specimens have

581   been collected from AODL 0001, including cervical and dorsal vertebrae, a caudal centrum

582   (AODF 2851, described below), a left radius, a right metacarpal IV (AODF 2854, described

583   below), a femur (QM F44302), and a left tibia (QM F44573) (Hocknull et al., 2021; Poropat

584   et al. 2021). AODL 0001 has also produced isolated teeth and bones pertaining to theropods,

585 ankylosaurs (Leahey and Salisbury, 2013), pterosaurs (Pentland et al. 2022), crocodyliforms,

586 turtles, and possibly plesiosaurs (S.F.P. and D.A.E., pers. obs., 2019).

587

588 ***Metacarpal IV***

589   A complete right metacarpal IV (Fig. 4AJ–AO; Fig. S1) is roughly 75% the size of

590 that of the *Diamantinasaurus* holotype (Table S5). Therefore, this element is interpreted to

591 derive from a subadult individual.

592   The proximal articular end is less expanded mediolaterally than the distal articular

593 end, as in *Diamantinasaurus* and *Savannasaurus* (Poropat et al., 2015b, 2020). As the shaft

594 expands distally, the distal half of the anterior surface is separated from the lateral and medial

595 surfaces by faint ridges oriented distolaterally and distomedially, respectively. In proximal

596 view, the metacarpal is subtriangular in outline, with a posterior projection that tapers slightly

597 laterally, as in *Diamantinasaurus* and *Wintonotitan* (Poropat et al., 2015a, 2015b).

598   The proximal surface is not heavily rugose, contrasting with those of

599 *Diamantinasaurus* and *Savannasaurus* (Poropat et al., 2015b, 2020). The proximal surface is

600 flat centrally, with rounded edges that curve onto the anterior, posterolateral and medial

601 surfaces. It bears a single foramen, situated anteriorly (Fig. 4AJ). The posterior-most

602 projection of the proximal surface gives rise distally to a prominent, proximodistally elongate

603 posterior ridge that extends distally to the mid-shaft, where it abruptly fades out, as in

604 *Diamantinasaurus*, *Savannasaurus* and *Wintonotitan* (Poropat et al., 2015a, 2015b, 2020).

605 This ridge is located closer to the medial margin than the lateral margin, such that the lateral

606 surface is more visible in posterior view than the medial surface, as in *Diamantinasaurus*,

607 *Savannasaurus* and *Wintonotitan* (Poropat et al., 2015a, 2015b, 2020). Therefore, this ridge

608 marks the junction between the medial and posterolateral surfaces.

609   Just distal to the proximal articular surface, the anterior surface is mediolaterally

610   convex, becoming flatter at the mid-shaft, as in *Diamantinasaurus* and *Wintonotitan* (Poropat

611   et al., 2015a, 2015b). The anterior surface is separated from the lateral surface by a rounded

612   ridge that extends to the distal posterolateral surface, as in *Diamantinasaurus*, *Savannasaurus*

613   and *Wintonotitan* (Poropat et al., 2015a, 2015b, 2020). The proximal half of the posterolateral

614   surface is anteroposteriorly concave, whilst it is flat along its distal half and faces posteriorly,

615   as in *Diamantinasaurus* and *Wintonotitan* (Poropat et al., 2015a, 2015b). The proximal

616   posterolateral surface possesses a prominent horizontal ridge close to the anteroproximal

617   margin, similar to a horizontal ridge present on *Diamantinasaurus* (Fig. 3AY and 4AM); this

618   ridge represents the articulation point for metacarpal V.

619   The proximal half of the medial surface is anteroposteriorly convex, as in

620   *Wintonotitan* (Poropat et al., 2015a). On the proximomedial surface, a shallow

621   proximolaterally–distomedially oriented fossa represents the proximal articular site for

622   metacarpal III. This fossa is bounded by a faint ridge anteriorly that extends to the proximal

623   surface, and distally by another faint ridge that extends to the posterior ridge. At the mid-

624   shaft, just proximal to the distal-most point of the posterior ridge, the surface at the

625   anterolateral junction produces a faint vertical ridge that extends to the distal articular

626   surface. The distal surface is hourglass-shaped, as was considered autapomorphic for

627   *Savannasaurus* (Poropat et al., 2020).

628

629   **AODF 2296, AODL 0247 ('Leo')**

630

631   The host unit at the AODL 0247 site is a fine sandstone. Several of the elements

632   recovered from the site show signs of hydraulic transport (e.g. processes are incomplete, finer

633   features are lacking). The site was underlain by a plant-rich layer in finer-grained sediment.

634 Surface fragments at AODL 0247 were collected in 2017, and the site was excavated in 2021

635 and 2022. Undescribed elements lacking useful anatomical information include fragmented

636 and weathered vertebrae, partial dorsal ribs, a partial scapular blade or sternal plate,

637 metapodials, a pelvic girdle element (possibly a partial pubis), and an astragalus.

638

639 ***Caudal vertebrae***

640   AODF 2296 preserves 20 caudal vertebrae (Fig. 6–8; Table S7). With a few

641 exceptions, the caudal vertebrae were not found in articulation with one another;

642 consequently, the completeness of the caudal series cannot be confidently assessed. However,

643 it is the second most complete caudal vertebral series described for an Australian Cretaceous

644 sauropod, after the holotype specimen of *Wintonotitan*, which preserves at least 26 caudal

645 vertebrae (Coombs and Molnar, 1981; Hocknull et al., 2009; Poropat et al., 2015a) (note that

646 the completeness of the tail in a specimen provisionally referred to *Australotitan* [EMF109],

647 was not stated in Hocknull et al. [2021]). The completeness of each individual caudal

648 vertebra is also variable, although at least one almost complete exemplar is preserved in each

649 of the anterior, middle, and posterior sections of the series. They are described below as

650 caudal vertebrae A–T.

651   Nearly all of the caudal centra are amphicoelous to amphiplatyan (excluding posterior

652 caudal vertebra Q), as in *Wintonotitan* and *Savannasaurus* (Poropat et al., 2015a, 2020).

653 Broken surfaces in the centrum and bases of the neural arches reveal the internal texture to be

654 cancellous, as in the centra of *Wintonotitan* and *Savannasaurus* (Poropat et al., 2015a, 2020;

655 Hocknull et al., 2021), but unlike the neural arches of these two taxa which are camellate

656 (Poropat et al., 2020; Hocknull et al., 2021). The anteroposterior length of the caudal centra

657 remains relatively consistent throughout the sequence, with only the posterior-most caudal

658 vertebrae showing a decrease in anteroposterior length, as in *Wintonotitan* (Poropat et al.,

659 2015a). By contrast, the average Elongation Index (aEI) of the caudal centra increases

660 posteriorly through the series (Table 2).

661   The articular faces of the centra of the anterior and middle caudal vertebrae are

662 generally dorsoventrally compressed, whereas the posterior caudal centra are

663 equidimensional; this variability is comparable to that seen in *Wintonotitan* (Poropat et al.,

664 2015a). The lateral and ventral surfaces are simple, lacking pneumatic fossae and longitudinal

665 ridges, as in *Wintonotitan*, but unlike *Savannasaurus* (Poropat et al., 2015a, 2020). No

666 distinct chevron facets are present. However, this could be taphonomic given that a single

667 distal anterior caudal vertebra of *Savannasaurus* bears chevron facets and chevron facets are

668 just discernible on the anterior caudal vertebrae of *Wintonotitan* (Poropat et al. 2015a, 2020).

669 The eight anterior-most caudal vertebrae possess transverse processes, with the posterior-

670 most three of these only retaining a faint, reduced transverse process. Poropat et al. (2015a)

671 predicted that transverse processes would have disappeared in *Wintonotitan* by the tenth

672 caudal vertebra. We suggest the same was probably true in AODF 2296: two anterior caudal

673 vertebrae are estimated as missing from the preserved series, meaning that transverse

674 processes were lost or at least greatly reduced by caudal vertebra 10.

675   The neural arches of the caudal vertebrae are positioned closer to the anterior than the

676 posterior margin. However, in some of the middle–posterior caudal vertebrae, the neural arch

677 is positioned more centrally, a trait that was identified as being locally autapomorphic for

678 *Wintonotitan* (Poropat et al., 2015a).

679

680 *Anterior caudal vertebrae*

681   Five anterior caudal vertebrae are preserved (caudal vertebrae A–E) and all are

682 virtually identical morphologically (Fig. 6). Whereas caudal vertebra B is almost complete,

683   only one of the other anterior caudal vertebrae (C) retains part of its neural arch. The

684   following description is based on caudal vertebra B (Fig. 6G–L) unless otherwise specified.

685   The centrum is amphicoelous, as in *Diamantinasaurus*, *Savannasaurus* and

686   *Wintonotitan* (Poropat et al., 2015a, 2020, 2023), and the anterior surface is slightly more

687   concave than the posterior one, as in *Wintonotitan* (Poropat et al., 2015a). The lateral margins

688   of the articular surfaces are convex where they meet the lateral surfaces, as in

689   *Diamantinasaurus* and *Savannasaurus* (Poropat et al., 2020, 2023). The centra are

690   dorsoventrally compressed, as in *Diamantinasaurus*, *Savannasaurus* and *Wintonotitan*

691   (Poropat et al., 2015a, 2020, 2023), and the anterior articular surface is slightly larger than the

692   posterior one, contrasting with *Wintonotitan* (Poropat et al., 2015a). The anterior articular

693   surface does not possess an undulating surface and the concavity is evenly expressed across

694   the element, meaning that AODF 2296 lacks the caudal vertebral autapomorphies of

695   *Savannasaurus* (Poropat et al., 2020).

696   The anterior articular surface projects further dorsally than the posterior articular

697   surface, and the articular surfaces are oriented perpendicular to the ventral surface, as in

698   *Diamantinasaurus* and *Savannasaurus* (Poropat et al., 2020, 2023). The articular ends are

699   slightly larger than the centrum at mid-length, but the centrum is not significantly pinched in.

700   The lateral surface is anteroposteriorly shallowly concave ventral to the transverse

701   processes. Aside from caudal vertebra D, no longitudinal ridges are present on the lateral and

702   ventral surfaces of the anterior caudal vertebrae of AODF 2296. Caudal vertebra D possesses

703   a longitudinal ridge at about two-thirds the height of the centrum (Fig. 6V), and this

704   delineates a directional change on the lateral surface. Dorsal to this ridge, the surface is flat

705   and faces laterally, whereas ventral to it the surface is transversely convex and

706   anteroposteriorly concave. The presence of a longitudinal ridge in this position, accompanied

707   by a flat lateral surface, was proposed as an autapomorphy of *Wintonotitan* (Poropat et al.,

29

708 2015a). The caudal centra of AODF 2296 lack lateral and ventral foramina, as is also the case

709 in *Wintonotitan*, but differentiating them from those of *Diamantinasaurus* and

710 *Savannasaurus* (Poropat et al., 2015a, 2020, 2023). The lateral and ventral surfaces are not

711 separated by prominent longitudinal ridges, which is similar to the condition in

712 *Diamantinasaurus* and *Wintonotitan* (Poropat et al., 2015a, 2023), but which distinguishes

713 AODF 2296 from *Savannasaurus* (Poropat et al., 2020). The ventral surface is transversely

714 narrow and flat, separated from the lateral surface by a change in direction.

715   The transverse processes are situated on the dorsal one-third of the centrum, and

716 project posterolaterally, such that their distal tips project up to and possibly slightly beyond

717 the posterior articular surface of the centrum. The anterior surface of each transverse process

718 is mediolaterally convex, whereas the posterior surface is mediolaterally concave and appears

719 'hook-like' in dorsal view (Fig. 6K and 12Q). Caudal vertebra B of *Savannasaurus* shows a

720 similar morphology (Fig. 9K). The tip of the transverse process is directed somewhat

721 dorsally, and no ridges or bulges are present on the process; this distinguishes AODF 2296

722 from *Savannasaurus* (Poropat et al., 2020).

723   The prezygapophyses are thin and are not as prominent as those of *Wintonotitan* and

724 *Savannasaurus* (Poropat et al., 2015a, 2020). They project anterodorsally beyond the anterior

725 articular surface of the centrum (Fig. 6K and 6Q), as in *Wintonotitan* and *Savannasaurus*

726 (Poropat et al., 2015a, 2020). The prezygapophyseal facets are flat and oriented

727 dorsomedially, as in *Wintonotitan* and *Savannasaurus* (Poropat et al., 2015a, 2020), and they

728 are anteroposteriorly longer than they are mediolaterally wide, as in *Savannasaurus* (Poropat

729 et al., 2020). The prezygapophyses are connected by a rounded TPRL that forms the roof of

730 the anterior neural canal opening, as well as the bases of the prezygapophyses. Between the

731 prezygapophyses, a PRSF hosts the base of a faint PRSL that extends to the tip of the

732 preserved neural spine, as in *Savannasaurus*; however, the PRSL in AODF 2296 is not as

733 robust as this structure in *Savannasaurus* (Poropat et al., 2020). Faint SPRLs border the

734 PRSL laterally, as in *Savannasaurus* (Poropat et al., 2020).

735   The postzygapophyseal articular surfaces are flat and face ventrolaterally, as in

736 *Wintonotitan* and *Savannasaurus* (Poropat et al., 2015a, 2020). They do not extend further

737 posteriorly than the posterior articular surface, as is also the case in caudal vertebra B of

738 *Savannasaurus* (Fig. 9K). The postzygapophyses are connected by a thin, rounded TPOL that

739 together form the dorsal margin of the posterior neural canal opening. The TPOL also forms

740 the ventral margin of a SPOF that is anteroposteriorly deeper than it is transversely wide, as

741 in *Wintonotitan* and *Savannasaurus* (Poropat et al., 2015a, 2020). The SPOF is laterally

742 bounded by prominent SPOLs that extend to the tip of the preserved neural spine, and does

743 not host a POSL; in this regard, AODF 2296 is similar to *Wintonotitan*, but this morphology

744 distinguishes it from *Savannasaurus* (Poropat et al., 2015a, 2020). Laterally, the neural spine

745 is flat, as in *Savannasaurus* (Poropat et al., 2020). The neural spine projects dorsally, unlike

746 *Savannasaurus*, in which it projects posterodorsally (Poropat et al., 2020). The lack of the

747 preserved apex of the neural spine means that it cannot be assessed whether or not the neural

748 spine increased in transverse breadth or anteroposterior length towards its tip.

749

750 *Middle caudal vertebrae*

751   Six middle caudal vertebrae (Fig. 7; caudal vertebrae F–K) are preserved, but only

752 one preserves a partial neural arch, including part of the neural spine (caudal vertebra F). The

753 morphology of the articular surfaces of the centra varies between specimens, although some

754 appear to have been taphonomically altered. The articular surfaces are generally flat centrally,

755 with convex edges, but range from being shallowly concave to flat, as in *Wintonotitan*

756 (Poropat et al., 2015a). Where observable, the median concavity is not more exaggerated on,

757 or restricted to, either the anterior or posterior surfaces — rather, its morphology varies

758   between vertebrae. This differentiates the middle caudal vertebrae from the anterior ones,

759   which are consistently more concave on their anterior articular surfaces than on the posterior

760   ones. None of the articular surfaces in the anterior or middle caudal vertebrae of AODF 2296

761   preserve the small median bulge that is characteristic of the distal anterior caudal centra of

762   *Savannasaurus* (Poropat et al., 2020).

763   The articular surfaces are dorsoventrally compressed, as in *Wintonotitan* and

764   *Savannasaurus*, and the anterior articular surface is slightly larger than the posterior articular

765   surface, as in *Wintonotitan* (Poropat et al., 2015a, 2020). This size increase is a consequence

766   of the anterior articular surface extending further dorsally than the posterior articular surface,

767   as in *Wintonotitan* and *Savannasaurus* (Poropat et al., 2015a, 2020).

768   Caudal vertebrae F–H preserve remnants of transverse processes that appear to have

769   been genuinely reduced to bulges *in vivo*. The lateral surfaces of the centra are flat to

770   shallowly concave anteroposteriorly, as in *Wintonotitan* (Poropat et al., 2015a), and lack any

771   longitudinal ridges or fossae, unlike *Wintonotitan*, which possesses a longitudinal ridge, and

772   *Savannasaurus*, which possesses longitudinal ridges and a fossa (Poropat et al., 2015a, 2020).

773   The lateral and ventral surfaces are separated by a smooth, rounded directional change, with

774   the lateral surfaces oriented essentially vertically and the ventral surface horizontal, as in

775   *Wintonotitan* (Poropat et al., 2015a). The ventral surface is flat to shallowly concave, as in

776   *Wintonotitan* and *Savannasaurus* (Poropat et al., 2015a, 2020), although a smooth convexity

777   is evident towards the anterior and posterior margins, where the ventral surface rounds onto

778   the articular faces. There are no pronounced chevron facets.

779   In most of the middle caudal vertebrae, the neural arch is situated closer to the

780   anterior margin of the centrum than the posterior one. However, in the most distally

781   preserved middle caudal vertebra (Fig. 7AI; caudal vertebra K), the neural spine is located

782   centrally, which has been interpreted as a local autapomorphy for *Wintonotitan* (Poropat et

783   al., 2015a). Caudal vertebra F is the only middle caudal vertebra that preserves more than the

784   base of the neural arch; thus, the description of the neural arch below is based on this

785   specimen.

786   The lateral surfaces of the neural arch are convex (Fig. 7A; based on the better-

787   preserved left lateral side of caudal vertebra F). The prezygapophyses project dorsally and

788   slightly anteriorly, extending just anterior to the anterior articular surface of the centrum. The

789   prezygapophyseal facet faces medially and is dorsoventrally taller than it is anteroposteriorly

790   long. The bases of the prezygapophyses are connected via a flat, pronounced TPRL that

791   forms the dorsal margin of the anterior neural canal opening, as well as the bases of the

792   prezygapophyses. The TPRL also forms the base of the PRSF, which is bounded laterally by

793   prominent SPRLs. Within the PRSF, a faint PRSL extends to the tip of the incompletely

794   preserved neural spine.

795   The left postzygapophysis is only partially preserved but its articular surface appears

796   to have faced laterally. The postzygapophyses do not appear to have projected posteriorly

797   beyond the posterior articular surface of the centrum. The bases of the postzygapophyses

798   appear to have been connected by a TPOL. Together, the TPOL and postzygapophyses form

799   the roof of the posterior neural canal opening, as in the anterior caudal vertebrae of

800   *Savannasaurus* (Poropat et al., 2020). The postzygapophyses also form the lateral margins of

801   a triangular SPOF, which is bounded ventrally by the TPOL. The dorsal-most projection of

802   the postzygapophyses represent the most dorsally preserved portion of the neural spine,

803   which is anteroposteriorly longer than it is transversely wide. The thin transverse width of the

804   neural spine implies that thick laminae were not present on the neural spine.

805

806   *Posterior caudal vertebrae*

807   Nine posterior caudal vertebrae are preserved (Fig. 8; caudal vertebrae L–T), three of

808 which possess partial neural arches and spines (Caudal vertebra L, N and P). Caudal vertebra

809 Q aside, the articular face of the posterior caudal vertebrae of AODF 2296 display the same

810 incipient biconvexity that has been regarded as locally autapomorphic for *Wintonotitan*

811 (Poropat et al., 2015a), with the articular surfaces medially concave and laterally convex.

812 Neither articular surface is more strongly concave than the other, unlike *Wintonotitan*

813 (Poropat et al., 2015a). The anterior articular surface extends further dorsally and is slightly

814 larger than the posterior cotyle, and the articular surfaces are dorsoventrally compressed, as

815 in *Wintonotitan* (Poropat et al., 2015a). Whereas the posterior articular surface of caudal

816 vertebra Q is incipiently convex (Fig. 8AG), the anterior articular surface hosts a prominent

817 median bulge on its ventral half (Fig. 8AE). This bulge differs to the bulge observed on two

818 of the anterior caudal vertebrae of *Savannasaurus* (Fig. 9A and 9M) in being more prominent

819 and occupying more space on the anterior surface. Given this, we cannot rule out a

820 pathological origin for the bulge of AODF 2296. Dorsal to this bulge, the anterior articular

821 surface is essentially flat, although near the base of the neural canal it forms a sharp lip.

822   The lateral surfaces of the centra are anteroposteriorly flat to shallowly concave, but

823 slightly convex near the articular ends, as in *Wintonotitan* (Poropat et al., 2015a). They lack

824 any laminae or fossae, and are essentially vertical, as in *Wintonotitan* (Poropat et al., 2015a).

825 The lateral and ventral surfaces are separated only by a smooth directional change. The

826 ventral surfaces are transversely flat and anteroposteriorly concave, with the degree of

827 concavity increasing in more distal caudal vertebrae, as in *Wintonotitan* (Poropat et al.,

828 2015a).

829   The neural arches are situated closer to the anterior margin of the centrum than the

830 posterior one, as in *Wintonotitan* (Poropat et al., 2015a). Among the posterior caudal

831   vertebrae of AODF 2296, caudal vertebra L (Fig. 8A–F) preserves the most complete neural

832   arch; as such, the following description is primarily based on this specimen.

833   Each prezygapophyseal articular surface faces dorsomedially and is slightly

834   anteroposteriorly longer than it is mediolaterally wide. The prezygapophyses extend beyond

835   the anterior articular surface of the centrum. Despite being less complete, the

836   prezygapophyses of caudal vertebra N (Fig. 8N) project relatively further anteriorly than

837   those of caudal vertebra L (Fig. 8B). The bases of the prezygapophyses are connected via a

838   sharp TPRL that forms the roof of the anterior neural canal opening, along with the

839   prezygapophyses. The TPRL also forms the ventral margin of a relatively deep SPRF, which

840   is bounded laterally by SPRLs that extend posterdorsally from the prezygapophyses until they

841   meet at the tip of the neural spine.

842   Each lateral face of the neural spine hosts a sharp, anteroposteriorly oriented ridge

843   that extends the entire length of the neural spine. This feature characterizes the distal

844   anterior–middle caudal vertebrae in several titanosauriforms (D'Emic et al., 2016), but it was

845   previously not possible to observe its genuine presence or absence in sauropod remains from

846   the Winton Formation because of poor preservation. The lateral faces of the neural arch and

847   spine are flat and anteroposteriorly angled; the two are separated by a slight directional

848   change that is manifested as a faint ridge (Fig. 8B and 8D), with the lateral face of the neural

849   arch oriented vertically and that of the neural spine deflected to face slightly dorsally. The

850   postzygapophyses are not completely preserved.

851

852   ***Chevrons***

853   Five chevrons have been recovered (Fig. 10), with four (Fig. 10A– P; chevrons A–D)

854   deriving from the anterior region of the caudal series and one from the posterior section of the

855   tail (Fig. 10Q–T; chevron E). The morphology of chevron A (Fig. 10A–D) is different to that

856 of the other anterior chevrons, and salient differences are noted below. The chevrons were not

857 found articulated with, but were found in close proximity to, several caudal vertebrae.

858 Chevron E was recovered next to a posterior caudal vertebra (Fig. 8AW–BA; caudal vertebra

859 T); as such, it is postulated that those elements are associated. If chevron E is associated with

860 caudal vertebra T, then at least the first twenty caudal vertebrae of AODF 2296 possessed

861 chevrons before they became rudimentary or completely absent. The chevrons are relatively

862 complete, with chevron B (Fig. 10E–H) and C (Fig. 10I–L) missing part of their distal blades

863 and possibly part of their proximal rami. As in *Diamantinasaurus* and *Wintonotitan* (Poropat

864 et al., 2015a, 2023), the chevrons are not forked.

865   In lateral view, the distal surfaces of the chevrons extend more posteriorly than the

866 proximal articular facets, creating a slight overall curvature. The proximal articular surfaces

867 range from flat to anteroposteriorly concave. In posterior view, the proximal articular

868 surfaces are oriented distomedially–proximolaterally and are offset anterodorsally–

869 posteroventrally relative to the horizontal, as in *Wintonotitan* (Poropat et al., 2015a). The

870 proximal articular surfaces of chevrons B–E are anteroposteriorly longer than they are

871 mediolaterally wide. By contrast, the proximal articular surfaces of chevron A are rounded,

872 similar to those of *Diamantinasaurus* and *Wintonotitan* (Poropat et al., 2015a, 2023), and are

873 wider mediolaterally than they are long anteroposteriorly. The anteroposterior length of the

874 proximal ramus remains consistent along their lengths in chevrons A–D, as in

875 *Diamantinasaurus* and *Wintonotitan* (Poropat et al., 2023). Poropat et al. (2015a) described a

876 different condition in *Wintonotitan,* and regarded the feature of the proximal articular

877 surfaces being anteroposteriorly shorter than the proximal rami in lateral view at the mid-

878 height of the haemal canal as an autapomorphy for *Wintonotitan*. The proximal articular

879 surfaces of chevron E are slightly anteroposteriorly longer than the anteroposterior length at

880 the midheight of the ramus.

881 As in *Diamantinasaurus* and *Wintonotitan,* there is no dorsal bridge to the haemal

882 canal (Poropat et al., 2015a, 2023). The haemal canals range in size between specimens, with

883 the height of the haemal canal of chevrons A, C and D about half the height of the chevron.

884 By contrast, the haemal canal of chevron B is one-third the height of the chevron, as in

885 *Diamantinasaurus* (Poropat et al., 2023), whereas in chevron E it occupies almost the entire

886 height of the chevron. However, these heights can only be estimated owing to incomplete

887 preservation of chevrons B and C. The mediolateral width of the haemal canal at the proximal

888 articular surface is slightly wider than at the mid-shaft in chevrons A–D; by contrast, it is

889 significantly wider in chevron E, as is the case for *Wintonotitan* (Poropat et al., 2015a). There

890 are no ridges on the lateral surfaces of the proximal rami.

891 The anterior surface of the distal blade of each chevron is defined by a sharp vertical

892 midline ridge, as in *Diamantinasaurus* and *Wintonotitan* (Poropat et al., 2015a, 2023). Either

893 side of this ridge, the anterior surface is angled anteromedially–posterolaterally. The midline

894 ridge of chevron A curves slightly to the right until it reaches its distal surface (Fig. 10A). As

895 is the case for *Diamantinasaurus* and *Wintonotitan* (Poropat et al., 2015a, 2023), the lateral

896 surfaces do not possess any ridges, fossae or bulges. The posterior surface of the distal blade

897 of chevron A is flat and does not possess a midline ridge (Fig. 10C). By contrast, the

898 posterior surface of the distal blade of the other chevrons forms a vertical midline ridge that is

899 slightly less sharp than those on the anterior surface. The chevron blades narrow towards

900 their distal surfaces and are mediolaterally compressed, as in *Wintonotitan* (Poropat et al.,

901 2015a).

902

903 ***Coracoid***

904 AODF 2296 includes a partial left coracoid (Fig. 1T–V), missing the anterodorsal

905 portion. Despite being incomplete, the coracoid is dorsoventrally taller than it is

906 anteroposteriorly long. The lateral surface is dorsoventrally convex and anteroposteriorly flat,

907 whereas the medial surface is dorsoventrally and anteroposteriorly concave. This

908 differentiates the coracoid of AODF 2296 from that of *Savannasaurus*, wherein the

909 posterodorsal portion is concave on the lateral surface and convex on the medial one (Fig. 1N

910 and 1P; Poropat et al., 2020). The medial and lateral surfaces lack any defining ridges or

911 fossae, which are also absent in the coracoid of *Diamantinasaurus* (Fig. 1Q and 1S; Poropat

912 et al., 2015b), but unlike the medial and lateral surfaces of *Savannasaurus* (Fig. 1N and 1P;

913 Poropat et al., 2020).

914   The glenoid is expanded laterally, and a prominent notch is developed towards its

915 ventrolateral point; this separates the glenoid from the glenoid fossa, which is distinctly

916 narrower mediolaterally than the glenoid (Fig. 1U), as in *Diamantinasaurus* (Fig. 1R; Poropat

917 et al., 2015b), but unlike *Savannasaurus* (Fig. 1O; Poropat et al., 2020). Although a

918 prominent notch is present in *Savannasaurus*, the glenoid fossa of that taxon is not as

919 distinctly separated from the glenoid as it is in AODF 2296 (Poropat et al., 2020). The

920 glenoid fossa is convex and laterally bevelled, as in *Diamantinasaurus* and *Savannasaurus*

921 (Poropat et al., 2015b, 2020). Unlike *Savannasaurus* (Poropat et al., 2020), the glenoid does

922 not possess any rugosity. The anteroventral tip of the coracoid forms a prominent point for

923 articulation with the sternal plate; this structure is seemingly dissimilar from the rounded,

924 dorsoventrally short (albeit incomplete) anteroventral margin of the coracoid of

925 *Savannasaurus* (Poropat et al., 2020).

926   As in *Savannasaurus* (Poropat et al., 2020), the scapular articulation is triangular in

927 posterior view and straight in medial and lateral views. The scapular articular surface extends

928 to the dorsal-most preserved margin of the coracoid. Similar to *Diamantinasaurus* and

929 *Savannasaurus* (Poropat et al., 2015b, 2020), the coracoid foramen is positioned just anterior

930 to the scapular articular surface and dorsal to the junction of the scapular articular surface and

931 the glenoid. It is an anteroposteriorly long and dorsoventrally short oval foramen, as in

932 *Savannasaurus* (Poropat et al., 2020). Owing to incomplete preservation on the medial

933 surface of the coracoid foramen, the angle at which the foramen projects through the coracoid

934 cannot be determined.

935

936 ***Sternal plate***

937   A partial left sternal plate is preserved (Fig. 1AB–AC; Table S8). The best-preserved

938 margin is the lateral one; very little of the anterior and posterior margins are preserved, and

939 the medial one is entirely lacking. Despite this, comparisons with the almost complete left

940 sternal plate of *Savannasaurus* (Fig. 1Z–AA; Poropat et al., 2020) indicate that only a

941 relatively small portion of the sternal plate has been lost. The fact that the lateral margin is

942 essentially straight implies that the sternal plate was 'D'-shaped when complete, as is

943 characteristic of both *Diamantinasaurus* and *Savannasaurus* (Poropat et al., 2016, 2021). The

944 anterior margin is dorsoventrally thickest anterolaterally, decreasing in thickness toward the

945 medial margin, as in *Savannasaurus* (Poropat et al., 2020). Aside from a slight dorsoventral

946 thickening at the posterolateral margin, also seen in *Savannasaurus* (Poropat et al., 2020), the

947 medial, lateral, and posterior margins are similar in dorsoventral thickness along their length,

948 unlike *Savannasaurus* in which the medial margin is thicker than the lateral margin (Poropat

949 et al., 2020).

950   The ventral surface is generally mediolaterally convex, with the lateral portion

951 displaying a slight concavity relative to the medial portion. The coracoid articulation is

952 located close to the anterolateral margin. The anterior-most projection of the coracoid

953 articulation is incomplete, but it is clear that it extended as far as, or very close to, the anterior

954 margin. It is dorsoventrally thickest proximally, decreasing in thickness posteriorly. The

955 ventral-most projection of the coracoid articulation culminates in a tuberosity that is laterally

956   offset, such that the surface medial to the tuberosity is not as steep as the surface lateral to the

957   tuberosity, as in *Savannasaurus* (Poropat et al., 2020). The tuberosity does not extend as far

958   anteroposteriorly, nor is it as prominent, as that of *Savannasaurus*. The dorsal surface is

959   concave along the lateral margin as well as anteriorly and posteriorly, but flat to shallowly

960   convex towards the medial margin, unlike *Savannasaurus* (Poropat et al., 2020). The sternal

961   plate does not thicken toward the centre of the element, unlike *Savannasaurus* (Poropat et al.,

962   2020).

963

964   ***Ulna***

965   The distal two-thirds of the shaft of a left ulna, lacking both articular ends, is

966   preserved (Fig. 2S–X). In proximal view, the exposed cross section of the shaft is 'L' shaped,

967   with a longer anteromedial than anterolateral process.

968   The anterior surface is separated from the posteromedial and posterolateral surfaces

969   by distinct vertical ridges. It appears that the ridge projecting from the base of the

970   anteromedial process would have been sharper than the ridge projecting from the

971   anterolateral process, as in *Diamantinasaurus* (Poropat et al., 2015b). The posteromedial and

972   posterolateral surfaces are separated by a smooth ridge projecting from the base of the

973   olecranon process; this is the least pronounced vertical ridge on the ulna.

974   The anterior surface is concave proximally, flat medially, and convex distally owing

975   to a sharp interosseous ridge that projects approximately two-thirds the length of the

976   preserved surface (Fig. 2T). A prominent interosseous ridge is present in the ulnae of

977   *Australotitan*, *Diamantinasaurus* and *Wintonotitan* (see above). The posteromedial and

978   posterolateral surfaces are both flat. In distal view, the broken surface of the ulna is

979   trapezoidal, as is also the case in the cross-section of *Diamantinasaurus* (Poropat et al.,

980   2015b; Hocknull et al., 2021).

40

981

Radius

      An incomplete right radius is preserved (Fig. 11M–R; Table S9), missing the proximal and distal articular ends. The horizontal cross-section of the proximal articular end is sub-circular, a feature that was identified as potentially autapomorphic for *Wintonotitan* (Poropat et al., 2015a). Although the proximal surface is incomplete, a medial projection appears to have been present: this is another feature that was identified as potentially autapomorphic for *Wintonotitan* (Poropat et al., 2015a). However, a similar medial projection also appears to be present in *Diamantinasaurus* (see Fig. 11G). In anterior view, the lateral and medial margins are shallowly concave, expanding toward the distal end, as in *Diamantinasaurus* and *Wintonotitan* (Poropat et al., 2015a, 2015b). The anterior surface is shallowly mediolaterally convex, as in *Diamantinasaurus* and *Wintonotitan* (Poropat et al., 2015a, 2015b), but does not possess the mediolaterally rounded ridge that is characteristic of *Diamantinasaurus* (Fig. 11H) and *Wintonotitan* (Poropat et al., 2015a, 2015b).

      The lateral surface is defined by an anterolateral ridge that projects slightly ventromedially from the proximolateral margin and fades out at the distal one-third, as in *Diamantinasaurus* and *Wintonotitan* (Poropat et al., 2015b). Proximal to this anterolateral ridge, the lateral surface is oriented posterolaterally, whereas distally it is oriented anterolaterally, as in *Diamantinasaurus* (Poropat et al., 2015b).

      The posterior surface is defined by two interosseous ridges, with the more lateral of the two being more pronounced (Fig. 11P). The lateral interosseous ridge is sharply defined, projects distolaterally, and extends along the distal half of the preserved shaft, as in *Diamantinasaurus*, *Wintonotitan* and *Savannasaurus* (Poropat et al., 2015a, 2015b, 2020). The medial interosseous ridge originates at about the same height as the lateral interosseous ridge and projects distolaterally, such that the two ridges are effectively parallel, as in

1006   *Diamantinasaurus* (Fig. 11J; Poropat et al., 2015b). The interosseous ridges do not extend as

1007   far proximally as do those of *Diamantinasaurus*, nor are they as pronounced (Poropat et al.,

1008   2015b). The posterior surfaces of the radii of *Savannasaurus* and *Wintonotitan* possess a

1009   single interosseous ridge (Fig. 11D; Poropat et al., 2015a, 2020), but this might only be

1010   because they are incompletely and poorly preserved: it remains possible that these surfaces

1011   were characterized by a second interosseous ridge *in vivo*. Dorsal to the interosseous ridges,

1012   the posterior surface of the radius of AODF 2296 is mediolaterally convex, whereas medial to

1013   them it is flat, as in *Diamantinasaurus* and *Wintonotitan* (Poropat et al., 2015a, 2015b). The

1014   distal end of the shaft is mediolaterally wider than the mid-shaft, as in *Diamantinasaurus*,

1015   *Wintonotitan* and *Savannasaurus* (Poropat et al., 2015a, 2015b, 2020). The incompletely

1016   preserved cross section of the distal end is rhomboidal.

1017

1018   ***Metacarpal IV***

1019   A complete left metacarpal IV is preserved (Fig. 4AP–AU). It is near identical in

1020   morphology to the right metacarpal of AODF 2854 (Fig. 4AJ–AO), aside from a few

1021   characteristics that are detailed below. The proximal surface lacks foramina, and the proximal

1022   posterolateral surface is concave, as in *Wintonotitan* (Poropat et al., 2015a). By contrast, in

1023   AODF 2854 and *Diamantinasaurus* a ridge is present on the proximal posterolateral surface

1024   that is lacking in AODF 2296. The posterior ridge in AODF 2296 extends from the proximal

1025   end and curves laterally until the distal posterolateral surface, rather than being oriented

1026   vertically and fading out about two-thirds the length of the posterior surface, as is the case in

1027   *Diamantinasaurus*, *Savannasaurus* and AODF 2854 (Poropat et al., 2020). The distal

1028   posterior surface is mediolaterally concave, as in *Diamantinasaurus*, but unlike AODF 2854

1029   and *Savannasaurus* (Poropat et al., 2020).

1030   The approximate ratio of metacarpal length to radius length of AODF 2296 is 0.50.

1031   By comparison, this ratio is 0.52 for *Diamantinasaurus*, 0.42 for *Savannasaurus*, and 0.48

1032   and 0.52 for the incomplete left and right radii of *Wintonotitan*, respectively (Poropat et al.,

1033   2015a, 2015b, 2020).

1034

1035   ***Fibula***

1036   A portion of a proximal right fibula shaft is preserved (Fig. 12X–AB; Table S10). It is

1037   missing the proximal articular surface and it does not extend as far distally as the lateral

1038   trochanter. In proximal view, the anterior proximal surface is oriented anteromedially,

1039   coming to a triangular point at its anteromedial-most projection, as in *Diamantinasaurus*

1040   (Poropat et al., 2015b). The posterior proximal surface is oriented posteriorly and is

1041   mediolaterally thicker than the anterior proximal surface, as in *Diamantinasaurus* (Poropat et

1042   al., 2015b).

1043   The medial and lateral surfaces are separated by anterior and posterior vertical ridges;

1044   this means that the anteroposteriorly convex lateral surface is visible in anterior view, as in

1045   *Diamantinasaurus* (Poropat et al., 2015b). The medial surface is generally flat and oriented

1046   anteroposteriorly. The centre of the proximomedial surface hosts a slight posteroproximally–

1047   anterodistally oriented ridge; anterior to this ridge the surface is shallowly concave. This

1048   ridge is interpreted to represent the distal-most portion of a triangular scar, similar to that

1049   observed in *Diamantinasaurus* (Poropat et al., 2015b). In distal view, the cross-section of the

1050   preserved shaft is 'D'-shaped, with a rounded lateral surface and a flat medial surface, as in

1051   *Diamantinasaurus* (Poropat et al., 2015b).

1052

1053   **AODF 0844, AODL 0215 ('Ian')**

1054

1055   The only fossils discovered at AODL 0215 are a sauropod scapula and a partial

1056 coracoid, preserved in articulation and partially fused (Fig. 1H–M), and collected from below

1057 the montmorillonite-rich vertisol (="black soil" layer). Additional coracoid fragments were

1058 discovered at the surface, some of which have been reattached to the partial coracoid. The

1059 scapulocoracoid was found medial side up. The host sedimentary rock is a grey siltstone,

1060 directly overlying a yellow massive fine-grained sandstone. The isolation of this specimen

1061 implies some degree of post mortem transport. Given that the scapula of AODF 0844 is

1062 roughly 85% the length of the scapula of *Diamantinasaurus* (Table S2) and the coracoid is

1063 only partially fused to the scapula (Fig. 1M), AODF 0844 is interpreted as a subadult

1064 individual.

1065

1066 ***Scapula***

1067   As in *Diamantinasaurus* (Poropat et al., 2015b; Rigby et al., 2022), the coracoid

1068 articular surface is heavily rugose and wedge-shaped. It is dorsoventrally taller but

1069 mediolaterally narrower than the glenoid articular surface. The glenoid is mediolaterally flat

1070 and dorsoventrally concave. Its lateral margin is straight and the medial margin is convex,

1071 resulting in the glenoid being wedge-shaped, as in *Diamantinasaurus* (Poropat et al., 2015b;

1072 Rigby et al., 2022). As in a juvenile specimen assigned to *Diamantinasaurus* (AODF 0663;

1073 Rigby et al., 2022), the glenoid is medially bevelled (Fig. 1M), contrasting with the laterally

1074 bevelled condition that characterizes both the holotype and a referred adult specimen (AODF

1075 0836) of *Diamantinasaurus* (Poropat et al., 2015b, 2022).

1076   The proximal two-thirds of the lateral surface of the acromion is shallowly concave

1077 and the distal one-third is flat, as in *Diamantinasaurus* (Rigby et al., 2022). These surfaces

1078 are separated by the acromial ridge that extends ventrally one-third the height of the

1079 acromion, then curves proximoventrally until it fades out halfway along the acromion

1080 surface, as in *Diamantinasaurus* and *Wintonotitan*, and to a lesser degree *Australotitan*

1081 (Hocknull et al., 2021; Poropat et al., 2015a, 2015b; Rigby et al., 2022). The dorsal-most

1082 portion of the acromial ridge is defined by a bulge that was likely a point of muscle

1083 attachment (Fig. 1K). This bulge appears to be present in *Australotitan* too, although this

1084 feature might be a taphonomic artefact in *Australotitan* (Hocknull et al., 2021).

1085   The medial surface of the acromion is concave and does not possess any ridges or

1086 fossae. Distal to the glenoid, the ventral margin of the acromion hosts a distinct concavity

1087 that is also present in *Diamantinasaurus* (Poropat et al., 2015b, 2021; Rigby et al., 2022).

1088 Further distally, the ventral surface of the acromion hosts a single tubercle that is visible in

1089 lateral and medial views (Fig. 1I and 1M). A similar tubercle has been observed in

1090 *Diamantinasaurus* and *Wintonotitan* (Poropat et al., 2015a, 2015b, 2021).

1091   The scapular blade is 'D'-shaped in cross section, as in *Diamantinasaurus* and

1092 *Wintonotitan* (Hocknull et al., 2021; Poropat et al., 2015b; Rigby et al., 2022). The blade is

1093 concave along its dorsal margin and flat along its ventral base, therefore expanding

1094 dorsoventrally towards its distal end. Laterally, the scapular blade is convex and defined by a

1095 horizontal ridge that is located at two-thirds the height of the shaft (Fig. 1M). This ridge

1096 extends from the acromion–blade junction until it fades out close to the distal margin of the

1097 blade, as in *Diamantinasaurus* (Poropat et al., 2015b; Rigby et al., 2022). The distal portion

1098 of the blade is flat and rectangular in cross-section, as in *Diamantinasaurus* and *Australotitan*

1099 (Hocknull et al., 2021; Poropat et al., 2015b; Rigby et al., 2022).

1100   The proximal medial surface of the scapular blade is shallowly concave, whereas the

1101 distal medial surface is flat, as in *Diamantinasaurus*, *Wintonotitan*, and *Australotitan*

1102 (Hocknull et al., 2021; Poropat et al., 2015a, 2015b; Rigby et al., 2022). Just posterior to the

1103 acromion–blade junction, there is a tuberosity located closer to the dorsal margin of the

1104 medial surface than the ventral margin (Fig. 1M); such a tuberosity has been identified in

45

1105 *Diamantinasaurus* and considered potentially autapomorphic for that taxon by Rigby et al.

1106 (2022). Those authors also provisionally identified a comparable tuberosity in *Wintonotitan*

1107 and *Australotitan*. The lack of preservation of the ventral margin of the scapula in

1108 *Australotitan* impedes interpretation of the position of this feature in that taxon (Rigby et al.

1109 2022). Ventral to this tuberosity, the medial surface possesses a concavity; such a feature was

1110 proposed as autapomorphic for *Wintonotitan* by Poropat et al. (2015a).

1111

1112 ***Coracoid***

1113   An incomplete right coracoid is preserved, missing only the anterior margin and part

1114 of the central portion of the element (anterior to the coracoid foramen). When articulated with

1115 the scapula, the dorsal margin of the coracoid is level with/just exceeds that of the scapula. It

1116 is similar in shape to that of AODF 2296, in that it is taller dorsoventrally than it is long

1117 anteroposteriorly, but less rounded than that of *Savannasaurus* (Poropat et al., 2020).

1118   The lateral surface is shallowly concave dorsoventrally along the posterior half, but

1119 appears to have been convex along the anterior half, unlike *Savannasaurus* (Poropat et al.,

1120 2020) and AODF 2296. By contrast, the medial surface is concave dorsoventrally and

1121 anteroposteriorly, as in AODF 2296, but unlike *Savannasaurus* (Poropat et al., 2020). The

1122 medial and lateral surfaces each possess a distinct bulge close to the dorsal margins; on the

1123 lateral surface this bulge is located close to the anterodorsal-most preserved portion of the

1124 element (i.e. approximately at mid-length if the coracoid was complete) (Fig. 1K), whereas

1125 on the medial surface the bulge is located further posteriorly (Fig. 1M), such that it is close to

1126 the posterodorsal margin. Similar ridges have not been observed in any other published

1127 sauropod coracoids from the Winton Formation, including those described here. However,

1128 the *Diamantinasaurus* holotype coracoid is not complete enough to determine whether or not

1129 this ridge is present (Poropat et al., 2015b). Similar ridges are present in AODF 0888 (Fig.

46

1130   1W and 1Y), another as yet undescribed sauropod specimen from the Winton Formation.

1131   Following Otero (2010, 2018), the lateral ridge is likely to be the attachment site for *M.*

1132   *biceps brachii*.

1133   The coracoid is mediolaterally narrowest along its anterodorsal margin, becoming

1134   thicker further posteriorly and ventrally, reaching its greatest mediolateral thickest at the

1135   glenoid, as in *Diamantinasaurus*, *Savannasaurus* (Poropat et al., 2015b, 2020) and AODF

1136   2296. The glenoid is laterally expanded, such that the lateral margin of the glenoid possesses

1137   a distinct notch, as in *Diamantinasaurus*, *Savannasaurus* (Poropat et al., 2015b, 2020) and

1138   AODF 2296. The glenoid is not bevelled and it is mediolaterally thicker than the glenoid

1139   fossa, with the two separated by a prominent notch, as in *Diamantinasaurus* (Poropat et al.,

1140   2015b) and AODF 2296. The notch and the separation between the glenoid and glenoid fossa

1141   is less prominent in *Savannasaurus* (Poropat et al., 2020). The glenoid fossa is the ventral-

1142   most projection of the coracoid and the surface rounds onto the lateral surface, causing it to

1143   become convex and subsequently visible in lateral view, as in *Diamantinasaurus*,

1144   *Savannasaurus* (Poropat et al., 2015b, 2020), and AODF 2296.

1145   In posterior view, the scapular articulation is triangular, becoming mediolaterally

1146   broader ventrally, as in *Savannasaurus* (Poropat et al., 2020) and AODF 2296. The coracoid

1147   foramen is located at about two-thirds the height of the element, unlike *Diamantinasaurus*

1148   and *Savannasaurus*, in which the coracoid foramen is located at about the mid-height of the

1149   element (Poropat et al., 2015b, 2020). In AODF 0844, the coracoid foramen is positioned just

1150   anterior to the scapular articular surface and dorsal to the glenoid, as in *Diamantinasaurus*,

1151   *Savannasaurus* (Poropat et al., 2015b, 2020) and AODF 2296. The coracoid foramen is oval

1152   and anteroposteriorly longer than it is dorsoventrally tall, as in *Savannasaurus* and AODF

1153   2296. It projects anterolaterally–posteromedially, unlike *Savannasaurus*, wherein it projects

1154   ventrolaterally–dorsomedially (Poropat et al., 2020).

1155

1156 **AODF 0590, AODL 0079 ('McKenzie')**

1157

1158   The right tibia and fibula of AODF 0590 were articulated when discovered and are the

1159 best-preserved elements of the material found at AODL 0079. Additional surface fragments

1160 were recovered and include a fragmentary caudal vertebra, distal condyles of a femur, and

1161 proximal and distal condyles of the left tibia and left fibula. Apart from the caudal vertebra,

1162 these additional elements are not sufficiently diagnostic to warrant description. The complete

1163 tibia and fibula of AODF 0590 are 30% longer than the corresponding elements in the

1164 *Diamantinasaurus* holotype (AODF 0603; Poropat et al., 2015b). If the same was true of the

1165 femur of AODF 0590, then this element would have been approximately 1.75 metres in

1166 proximodistal length; thus, AODF 0590 was only slightly smaller than the holotype specimen

1167 of *Australotitan cooperensis*, which has a femoral proximodistal length of ~1.89 metres

1168 (Hocknull et al., 2021). The only other fossil found at the site was a single bivalve.

1169

1170 ***Caudal vertebra***

1171   A fragmentary anterior caudal vertebra was pieced together from surface fragments

1172 (Fig. 9V–Y). The internal texture is spongiose throughout the centrum and camellate nearest

1173 the neural arch, as in *Savannasaurus* (Poropat et al., 2020) and *Wintonotitan* (Poropat et al.,

1174 2015a; Hocknull et al., 2021). The anterior articular surface of the centrum is convex along

1175 the right lateral margin and becomes concave medially, unlike the anterior caudal centra of

1176 *Diamantinasaurus*, *Wintonotitan* and AODF 2296, which are consistently concave (Poropat

1177 et al., 2015a, 2023). Additionally, the anterior articular surface of AODF 0590 is unlike the

1178 undulating anterior articular surface of *Savannasaurus*, which is concave along the dorsal

1179 half and convex along the ventral half (Poropat et al., 2020). Despite being only partially

48

1180   preserved, the posterior articular surface is clearly shallowly concave, as in the posterior

1181   caudal centra of *Diamantinasaurus*, *Savannasaurus* and *Wintonotitan* (Poropat et al., 2015a,

1182   2020, 2023). The right lateral surface preserves a partial transverse process (Fig. 6Y) but

1183   lacks any ridges or fossae, as in *Wintonotitan*, but differing from *Savannasaurus* (Poropat et

1184   al., 2015a, 2020). The ventral surface is not preserved.

1185

1186   ***Tibia***

1187   The right tibia of AODF 0590 (Fig. 13G–L; Fig. S2; Table S11) is well-preserved but

1188   was fragmented when discovered. It is mediolaterally expanded proximally and distally, and

1189   mediolaterally compressed at the mid-shaft. The anteromedial and proximoposterior edges

1190   are incompletely preserved, resulting in the proximal surface being superficially rhomboidal.

1191   Prior to breaking, the preserved edges of the proximal end indicate that it was rectangular, as

1192   in the type and a referred specimen of *Diamantinasaurus* (Poropat et al., 2015b, 2023).

1193   The proximal surface is smoothly convex anteroposteriorly and bounded by rounded

1194   edges. The cnemial crest projects anteriorly, curving anterolaterally from the proximal

1195   anterior surface, as in *Diamantinasaurus* (Poropat et al., 2015b). The presence of the cnemial

1196   crest results in a concavity on the anterolateral margin. This concavity is bounded posteriorly

1197   by a faint ridge that originates proximolaterally and extends distally until it fades out just

1198   proximal to the base of the cnemial crest; this structure is reminiscent of, albeit less

1199   prominent than, the lateral ridge described as autapomorphic for *Diamantinasaurus* (Poropat

1200   et al., 2015b). Posterior to this ridge, the proximolateral surface is flat, unlike

1201   *Diamantinasaurus* (Poropat et al., 2015b). There is no second cnemial crest, which is also

1202   absent in *Diamantinasaurus* (Poropat et al., 2015b).

1203   Lateral to the base of the cnemial crest, a sharp longitudinal ridge runs

1204   anterodorsally–posteroventrally, terminating at the distal-third of the shaft. Such a ridge was

1205 considered to be autapomorphic for *Diamantinasaurus* by Poropat et al. (2015b). Medial to

1206 the base of the cnemial crest, a smooth ridge descends distomedially along the mid-shaft

1207 where it becomes slightly more pronounced, extending to the distal medial surface where it

1208 joins the anterior-most projection of the medial malleolus. Collectively, these ridges

1209 characterise the anterolateral and anteromedial margins distal to the cnemial crest, as seen in

1210 *Diamantinasaurus* (Poropat et al., 2015b). The anterior surface is smoothly convex along its

1211 mid-shaft and the distal anterior surface is flat, as in *Diamantinasaurus* (Poropat et al., 2015b,

1212 2023). Proximally, the medial surface is flat, becoming smoothly convex at the mid-shaft,

1213 owing to the migration of the aforementioned distomedially oriented ridge. Distal to the

1214 cnemial crest, the lateral surface is flat, apart from the proximal projection of the lateral

1215 malleolus which causes the distal lateral surface to splay out. The lateral and medial surfaces

1216 are separated posteriorly by a faint, proximodistal ridge that becomes slightly more

1217 prominent just proximal to the distal surface.

1218 The mediolateral width of the distal end is more than twice that of the mid-shaft

1219 (Table S11), as in *Diamantinasaurus* (Poropat et al., 2015b). The medial malleolus surface is

1220 flat anteroposteriorly and smoothly convex mediolaterally. This process is angled

1221 posterodistally and bevels onto the medial surface, as well as onto the posterior surface to a

1222 lesser degree. The lateral malleolus surface is flat and is bevelled posterodorsally, such that

1223 its distal surface is visible in posterior view. A vertical groove separates the medial and

1224 lateral malleoli posteriorly, as in *Diamantinasaurus* (Poropat et al., 2015b). The medial

1225 malleolus projects further distally than the lateral malleolus, whereas the lateral malleolus

1226 projects further posteriorly than the medial malleolus, as in *Diamantinasaurus* (Poropat et al.,

1227 2015b).

1228

1229   *Fibula*

1230   The right fibula (Fig. 12M–R; Fig. S3; Table S10) is well-preserved but has been

1231   pieced together from multiple fragments. It is slightly shorter than the tibia and much more

1232   gracile. The fibula is mediolaterally compressed and anteroposteriorly expanded. The

1233   proximal surface is rugose, and only slightly expanded (more so laterally than medially)

1234   relative to the shaft. It is convex anteroposteriorly, as well as mediolaterally, as in

1235   *Diamantinasaurus* (Poropat et al., 2015b), and is oval, slightly tapering to an anteromedial

1236   process, albeit to a lesser degree than *Diamantinasaurus* (Poropat et al., 2015b).

1237   The medial and lateral surfaces are defined by anterior and posterior proximodistal

1238   ridges, both of which run the length of the shaft. As in *Diamantinasaurus* (Poropat et al.,

1239   2015b), the horizontal shaft cross section is 'D'-shaped. The medial surface is convex

1240   proximally, becoming more flattened along the mid-shaft and distally. A subtle

1241   anteroposteriorly-expanded concavity is situated anteromedially, which corresponds to the

1242   proximal triangular scar recognised in *Diamantinasaurus* by Poropat et al. (2015b).

1243   The proximal lateral surface is convex and the lateral trochanter is situated at about

1244   one-third the length of the shaft from the proximal end. The long axis of the lateral trochanter

1245   runs posterodistally, and there is a low ridge anterior to it, as is also the case in

1246   *Diamantinasaurus* (Poropat et al., 2015b). The lateral surface becomes increasingly convex

1247   distally until it reaches the distal margin. Proximal to the distal end of the medial surface,

1248   there is a slight bulge that coincides with the anterior proximodistal ridge, such that the latter

1249   is deflected medially. The distal surface is triangular, with points projecting anteriorly,

1250   posteriorly, and laterally. As in *Diamantinasaurus* (Poropat et al., 2015b), the distal surface is

1251   convex and rounds up onto the posterior and lateral surfaces.

1252

AODF 0591, AODL 0080 ('Bob')

AODF 0591 has only been partially prepared, in part because it was preserved within a weathered concretion. To date, the only diagnostic elements that have been prepared are two caudal vertebrae and a partial left fibula. Additional surface fragments that form part of this specimen include an element that is either the proximal end of a tibia or metapodial, and a weathered element that is either the distal end of a humerus or femur. Given that these latter two elements are too fragmentary and weathered to even confidently identify them, they are not described below.

Caudal vertebrae

Two middle–posterior caudal vertebrae are preserved (Fig. 9AF–AQ; Fig. S4). Both are incomplete, with the larger of the two (caudal vertebra A; Table S12) retaining the base of the neural arch. Based on their relative sizes and morphological disparity, it is inferred that these two caudal vertebrae were not serially adjacent to one another, despite deriving from a similar section of the tail: caudal vertebra A is from a more proximal part of the tail than caudal vertebra B. Caudal vertebra A is most similar in shape to caudal vertebra I of AODF 2296, whereas caudal vertebra B is similar to the posterior caudal vertebrae of AODF 2296. The broken surface of caudal vertebra B reveals a spongiose internal texture. The aEI of the centra of caudal vertebrae A and B is 1.30 and 1.74, respectively (Table 2).

The anterior articular surfaces of both caudal centra are concave centrally and convex around the outer edges. The posterior articular surfaces are shallowly concave, with the anterior surface being slightly larger than the posterior surface, as in the middle caudal centra of *Wintonotitan* (Poropat et al., 2015a). In both specimens, the posterior articular surface is more deeply concave than the anterior surface.

1278   The articular faces of caudal vertebra A are slightly transversely compressed to

1279   subcircular, whereas the articular faces of caudal vertebra B are slightly dorsoventrally

1280   compressed, as in *Wintonotitan* and AODF 2296 (Poropat et al., 2015a). The dorsal margin of

1281   the anterior surface is situated slightly more dorsally than that of the posterior surface in

1282   caudal vertebra A, as in *Wintonotitan* (Poropat et al., 2015a). The articular surfaces of caudal

1283   vertebra B are not sufficiently well preserved to determine if any offset existed. The anterior

1284   margin of each centrum is oriented perpendicular to the ventral margin of the centrum, as is

1285   characteristic of *Savannasaurus* (Poropat et al., 2020). This orientation in *Wintonotitan*

1286   appears to vary throughout the tail; however, it is difficult to determine owing to the

1287   incompleteness of a number of specimens.

1288   There are no lateral pneumatic openings on either specimen, nor do the ventral

1289   surfaces possess any fossae, vascular foramina or ventrolateral ridges, as is also the case in

1290   the centra of *Wintonotitan* (Poropat et al., 2015a), but differing from *Savannasaurus* (Poropat

1291   et al., 2020). The lateral and ventral surfaces of the centra round to meet each other, and in

1292   caudal vertebra A these surfaces are separated by subtle ridges that define the directional

1293   change, as in the middle caudal vertebrae of *Wintonotitan* (Poropat et al., 2015a). The lateral

1294   longitudinal ridge present on some middle caudal vertebrae of *Wintonotitan* is not present in

1295   either of the AODF 0591 centra (Poropat et al., 2015a). However, caudal vertebra A of

1296   AODF 0591 is most similar in size and shape to caudal vertebra N of *Wintonotitan* and the

1297   latter specimen does not possess the aforementioned longitudinal ridge (Poropat et al., 2015a:

1298   fig. 3NA–NF). The right lateral surface of caudal vertebra A has not been prepared, and

1299   fossilised plant material remains adhered to this surface.

1300   The ventral surfaces are flat medially and shallowly convex laterally, as in

1301   *Wintonotitan* (Poropat et al., 2015a). No chevron facets are preserved in either specimen,

1302   although it is unclear whether or not there were any *in vivo* given the distal position of these

1303 vertebrae in the tail. Caudal vertebra A preserves the base of the neural arch, which is located

1304 closer to the anterior than the posterior margin, as in most of the middle–posterior caudal

1305 vertebrae of *Wintonotitan* (Poropat et al., 2015a).

1306

1307 ***Fibula***

1308   AODF 0591 preserves a partial left fibula, missing much of the distal half and a

1309 substantial amount of the anterior surface (Fig. 12S–W; Fig. S5). The proportions of the

1310 fibula indicate that it pertains to a smaller individual (~65%) than the *Diamantinasaurus*

1311 holotype (Fig. 12; Table S10).

1312   The rugose proximal surface is mediolaterally convex and rounds distally onto the

1313 medial and lateral shafts. Along the proximal half of the element, the lateral surface is

1314 anteroposteriorly convex until the projection of the lateral trochanter, whereas the proximal

1315 medial surface is characterised by a shallow triangular scar, with the dorsal edge forming part

1316 of the proximomedial surface. The lateral trochanter is defined by a single ridge, as opposed

1317 to the double ridge that defines the lateral trochanter of *Diamantinasaurus* (Poropat et al.,

1318 2015b). Distal to the triangular scar, the medial surface is flat and does not preserve any

1319 ridges or grooves. The distal-most preserved portion of the element is approximately

1320 equivalent to the mid-shaft and has a 'D'-shaped cross section.

1321

1322 **AODF 2851, AODL 0001**

1323

1324   See discussion of AODF 2854 for a synopsis of the AODL 0001 locality.

1325

Caudal vertebra

This caudal vertebra is represented only by a worn platycoelous centrum (Fig. 9AX–BC; Fig. S6; Table S12), not dissimilar from the posterior caudal vertebrae of AODF 2296 and caudal vertebra B of AODF 0591. The anterior articular surface is flat, whereas the posterior articular surface is slightly concave. The completely preserved lateral surface is anteroposteriorly concave and does not possess any ridges, fossae, or a transverse process. The ventral surface is more strongly concave anteroposteriorly than the lateral surface. Dorsally, the base of the neural arch is preserved, indicating that it was situated on the anterior two-thirds of the centrum.

AODF 0656, AODL 0117 ('Dixie')

Much of AODF 0656 remains unprepared, including several vertebrae, in part because each element (or associated set thereof) was preserved in a fragmented siltstone concretion. These concretions were found atop a fine, grey, massive claystone, and effectively defined a northwest–southeast trending line. The few prepared remains of AODF 0656 include a partial left scapula and a right ulna. These elements demonstrate that AODF 0656 pertains to a larger individual than the *Diamantinasaurus* holotype: the ulna is 10% proximodistally longer (Fig. 2; Table S4). By contrast, the ulna of AODF 0656 is approximately 85% the size of the ulna of the *Australotitan* holotype.

Scapula

All that is preserved of the left scapula is the proximal part of an acromion (Fig. 1E–G). The acromial ridge is not preserved. The proximal surface is rugose, with the coracoid articulation wedge-shaped, and shallowly convex mediolaterally. The glenoid is similarly

55

1351   angled to *Diamantinasaurus* (Poropat et al., 2015b; Rigby et al., 2022). The glenoid articular

1352   surface is flat with rounded edges, and is mediolaterally wider than the coracoid articular

1353   face, as in *Diamantinasaurus* (Poropat et al., 2015b; Rigby et al., 2022). The glenoid is

1354   medially bevelled (Fig. 1E), as in AODF 0663, a juvenile specimen referred to

1355   *Diamantinasaurus* (Rigby et al., 2022), and AODF 0844. The medial surface of the acromion

1356   is dorsoventrally concave, whereas the lateral surface is convex, as in *Diamantinasaurus*,

1357   *Wintonotitan* and *Australotitan* (Poropat et al., 2015a, 2015b; Hocknull et al., 2021; Rigby et

1358   al., 2022). The ventral surface is convex, as in *Diamantinasaurus* and *Wintonotitan* (Poropat

1359   et al., 2015a, 2015b; Rigby et al., 2022).

1360

1361   ***Ulna***

1362   AODF 0656 preserves an almost complete right ulna (Fig. 2Y–AD) that has

1363   experienced slight damage in several regions. The proximal surface is strongly rugose and

1364   'L'-shaped (somewhat exaggerated by the incompleteness of the olecranon process), with the

1365   anteromedial process being more extensive than the anterolateral process, as in

1366   *Diamantinasaurus, Wintonotitan*, and *Australotitan* (Poropat et al., 2015a, 2015b; Hocknull

1367   et al., 2021). The olecranon process is pronounced and projects further dorsally than the

1368   anteromedial and anterolateral processes, as in *Diamantinasaurus, Wintonotitan*, and

1369   *Australotitan* (Poropat et al., 2015a, 2015b; Hocknull et al., 2021). As is the case in

1370   *Diamantinasaurus* and *Australotitan* (Poropat et al., 2015b; Hocknull et al., 2021), the

1371   anteromedial process is flat, with rounded edges at its most prominent point, and becomes

1372   concave as it extends along the proximal surface to meet the olecranon process. Although

1373   incomplete, the anterolateral process appears to have been flat, gently sloping dorsally

1374   towards the olecranon process, as in *Diamantinasaurus* (Poropat et al., 2015b).

1375   The anterior, posterolateral and posteromedial margins of the shaft are separated by

1376   well-defined, proximodistally oriented ridges that extend from the bases of the anteromedial,

1377   anterolateral and olecranon processes to a level just proximal to that of the distal end. Of the

1378   three ridges, the anteromedial ridge is the most prominent, as in *Diamantinasaurus* (Poropat

1379   et al., 2015b). The proximal anterior and posteromedial surfaces are concave, whereas the

1380   proximal posterolateral surface is flat, as in *Diamantinasaurus* (Poropat et al., 2015b). The

1381   distal anterior, posteromedial and posterolateral surfaces are flat, other than the presence of

1382   an interosseous ridge. This extends across approximately the distal two-thirds of the anterior

1383   surface, running from the anterolateral ridge and projecting distomedially, until it terminates

1384   just lateral to the midline of the distal end (Fig. 2Z). The distal surface is heavily rugose and

1385   'D'-shaped, similar to the shape seen in *Diamantinasaurus* and *Wintonotitan* (Poropat et al.,

1386   2015a, 2015b). It is flat medially, becoming convex as the surface rounds up onto the shaft,

1387   as in *Wintonotitan* (Poropat et al., 2015a).

1388

1389   **AODF 0665, AODL 0125 ('Trixie')**

1390

1391   AODF 0665 comprises a partial sauropod skeleton consisting mostly of appendicular

1392   remains, in addition to dorsal ribs. Several elements of AODF 0665 remain unprepared,

1393   including the ribs, a left femur, a left tibia, and other unidentified elements. All preserved

1394   elements of AODF 0665 indicate that it is 10–15% larger than the *Diamantinasaurus*

1395   holotype individual (Table S4, S10–11, S13–14). AODF 0665 was discovered within 100

1396   metres of AODF 0656, but the presence of a right ulna in each specimen demonstrates that

1397   they derive from different individuals, with AODF 0656 slightly larger (Fig. 2; Table S4).

1398

1399   *Ulna*

1400   An incomplete right ulna is preserved (Fig. 2M–R). Based on comparisons with

1401   *Australotitan*, *Diamantinasaurus*, and *Wintonotitan*, relatively little of the distal end is

1402   missing (Fig. 2); by contrast, a significant portion of the proximal end is not preserved. The

1403   transverse cross-section of the proximal-most preserved end is triradiate, as in

1404   *Diamantinasaurus* and *Australotitan* (Hocknull et al., 2021; Poropat et al., 2015b).

1405   Furthermore, comparison of the proximal ulnae of AODF 0665 and *Australotitan* indicates

1406   that these elements are incompletely preserved at a similar horizontal plane, resulting in an

1407   almost identical cross-section.

1408   The preserved portions of the anteromedial and anterolateral processes indicate that

1409   the former extended slightly further than the latter, and was more mediolaterally expanded, as

1410   in *Diamantinasaurus* and *Wintonotitan* (Poropat et al., 2015a, 2015b). The anterolateral and

1411   anteromedial processes of *Diamantinasaurus* and *Australotitan* may have similar dimensions

1412   (accounting for the incompleteness of the proximal end of the latter).

1413   The preserved posterolateral surface, defined by the olecranon and the anterolateral

1414   process, is essentially flat, whereas the anterior and posteromedial surfaces are concave, as in

1415   *Diamantinasaurus, Wintonotitan*, and *Australotitan* (Hocknull et al., 2021; Poropat et al.,

1416   2015a, 2015b). The anterior, medial, and lateral margins are separated by prominent

1417   proximodistally oriented ridges that run the length of the shaft. The distal half of the anterior

1418   surface preserves an interosseous ridge that is situated medially and oriented proximodistally.

1419   This ridge extends to the distal-most portion of the preserved element. Lateral to the ridge,

1420   the surface is flat, whereas medially the surface is concave.

1421

Pubis

Both pubes are preserved in AODF 0665, with the left one more complete than the right element. The left pubis (Fig. 14J, 14L–M, Table S13) preserves neither the ischiadic articulation nor the obturator foramen; instead, fragments of the pubis (and/or ischium) have been distorted and fused in this region. The right pubis (Fig. 14K) preserves the main shaft, but is missing the posteroproximal- and anterodistal-most surfaces of the shaft. The shaft of the right pubis has suffered some post-mortem compaction, and fragments of other bones appear to have fused with this element and fossilised together. Because of the distortion to which the right pubis has been subjected, the following description is based primarily on the left element, unless otherwise specified. The pubis is described in its *in vivo* orientation.

The acetabular region is not well preserved. The preserved portion of the right obturator foramen does not allow for its alignment to be determined, although it resembles the corresponding area in the pubis of *Diamantinasaurus* (Poropat et al., 2015b). Owing to incomplete preservation of the obturator foramen, the presence of a ridge that extends distally from the posterior surface of the obturator foramen, as was regarded autapomorphic for *Savannasaurus* by Poropat et al. (2020), cannot be assessed.

The posteroproximal-most point of the shaft is expanded mediolaterally, becoming increasingly narrow toward the midline of the shaft and then slightly expanding again at the anterodistal-most point of the shaft, as in *Diamantinasaurus* and *Australotitan* (Hocknull et al., 2021; Poropat et al., 2015b). The lateral proximodistal margin is dorsoventrally thicker than the medial proximodistal margin, as in *Diamantinasaurus* and *Australotitan* (Hocknull et al., 2021; Poropat et al., 2015b). The lateral proximodistal margin is concave at a similar angle to *Diamantinasaurus* and *Australotitan* (Hocknull et al., 2021; Poropat et al., 2015b). By contrast, *Savannasaurus* retains a consistently mediolaterally compressed shaft along its axis (Poropat et al., 2020).

1447   The proximal anterior surface of the shaft is shallowly convex until about one-third

1448 the length the shaft, where the surface becomes flat, and remains this way until the distal

1449 anterior surface, as in *Diamantinasaurus* (Poropat et al., 2015b). The proximal posterior

1450 surface is less convex than the proximal anterior surface, as in *Diamantinasaurus* (Poropat et

1451 al., 2015b). The anterodistal-most point of the shaft preserves some rugosity and has a notch

1452 on both the anterior and posterior surfaces, which causes the distal surface to be

1453 anteroposteriorly expanded, as in *Diamantinasaurus* (Poropat et al., 2015b) and

1454 *Savannasaurus* (Poropat et al., 2020), although this is not as prominently developed in the

1455 latter. The distal surface is shallowly convex transversely, as in *Diamantinasaurus* and

1456 *Savannasaurus* (Poropat et al., 2015b, 2020).

1457

1458 ***Femur***

1459   A complete right femur is preserved (Fig. 15S–X, Table S14). The anterior surface is

1460 better preserved than the other surfaces, but poor preservation of the distal condyles impedes

1461 description of their rugosity. The posterior surface is anteroposteriorly crushed and flattened

1462 along its midline, resulting in the femoral shaft appearing more anteroposteriorly compressed

1463 than it would have been in life.

1464   The proximal surface of the femoral head is raised anteromedially, as in

1465 *Diamantinasaurus* (Poropat et al., 2015b, 2023), and the articular head projects medially, as

1466 in *Diamantinasaurus* and *Australotitan* (Hocknull et al., 2021; Poropat et al., 2015b, 2023;

1467 Rigby et al., 2022). The femoral head projects further dorsally than the greater trochanter, as

1468 in a referred specimen of *Diamantinasaurus* (AODF 0906: Poropat et al., 2023); however,

1469 this could be a consequence of a lack of preservation on the posterior surface of the greater

1470 trochanter, rather than representative of its true morphology.

A lateral bulge is present at the proximal-third of the shaft. Dorsal to the lateral bulge, the proximolateral margin is deflected medially to meet with the greater trochanter. Distal to the lateral bulge, the lateral margin is concave, curving medially until about the distal one-third of the shaft, where it curves laterally to the fibular condyle. The anterior shaft is weakly convex, with a proximodistal ridge along the midline. This *linea intermuscularis cranialis* has also been identified in *Diamantinasaurus* and *Australotitan* (Hocknull et al., 2021; Poropat et al., 2015b, 2023; Rigby et al., 2022). The *linea intermuscularis cranialis* is essentially straight along three-quarters of the length of the anterior shaft before changing direction to become a subtly expressed, medially-deflected ridge that meets with the anterior margin of the tibial condyle, as in *Diamantinasaurus* and *Australotitan* (Hocknull et al., 2021; Poropat et al., 2015b). Where the anterior ridge turns medially, the anterior shaft becomes subtly concave along its distal surface.

The proximal posterior surface has suffered crushing. The posterolateral surface is flat until the distal-third of the shaft, where a large concavity is present as the posterior intercondylar fossa, bounded by the fibular and tibial condyles. The depth of this concavity has likely been exaggerated by crushing. The entire posteromedial surface is raised, dropping off at a sharp angle just medial to the position of the fourth trochanter where the surface remains flat until the medial margin. This ridge runs distally until it meets the posterior portion of the tibial condyle, although it has likely been deformed by taphonomic processes. The fourth trochanter is situated just proximal to the mid-length of the posterior medial-most margin, as in *Diamantinasaurus* and *Australotitan* (Hocknull et al., 2021; Poropat et al., 2015b, 2023). The fourth trochanter is incomplete; however, comparison with *Diamantinasaurus* and *Australotitan* suggests little bone is missing. As in *Diamantinasaurus* (Poropat et al., 2015b, 2023), the fourth trochanter is not visible in anterior view.

1495   The medial surface of the tibial condyle is flat, as in *Diamantinasaurus* and

1496   *Australotitan* (Hocknull et al., 2021; Poropat et al., 2015b). The tibial condyle is longer

1497   anteroposteriorly, but narrower mediolaterally, than the fibular condyle, as in

1498   *Diamantinasaurus* and *Australotitan* (Hocknull et al., 2021; Poropat et al., 2015b). Although

1499   not completely preserved, the fibular condyle is divided, forming two distinct condylar

1500   processes (i.e. a well-developed epicondyle). This was considered to be autapomorphic for

1501   *Diamantinasaurus* (Poropat et al., 2015b), although it characterizes most eusauropods

1502   (Carballido et al., 2017; Sekiya, 2011), including *Australotitan* (Hocknull et al., 2021). Along

1503   the distal ventral surface, the fibular condyle extends further distally than the tibial condyle,

1504   as in *Diamantinasaurus* and *Australotitan* (Hocknull et al., 2021; Poropat et al., 2015b).

1505

1506   **Tibia**

1507   Some anteroposterior compression of the right tibia (Fig. 13M–R) appears to have

1508   occured. The ratio of tibia proximodistal length to femur proximodistal length is 0.59;

1509   identical to the ratio in the *Diamantinasaurus* holotype (Poropat et al., 2015b).

1510   The proximal and distal ends are expanded, and the proximal articular surface is

1511   rectangular, although this has likely been exaggerated by anteroposterior compression.

1512   Centrally, the proximal surface is concave, bounded by convex edges. The proximolateral

1513   surface has been crushed distolaterally, such that it almost interrupts the cnemial crest. Along

1514   its anterior and anterolateral margins, the cnemial crest is incompletely preserved.

1515   Nevertheless, it projects anteriorly from the proximal surface and then changes to a lateral

1516   projection, as in *Diamantinasaurus* (Poropat et al., 2015b). The anterolateral fossa is present

1517   posterior to the proximal portion of the cnemial crest, although its true depth cannot be

1518   determined because of the distortion to which the tibia has been subjected. A second

1519   proximodistally expanded fossa is present, just posterior to the base of the cnemial crest.

1520   These two fossae probably represent a single anterolateral fossa that has been distorted.

1521   Posterior to the anterolateral fossa, the crushed posterolateral surface possesses a distomedial

1522   ridge that likely bounded the fossa in life. The distal-most point of this ridge terminates just

1523   proximal to the base of the cnemial crest and meets with the base of an almost vertical

1524   longitudinal ridge that extends close to the base of the posteroproximal surface. Despite this

1525   distortion, these ridges and fossae appear to be similar to those that autapomorphically

1526   characterise the proximolateral surface of *Diamantinasaurus* (Poropat et al., 2015b).

1527   The proximal anteromedial surface is incompletely preserved but appears to have

1528   rounded anteromedially from the cnemial crest to the posteromedial surface. The

1529   proximodistal medial margin is convex and, at the distal one-third of the medial margin, a

1530   faint, rounded anteromedial ridge projects proximolaterally until it fades into the distal

1531   anterior margin of the cnemial crest. Distal to the lateral margin of the cnemial crest, a sharp

1532   ridge defines the proximodistal junction of the anterolateral and posterolateral margins. This

1533   ridge continues just proximal to the distal lateral surface. The distal one-third of the anterior

1534   surface is characterised by a deep fossa bounded by the medial, lateral and distal margins.

1535   This fossa is not a true characteristic of the element; rather, buckling of this element along the

1536   proximal one-quarter indicates that this fossa is a consequence of taphonomic distortion.

1537   The posterior surface is generally flat proximodistally, defined laterally by a sharp

1538   proximodistal ridge and medially by smooth, rounded convexity that continues along the

1539   medial margin. The distal posteromedial surface is flat, as in *Diamantinasaurus* (Poropat et

1540   al., 2015b), and the rugosity from the distal articular surface rounds up onto the medial

1541   surface. The distal articular surface is defined by a medial and lateral malleolus, separated by

1542   a semicircular wedge and vertical groove. The surface of the medial malleolus projects

1543   posterodistally, becoming convex and curving up onto the posterior and posteromedial

1544   surfaces, whereas the surface of the lateral malleolus projects posteroproximally.

63

1545

1546   *Fibula*

1547   The right fibula (Fig. 12G–L) is almost complete but has suffered mediolateral

1548   compression that has resulted in buckling, causing the lateral surface to be more convex than

1549   in life, and the medial surface to be deeply concave. The lateral surface is better preserved

1550   than the medial one, and the proximal and distal ends are incompletely preserved on the

1551   latter. The proximal articular end is mediolaterally compressed and crescentic in cross-

1552   section, as in *Diamantinasaurus* (Poropat et al., 2015b). Laterally, the proximal surface is

1553   convex and rugose. The anterior-most surface of the proximal end has been compressed

1554   distally. Nevertheless, it appears to narrow to an anteromedially facing triangular crest.

1555   The incompleteness and buckling of the medial surface impedes the identification of

1556   most diagnostic features. The proximal posteromedial surface is shallowly concave, bounded

1557   posteriorly by a sharp proximodistally oriented ridge that defines the posterior medial and

1558   lateral surfaces, and anteriorly by a low, vertical ridge that terminates at the mid-length.

1559   Anterodorsal to the ridge, the element is incomplete, whereas anteroventrally it is shallowly

1560   concave. Further distally along the medial shaft, the element becomes increasingly convex,

1561   owing to buckling, until just proximal to the distal end where it is incompletely preserved.

1562   The proximolateral surface is shallowly convex, as in *Diamantinasaurus* (Poropat et

1563   al., 2015b, 2023). A prominent lateral bulge is present at the midline, about one-third the

1564   length of the lateral shaft. This bulge is posterodistally oriented, and bounded proximally and

1565   distally by a faint vertical ridge that terminates a short distance from it, as in

1566   *Diamantinasaurus* (Poropat et al., 2015b, 2023). Posteromedial to the lateral bulge, a shallow

1567   groove is present. A second, more subtle ridge is present just anterodistal to the lateral bulge,

1568   and curves distally along the lateral shaft to the posterior distal surface. A similar shallow

1569 ridge is also present in *Diamantinasaurus* (Poropat et al., 2023). Distal to the lateral bulge,

1570 the lateral shaft is shallowly convex until the distal articular end.

1571   The medial and lateral surfaces are separated by sharp, proximodistally extensive

1572 ridges along the anterior and posterior margins. Whereas the anterior ridge has been

1573 exaggerated by buckling, the posterior one appears more or less as it would in life: it is

1574 sharper towards the proximal end and becomes shallowly convex at the level of the lateral

1575 bulge, as in *Diamantinasaurus* (Poropat et al., 2015b). The distal posterior surface is

1576 incomplete. The distal articular surface is flat to shallowly concave and triangular, with

1577 anterior, posterior, and medial points. As in *Diamantinasaurus* (Poropat et al., 2015b), the

1578 surface is wider anteroposteriorly than mediolaterally, although this might have been

1579 exaggerated by buckling of the AODF 0665 fibula.

1580

1581 **AODF 0666, AODL 0128 ('Devil Dave')**

1582

1583   The astragalus of AODF 0666 was found at the surface, along with numerous

1584 fragments pertaining to a tibia and fibula. Whereas the fibular fragments do not preserve any

1585 diagnostic characters, the tibia and astragalus do, and they are described below. A single

1586 megaraptoran theropod tooth (AODF 0893) was also found at the site. All fossils were hosted

1587 in a fine siltstone horizon overlying an extremely rich macroplant fossil layer.

1588   Because the shaft of the tibia of AODF 0666 has been significantly deformed by

1589 infiltration of the "black soil", its true proximodistal length cannot be obtained. Although it is

1590 proximodistally longer than the tibia of AODF 0603, the dimensions of the proximal and

1591 distal ends are smaller than that of AODF 0603 (Fig. 13, Table S11; Poropat et al., 2015b:

1592 table 16). Comparison of the astragalus of AODF 0666 with that of the *Diamantinasaurus*

1593 holotype indicates that AODF 0666 was a subadult individual, approximately 80% the size of

1594 AODF 0603.

1595

1596 ***Tibia***

1597   The incomplete right tibia (Fig. 13S–X) of AODF 0666 is preserved in two pieces:

1598 one comprising the proximal end, including the cnemial crest, and the other consisting of the

1599 crushed shaft and less distorted distal end. Whereas the shaft of the tibia is infiltrated by

1600 "black soil" (particularly on the medial and posterior surfaces) and is largely uninformative,

1601 the better preserved anterior and lateral surfaces preserve some characteristics. The proximal

1602 anterior and lateral margins are preserved, but the medial and posteromedial surfaces are

1603 incomplete.

1604   The proximal surface is shallowly convex, and the cnemial crest extends from the

1605 proximal anterior surface, curving anterolaterally. Posterior to the preserved cnemial crest is a

1606 fossa that is bounded posteriorly by a lateral ridge that represents the lateral-most projection

1607 of the proximal lateral surface. The proximal posterolateral surface is shallowly convex,

1608 similar to the condition seen in AODF 0590. Distal to the cnemial crest, a sharp anterolateral

1609 ridge separates the anterior and lateral margins and projects distally, until it terminates about

1610 two-thirds the length of the shaft. This anterolateral ridge does not appear to be continuous

1611 with the distal-most point of the cnemial crest; rather, there would have been a smoothly

1612 convex surface separating the two. The preserved distal anterior and lateral surfaces either

1613 side of the anterolateral ridge are generally flat, with the anterior surface shallowly convex at

1614 the mid-shaft.

1615   The distal surface is completely preserved other than the medial margin of the medial

1616 malleolus. The lateral malleolus is flat and is slightly deflected proximoposteriorly–

1617 distoanteriorly; however, the extent of this deflection is insufficient to enable the distal

1618 surface to be visible in lateral view. There is no vertical groove situated between the lateral

1619 and medial malleoli, unlike that observed in *Diamantinasaurus* (Poropat et al., 2015b),

1620 AODF 0590 and AODF 0665. The medial malleolus projects further distally than the lateral

1621 malleolus; however, incompleteness of the medial margin precludes determination of whether

1622 the distal medial surface projected dorsally onto the medial surface of the shaft.

1623

1624 ***Astragalus***

1625   A complete right astragalus is preserved (Fig. 16M–R; Fig. S7; Table S15). The

1626 mediolateral width is 1.40 times greater than the anteroposterior length, similar to the ratio of

1627 1.47 of *Diamantinasaurus* (Poropat et al., 2015b), but unlike the autapomorphically low ratio

1628 of 0.98 for *Savannasaurus* (Poropat et al., 2020). The mediolateral width is 1.5 times greater

1629 than the proximodistal height, identical to the ratio of *Diamantinasaurus* (Poropat et al.,

1630 2015b), but unlike the autapomorphic ratio of 0.87 for *Savannasaurus* (Poropat et al., 2020).

1631   In proximal view, the astragalus is wedge-shaped, with the anterior and lateral

1632 margins of the astragalus essentially straight and meeting at a right angle, as in

1633 *Diamantinasaurus* (Poropat et al., 2015b). The posterolateral margin is straight, with a slight

1634 posterodistal process just posterior to the posteromedial ridge (Fig. 16M and 16P). This

1635 process is in a similar position to the posterior tongue-like process of many sauropods

1636 (D'Emic, 2012; Mannion et al., 2013), but is not as prominent as it is in *Diamantinasaurus*

1637 (Fig. 16J). Medial to this posteriorodistal process, the posterior margin tapers slightly

1638 anteromedially, and the anterior margin curves slightly posteromedially, as in

1639 *Diamantinasaurus* (Poropat et al., 2015b).

1640   A square ascending process is situated on the proximal surface, on the lateral half of

1641 the element, as in *Diamantinasaurus* (Poropat et al., 2015b). Anterior to the tip of the

1642 ascending process, the anterolateral surface is flat and oriented anterodistally. Posterior to the

1643 tip of the ascending process, the posterolateral surface is oriented posterodistally, as in

1644 *Diamantinasaurus* (Poropat et al., 2015b). The anterolateral and posterolateral surfaces meet

1645 at a right-angle at the apex of the ascending process, as in *Diamantinasaurus* and

1646 *Savannasaurus* (Poropat et al., 2015b, 2020).

1647 Just posterior to the apex of the ascending process, there is a shallow sub-triangular

1648 fossa with small foramina within (Fig. 16M), unlike *Savannasaurus* (Fig. 16A; Poropat et al.,

1649 2020). This portion of the holotype astragalus of *Diamantinasaurus* is not sufficiently well-

1650 preserved to allow comparison of this region. The ascending process splits into two ridges,

1651 with the anteromedial ridge projecting medially until it fades out at the proximomedial

1652 surface. The anteromedial ridge is anteroposteriorly thicker, but less well-defined, than the

1653 posteromedial one. The posteromedial ridge is sharp and oriented posteromedially until it

1654 meets the posterior surface. The anteromedial and posteromedial ridges form the anterior and

1655 posterior margins of a set of four foramina located on the medial face of the ascending

1656 process (Fig. 16M and 16O): three foramina occur along the posteromedial ridge, with the

1657 lateral two being larger than the medial-most foramen; and a single, smaller foramen is

1658 located anterior to the middle foramen and medial to the lateral-most foramen. Medial to

1659 these foramina, the medial surface is square and shallowly concave with a raised lip along the

1660 anteroproximal and posteroproximal surfaces.

1661 Foramina are located on the lateral surface (Fig. 16R). The lateral surface does not

1662 possess a rounded anterolateral ridge, unlike *Diamantinasaurus*, for which a lateral ridge was

1663 identified as being potentially autapomorphic by Poropat et al. (2015b). The astragalus is

1664 rugose along its posterior and distal margins, and heavily rugose posteromedially and along

1665 the junctions of the lateral, posterior and distal margins. The posterior and distal surfaces are

1666 convex and merge with each other as the surface rounds, as in *Diamantinasaurus* and

1667 *Savannasaurus* (Poropat et al., 2015b, 2020).

1668

1669 **AODF 0832, AODL 0160 ('Patrice')**

1670

1671   The sauropod fossils discovered at AODL 0160 were encased in several large

1672 concretions that were separated from one other by some distance. Consequently, the fossils

1673 catalogued as AODF 0832 might not belong to a single individual. The relative positions of

1674 bones within individual concretions, and between adjacent ones, were difficult to determine

1675 in the field, partly because the concretions had to be broken up on site using jackhammers to

1676 facilitate their extraction and collection. The majority of these concretions have not been

1677 mechanically prepared, meaning that the overall anatomical scope of AODF 0832 remains

1678 unknown, and only a caudal vertebra and a femur are described below.

1679

1680 *Caudal vertebra*

1681   A single middle caudal vertebra is preserved (Fig. 9AR–AW). Whereas the centrum is

1682 almost complete, the neural arch is represented only by the effectively complete

1683 prezygapophyses, the incomplete postzygapophyses, and the base of the neural spine. The

1684 aEI of this element is 1.41 (Table 2).

1685   Both articular surfaces are transversely compressed and shallowly concave to flat,

1686 with the posterior surface slightly more concave than the anterior. The anterior surface is

1687 slightly larger than the posterior one and is slightly offset dorsally, as in *Wintonotitan*

1688 (Poropat et al., 2015a). The anterior margin of the centrum is perpendicular to the long axis

1689 of the element, as in *Savannasaurus* and potentially *Wintonotitan* (Poropat et al., 2015a,

1690 2020).

1691   Centrally, the lateral surface is anteroposteriorly flat, whereas it is concave close to

1692 the anterior and posterior margins. The lateral surface is dorsoventrally shallowly concave

69

1693 and does not round smoothly to meet with the ventral surface, unlike *Wintonotitan* (Poropat

1694 et al., 2015a). Three horizontal ridges define each lateral surface (Fig. 9AS). The most

1695 prominent ridge is located at about one-third of the dorsoventral height of the centrum. A less

1696 prominent ridge is located at about two-thirds of the dorsoventral height of the centrum. The

1697 other ridge forms the boundary between the lateral and ventral surfaces. The definition of

1698 these ridges is similar to those that were regarded as autapomorphic for *Wintonotitan*

1699 (Poropat et al., 2015a), but they are not as well-defined as those in *Savannasaurus* (Fig. 9N,

1700 9P; Poropat et al., 2020). A small triangular fossa is located at the posteroventral corner of

1701 the right lateral face (Fig. 9AU). This feature is bounded dorsally by the less prominent

1702 lateral ridge, ventrally by the ridge that forms the boundary between the lateral and ventral

1703 surfaces, and posteriorly by the cotyle.

1704 The ventral surface is shallowly anteroposteriorly concave and hosts a posterior

1705 median triangular fossa between the ventrolateral ridges, along the posterior quarter of the

1706 centrum (Fig. 9AW). This posteroventral fossa is deeper, but smaller in diameter, than the

1707 posterolateral fossa. Such distinct posterolateral and posteroventral fossae are not present in

1708 any other sauropod caudal vertebrae reported from the Winton Formation.

1709 The neural arch is similar to that of caudal vertebra L in AODF 2296. The middle of

1710 its base is situated anterior to the mid-length of the centrum, as in most of the middle–

1711 posterior caudal vertebrae of *Wintonotitan* (Poropat et al., 2015a). The neural spine is

1712 transversely narrower than the centrum, whereas the prezygapophyses are elongate and

1713 project further anteriorly than the anterior margin of the centrum. The left prezygapophyseal

1714 articular surface is oriented dorsolaterally, whereas the right is oriented dorsally. The bases of

1715 the prezygapophyses are joined by a thin TPRL that does not form the dorsal margin of the

1716 neural canal, but does form the anteroventral margin of an anteroposteriorly elongated SPRF.

1717 This fossa is bounded laterally by SPRLs that project posterodorsally to the tip of the neural

70

1718 spine, as in AODF 2296. The preserved tip of the neural spine constitutes a longitudinal ridge

1719 that extends along the entire dorsal margin. A longitudinal lateral ridge is present, close to the

1720 tip of the preserved neural spine on both sides, as in AODF 2296. It is more prominent on the

1721 right side. The posterior neural canal is transversely compressed, and the postzygapophyses

1722 are thin, laterally facing processes on the neural spine.

1723

1724 ***Femur***

1725   A complete right femur is preserved (Fig. 15G–L). Its proximodistal length is

1726 approximately 85% the size of the *Diamantinasaurus* holotype (Poropat et al., 2015b). The

1727 proximal surface is heavily rugose and mediolaterally concave, as in *Diamantinasaurus*

1728 (Poropat et al., 2015b). The femoral head is located only slightly dorsal to the greater

1729 trochanter and projects further medially than any other part of the element, as in

1730 *Diamantinasaurus* and *Australotitan* (Hocknull et al., 2021; Poropat et al., 2015b; Rigby et

1731 al., 2022).

1732   Distal to the greater trochanter, the lateral margin is convex, forming a crest at the

1733 lateral bulge. Proximal to the lateral bulge, the proximolateral margin is deflected medially,

1734 as in *Diamantinasaurus* and *Australotitan* (Hocknull et al., 2021; Poropat et al., 2015b,

1735 2023), whereas distal to the lateral bulge, the distolateral margin is concave, as in

1736 *Diamantinasaurus* (Poropat et al., 2015b, 2023). Distal to the femoral head, the medial

1737 margin is convex; in anterior view, the fourth trochanter is not visible.

1738   The proximal anterior surface is flat, unlike *Diamantinasaurus* (Poropat et al., 2015b).

1739 Distal to this, the anterior surface is defined by a median vertical cavity that extends the distal

1740 two-thirds of the shaft, such that the distal two-thirds of the anterior surface are transversely

1741 concave. At the distal one-third of the anterior shaft, this cavity curves medially until it

1742 reaches the tibial condyle, creating a mediolaterally wider concavity present between the

1743   fibular and tibial condyles. *Diamantinasaurus* and *Australotitan* each possess an anterior

1744   concavity between the fibular and tibial condyles (Hocknull et al., 2021; Poropat et al.,

1745   2015b, 2023; Rigby et al., 2022). We note the possibility that the anterior cavity of AODF

1746   0832 is congruent with the concavity present lateral to the *linea intermuscularis cranialis*

1747   observed in *Diamantinasaurus* by Poropat et al. (2015b). If true, it would mean the faint

1748   medial ridge on the distal-anterior surface that curves laterally to join the tibial condyle is, in

1749   fact, the *linea intermuscularis cranialis*.

1750   The proximal posterior surface is defined laterally by a trochanteric shelf which

1751   projects from the proximolateral surface vertically until it fades out at the same point as the

1752   distal-most projection of the fourth trochanter. The trochanteric shelf of *Diamantinasaurus*

1753   does not extend as far distally as the fourth trochanter, but both AODF 0832 and

1754   *Diamantinasaurus* possess a concavity lateral to the trochanteric shelf (Poropat et al., 2015b).

1755   Medial to the trochanteric shelf, the proximal posterior surface is shallowly concave.

1756   The fourth trochanter is a prominent ridge that is longer proximodistally than it is

1757   wide mediolaterally. Lateral to the fourth trochanter and medial to the trochanteric shelf, a

1758   deep concavity is present that is defined by the dimensions of these trochanters. The posterior

1759   mid-shaft surface is flat and the distal surface is concave, bounded medially by a

1760   posteromedial ridge and laterally by a posterolateral one. Each of these ridges becomes more

1761   prominent until the former meets the tibial condyle and the latter meets the fibular condyle.

1762   These ridges are more prominent than those observed in *Diamantinasaurus* and *Australotitan*

1763   (Hocknull et al., 2021; Poropat et al., 2015b, 2023), but are similar to those seen in AODF

1764   0665.

1765   The tibial condyle is longer anteroposteriorly, but narrower mediolaterally, than the

1766   fibular condyle. As in *Diamantinasaurus* and *Australotitan*, the medial surface of the tibial

1767   condyle is flat (Hocknull et al., 2021; Poropat et al., 2015b). Two prominent ridges that are

1768 separated by a deep groove define the fibular condyle. The fibular condyle does not extend

1769 further distally than the tibial condyle, unlike *Diamantinasaurus* and *Australotitan* (Hocknull

1770 et al., 2021; Poropat et al., 2015b, 2023).

1771

1772 **AODF 2306, AODL 0137**

1773

1774 The only fossil collecting conducted at AODL 0137 was surficial; the site has not

1775 been excavated. Consequently, the geological context of the caudal vertebra described below

1776 remains unknown.

1777

1778 ***Caudal vertebra***

1779 This specimen constitutes an isolated caudal vertebra (Fig. 9Z–AE) deriving from the

1780 anterior–middle region of the tail. Whereas the dorsal half of the centrum is complete, the

1781 ventral half is incompletely preserved. The posterior articular surface is better preserved than

1782 the anterior one and only the base of the neural arch is preserved. The broken surfaces of the

1783 caudal centrum reveal a spongoise internal texture, as in *Diamantinasaurus*, *Wintonotitan*,

1784 *Savannasaurus* (Hocknull et al., 2021; Poropat et al., 2015a, 2020, 2023) and AODF 2296.

1785 The centrum is anteroposteriorly longer than it is transversely wide, and does not appear to

1786 show any compression, although this could be an artefact of its incomplete preservation. The

1787 aEI of this element is 1.02 (Table 2), unlike *Diamantinasaurus* (0.63; Poropat et al., 2023)

1788 and the middle caudal vertebrae of *Wintonotitan* (1.19–1.90; Poropat et al., 2015a). In

1789 comparison, the anterior and middle caudal centra of *Savannasaurus* have aEIs that range

1790 between 0.59 and 1.09 (Table 2).

1791 The centrum is amphicoelous, with the posterior surface more concave than the

1792 anterior surface, as in *Savannasaurus* (Poropat et al., 2020). The centre of each articular

1793 surface hosts a distinct bulge, with the anterior bulge (Fig. 9Z) better defined than the

1794 posterior one (Fig. 9AB). An identical bulge has been identified on the anterior surface of

1795 two anterior caudal vertebrae of *Savannasaurus* (Fig. 9A and 9M; Poropat et al., 2020), but

1796 not on any caudal vertebrae of *Diamantinasaurus* or *Wintonotitan* (Poropat et al., 2015a,

1797 2023). The anterior surface extends further dorsally than the posterior one, as in *Wintonotitan*

1798 and *Savannasaurus* (Poropat et al., 2015a, 2020), and the edges of the articular surfaces are

1799 convex as they round onto the dorsal and lateral surfaces.

1800   The lateral surfaces are dorsoventrally flat and anteroposteriorly concave. It is

1801 possible that this concavity formed part of a pneumatic fossa, as is characteristic of

1802 *Savannasaurus* (Poropat et al., 2020), although this is speculative in light of the

1803 incompleteness of the element. A reduced transverse process is preserved on the left lateral

1804 surface, situated just ventral to the anterior-most point of the neural arch. It projects

1805 posteroventrally until the level of the posterior-most point of the neural arch. The process

1806 becomes more distinct the further posteriorly it projects. A similarly reduced transverse

1807 process has been recognised in an anterior caudal vertebra of *Savannasaurus* (Poropat et al.,

1808 2020). The transverse process forms the ventral base of a triangular concavity that is bounded

1809 dorsally by the base of the neural arch, which is located closer to the anterior margin than the

1810 posterior one. The right lateral surface of AODF 2306 possesses two anteroposteriorly

1811 elongate longitudinal ridges, similar to those of *Savannasaurus* (Poropat et al., 2020).

1812

1813 **AODF 0032, AODL 0049 ('Mick')**

1814

1815   AODF 0032 was discovered on a property west of Winton, Queensland. The AODL

1816 0049 site has never been excavated, and its geological setting remains unconstrained; all

1817 material pertaining to AODF 0032 was collected at the surface, and each element has been

1818   pieced together from fragments. These elements include three cervical vertebrae, eight caudal

1819   vertebrae, a left humerus, a left pubis, and a left ischium.

1820

1821   ***Cervical vertebrae***

1822   Two elongate middle cervical vertebrae and a dorsoventrally shorter, more robust

1823   posterior cervical vertebra are preserved (Fig. 17D–R; Fig. S8–S9; Table S16). None of these

1824   are complete, although the lengths of their centra can be ascertained, and some significant

1825   anatomical information can be derived from the preserved portions. The vertebrae are

1826   strongly opisthocoelous and have a semicamellate internal texture.

1827

1828   *Middle cervical vertebrae*

1829   Two middle cervical vertebrae are preserved, hereby referred to as middle cervical

1830   vertebra A (Fig. 17D–H) and B (Fig. 17I–M). The more completely preserved vertebra (A) is

1831   fragmentary, but preserves a virtually complete centrum along the right lateral surface. The

1832   centrum has been crushed, the neural spine is absent, and only one apophysis — the right

1833   parapophysis — is preserved. Only the ventral half of the centrum of cervical vertebra B is

1834   preserved, and it is almost the same length as cervical vertebra A. Owing to its greater

1835   completeness, the following description of the middle cervical vertebrae will be primarily

1836   based upon cervical vertebra A unless otherwise specified.

1837   The middle cervical centra of AODF 0032 are elongate, with cervical vertebra B

1838   having an approximate aEI of ~2.87. Crushing of the centrum has caused the anterior condyle

1839   and posterior cotyle to appear significantly taller dorsoventrally than they are wide

1840   transversely. However, the posterior cotyle appears to have been less affected by crushing.

1841   Neither condyle nor cotyle is completely preserved, although it appears that the posterior

1842 cotyle more accurately reflects the relative dimensions of the articular ends of the centrum in

1843 being slightly transversely wider than dorsoventrally tall.

1844 The lateral surface of the centrum is incompletely preserved but can be seen to

1845 undulate along its length. At the anterior end of the centrum, the lateral surface is shallowly

1846 anteroposteriorly concave immediately posterior to the condyle and dorsal to the

1847 parapophysis. This concavity extends along much of the surface, becoming more pronounced

1848 medially towards the mid-length of the centrum, before sweeping laterally further posteriorly

1849 as it approaches and reaches the posterior cotyle. The lateral fossa is presumably responsible

1850 for this medial constriction. Anterior to the parapophysis, the lateral and ventral surfaces are

1851 separated by the ACPL, whereas posteriorly they are separated by the PCPL. The ventral

1852 surface of the centrum is markedly anteroposteriorly concave between the parapophysis and

1853 its associated laminae, and a subtle midline keel is present along the mid-line; this feature

1854 does not extend as far as the anterior or posterior margins.

1855 The dorsal surface of the parapophysis is flat to broadly convex anteroposteriorly,

1856 with a thin anterolaterally–posteromedially oriented ridge. Anterior to this ridge, the

1857 parapophysis is largely flat, sloping slightly anteriorly before descending abruptly to merge

1858 with the ventral surface of the parapophysis, which is poorly preserved. Its dorsal surface is

1859 unexcavated, as is also the case in *Savannasaurus* and a referred specimen of

1860 *Diamantinasaurus* (AODF 0836: Poropat et al., 2016, 2020, 2021).

1861

1862 *Posterior cervical vertebra*

1863 The posterior cervical vertebra (vertebra C) preserves much of the centrum but the

1864 anterior surface is incomplete. Despite its incomplete preservation, it is clear that cervical

1865 vertebra C (Fig. 17N–R) was less elongate than the middle cervical vertebrae, with an

1866 approximate aEI of ~0.94. It is postulated that this cervical vertebra was situated very close to

1867 the base of the neck on the basis of its morphology, its massive construction, and

1868 comparisons with the presacral vertebrae of *Savannasaurus* (Poropat et al., 2020).

1869   The markedly concave posterior cotyle is dorsoventrally compressed, as in the sole

1870 preserved cervical vertebra of *Savannasaurus* (Poropat et al., 2020). The ventral surface of

1871 the centrum is smooth, transversely convex and anteroposteriorly concave. The ventral

1872 surface lacks a midline keel, unlike *Savannasaurus* (Fig. 17B; Poropat et al., 2020).

1873 However, this feature can be prone to serial variation (Poropat et al., 2020, 2021). An

1874 anteroposteriorly elongate, deep, elliptical pneumatic fossa, defines the lateral surface of the

1875 centrum, contrasting with the short, shallow, elliptical pneumatic fossa of the posterior

1876 cervical vertebra of *Savannasaurus* (Poropat et al., 2020). The ventral margin of the lateral

1877 fossa probably represents the base of the PCPL. The base of the left PCDL originates dorsal

1878 to the mid-point of the lateral fossa, whereas that of the right PCDL originates dorsal to the

1879 posterior-most part of the fossa, which is also the case in *Savannasaurus* (Poropat et al.,

1880 2020). Although it is missing much of its mid-section, the PCDL is clearly inclined

1881 anterodorsally–posteroventrally, and the anterior portion of this lamina can be observed on

1882 the posterior margin of the right diapophysis (the only preserved apophysis). The laterally-

1883 projecting diapophysis is extremely weathered, rendering it relatively uninformative.

1884

1885 ***Caudal vertebrae***

1886   A total of five anterior–middle and three middle–posterior caudal vertebrae are

1887 preserved (herein referred to as caudal vertebrae A–H), as well as a presumed pair of isolated

1888 anterior–middle left and right prezygapophyses, and a partial anterior–middle neural spine

1889 with prezygapophyses (Fig. 18–19; Fig. S10). All preserved caudal centra are shallowly

1890 amphicoelous, as in *Savannasaurus*, a referred specimen of *Diamantinasaurus* (AODF 0906),

1891 and most of the caudal vertebrae of *Wintonotitan* (Poropat et al., 2015a, 2020, 2023). The

1892 anterior caudal vertebrae are anteroposteriorly shorter than the posterior caudal vertebrae,

1893 unlike *Wintonotitan* (Poropat et al., 2015a). In places where the surface bone has worn away,

1894 the internal texture of the centrum and neural spine is spongiose. Owing to incompleteness,

1895 the aEIs cannot be accurately calculated for any of the caudal vertebrae, but the minimum

1896 aEIs of the more complete anterior–middle caudal vertebrae (outlined in Table 1) range from

1897 0.25–0.37, which is the plesiomorphic condition in titanosauriforms (Mannion et al., 2013).

1898

1899 *Anterior–middle caudal vertebrae*

1900   The anterior-most caudal vertebra (A) comprises an incomplete centrum preserving

1901 the bases for the transverse processes, the base of the neural arch, and the floor of the neural

1902 canal (Fig. 18A–F). Caudal vertebra B (Fig. 18G–L) is the second largest in the series, and is

1903 much more complete than caudal vertebra A. Its centrum is complete on all faces except the

1904 posterior one, whereas the neural arch is represented by complete prezygapophyses, the base

1905 of the neural spine, and the incomplete bases of the postzygapophyses. The third largest

1906 caudal vertebra (C) preserves the posterior and ventral portions of the centrum, but is missing

1907 the dorsal portion of the centrum and the majority of the anterior surface (Fig. 18M–R). The

1908 next largest (D) preserves the posterior articular surface, the majority of the lateral and

1909 ventral margins of the centrum, and the base of the neural spine (Fig. 18S–X); however, the

1910 remainder of the vertebra has been lost. Caudal vertebra E (Fig. 18Y–AD) is represented only

1911 by a partial centrum preserving the anterior articular surface and much of the lateral and

1912 ventral margins.

1913   The caudal centra are slightly concave on both articular surfaces, and the anterior end

1914 is larger than the posterior cotyle. The anterior and posterior articular surfaces are slightly

1915 broader than the mid-section of the vertebra, creating a subtle hourglass-shape in cross-

1916 section. As in *Wintonotitan* and a referred specimen of *Diamantinasaurus* (AODF 0906), the

articular faces are dorsoventrally compressed (Poropat et al., 2015a, 2023). The centrum of caudal vertebra E is more dorsoventrally compressed than the preceding caudal vertebrae, a trend continued in the more posterior caudal vertebrae. This is unlike *Wintonotitan*, which does not show an increase in dorsoventral compression through its caudal sequence (Poropat et al., 2015a). In each caudal vertebra of AODF 0032, the articular faces are transversely wider and dorsoventrally taller than the centrum is anteroposteriorly long.

The lateral surfaces lack pneumatic fossae and are smoothly concave anteroposteriorly, with convex edges that curve onto the anterior and posterior faces, as in *Wintonotitan*, a referred specimen of *Diamantinasaurus* (Poropat et al., 2015a, 2023) and AODF 2296, but unlike *Savannasaurus* (Poropat et al., 2020). The ventral surfaces are convex, rounding onto the lateral faces. The exception to this is the ventral surface of the centrum of caudal vertebra B, which has a very subtle mid-line transverse concavity bounded by two minor anteroposterior ridges (Fig. 18L). Subtle ventrolateral ridges define caudal vertebrae C, D, and E.

The bases of the transverse processes are situated slightly dorsal to the mid-height of the centrum, and are oriented posterolaterally. This, combined with their relatively small size, suggests that they were reduced. In comparison, the transverse processes of caudal vertebra D are reduced to small, posterolaterally-directed nodes on the dorsolateral margins of the centrum, as in *Wintonotitan* (Poropat et al., 2015a) and AODF 2296.

The prezygapophyses are simple structures that project beyond the anterior articular surface of the centrum (Fig. 18K). The prezygapophyseal facets face dorsomedially (Fig. 18K, 19U and 19W), and the bases of the articular facets descend ventrolaterally to connect with the dorsal margin of the transverse processes, as in *Savannasaurus* (Poropat et al., 2020). Unlike AODF 2296, the prezygapophyses are not connected by a TPRL. Based on the preserved portion of its base, the neural spine would have projected strongly posterodorsally.

1942

1943   *Middle–posterior caudal vertebrae*

1944   The middle–posterior caudal vertebrae F, G and H (Fig. 19A–F, 19G–L and 19M–R,

1945   respectively) are each composed of the ventral half of a centrum. They are more elongate

1946   than the anterior caudal vertebrae, although only the ventral margins are relatively complete.

1947   The articular faces are amphicoelous–amphiplatyan and do not possess the incipient

1948   biconvexity seen in the posterior caudal vertebrae of *Wintonotitan* (Poropat et al., 2015a) and

1949   AODF 2296. The lateral surfaces are incompletely preserved on all three vertebrae, but

1950   appear to round onto the ventral surfaces. As in *Wintonotitan* (Poropat et al., 2015a), the

1951   preserved portions do not possess ventral or ventrolateral ridges, and the ventral surface is

1952   anteroposteriorly flat and transversely convex.

1953

1954   **Humerus**

1955   Both the proximal and distal ends of the posterior face of the left humerus are

1956   preserved in AODF 0032 (Fig. 20M–R; Fig. S11; Table S17). The anterior surface is not

1957   preserved, nor is the mid-shaft; thus, the minimum total length of this element can only be

1958   estimated. The proximolateral margin is better preserved than the proximomedial one. The

1959   humeral head is located closer to the medial margin than the lateral one, as in

1960   *Diamantinasaurus* (Poropat et al., 2015b), and the proximal end becomes more

1961   anteroposteriorly compressed further laterally. The humeral head is less pronounced, and

1962   does not project as far dorsally above the proximal medial and lateral surfaces as it does in

1963   *Diamantinasaurus* and *Savannasaurus* (Poropat et al., 2015b, 2020).

1964   The proximal surface is expanded mediolaterally and is convex posteriorly and

1965   transversely, sloping only slightly from a distinctly rugose humeral head onto the lateral and

1966   medial margins. The proximal surface meets the lateral margin at an angle of approximately

1967 90°, as is characteristic of *Diamantinasaurus* (Poropat et al., 2015b). The proximal-most

1968 point of the medial margin projects proximodistally, unlike the medial projection of

1969 *Diamantinasaurus* and *Australotitan* (Hocknull et al., 2021; Poropat et al., 2015b). The

1970 proximal portion of the lateral margin continues to project distally until approximately one-

1971 third the length of the posterolateral margin of the shaft, where there is a bulge (Fig. 20Q).

1972 This bulge is the site for *M. scapulohumeralis anterior* or *M. deltoideus clavicularis* (Otero,

1973 2010; Upchurch et al., 2015) and is also characteristic of the juvenile specimen of

1974 *Diamantinasaurus* (AODF 0663; Rigby et al., 2022), but it is absent in the holotype

1975 specimens of *Diamantinasaurus* and *Australotitan* (Hocknull et al., 2021; Poropat et al.,

1976 2015b). By contrast, it cannot be confidently assessed in *Savannasaurus* or *Wintonotitan*

1977 (Poropat et al., 2015a, 2020). The medial and lateral margins do not appear to have hosted a

1978 proximodistally oriented ridge separating the anterior and posterior surfaces, distinguishing

1979 AODF 0032 from *Savannasaurus* (Poropat et al., 2020).

1980 The posterior surface of the humerus is defined by a proximodistally oriented ridge

1981 that stems from the base of the humeral head, as in *Diamantinasaurus, Savannasaurus*, and

1982 *Australotitan* (Hocknull et al., 2021; Poropat et al., 2015b, 2020). However, the orientation of

1983 the posterior ridge of AODF 0032 is more similar to that of the referred juvenile

1984 *Diamantinasaurus* specimen (AODF 0663; proximodistal) than those of the adult holotype

1985 specimens of *Diamantinasaurus* and *Savannasaurus*, which both project distomedially

1986 (Poropat et al., 2015b, 2020; Rigby et al., 2022). Owing to incompleteness of the element, the

1987 distal-most projection of this ridge cannot be determined. Lateral to the longitudinal ridge,

1988 the posterior surface of the humerus is slightly concave, as in *Diamantinasaurus,*

1989 *Wintonotitan*, and *Australotitan*, but unlike *Savannasaurus* (Hocknull et al., 2021; Poropat et

1990 al., 2015a, 2015b, 2020; Rigby et al., 2022). The shaft narrows significantly at the mid-shaft

1991 along both the medial and lateral margins (although to a higher degree along the lateral

1992   margin), and then expands towards the distal epiphysis to a similar mediolateral width, as

1993   seen in *Diamantinasaurus* (Poropat et al., 2015b; Rigby et al., 2022).

1994   Along the anterolateral margin of the distal anterior surface, a shallow fossa is

1995   present, as in *Diamantinasaurus* and *Australotitan* (Hocknull et al., 2021; Poropat et al.,

1996   2015b). The distal-most anterior surface, although incompletely preserved, appears to have

1997   had a divided condyle, with the lateral condyle being more prominent than the medial. This

1998   divided surface is characteristic of *Diamantinasaurus* and *Australotitan* (Hocknull et al.,

1999   2021; Poropat et al., 2015b; Rigby et al., 2022).

2000   The distal portion of the humerus is fairly well-preserved on its posterior surface,

2001   where a distinct depression is present between the medial and lateral condyles. This anconeal

2002   fossa is deep, as in *Diamantinasaurus* and *Australotitan*, but more so than in *Savannasaurus*

2003   (Hocknull et al., 2021; Poropat et al., 2015b, 2020; Rigby et al., 2022). This fossa extends

2004   distally to the base of the element, but its proximal-most projection cannot be assessed owing

2005   to incompleteness. The distal posterior surface is broadly convex anteroposteriorly and is flat

2006   to shallowly convex mediolaterally. The distal posterior surface is broadly convex

2007   anteroposteriorly and is flat to shallowly convex mediolaterally, rounding up onto the anterior

2008   and posterior surfaces. The lateral condyle is slightly better-developed and thicker

2009   anteroposteriorly than the medial one, as in *Diamantinasaurus* and *Australotitan* (Hocknull et

2010   al., 2021; Poropat et al., 2015b; Rigby et al., 2022).

2011

2012   ***Pubis***

2013   The left pubis preserves the acetabular margin, the ischiadic articulation and a

2014   virtually complete shaft (Fig. 14N–P; Fig. S12). However, only the base of the iliac peduncle

2015   is preserved; the anterior and posterior surfaces of the shaft both appear to preserve complete

2016   edges, with the posterior surface being more complete than the anterior one. The

2017 anteroposterior thickness of the pubis is significantly less than that of *Diamantinasaurus*,

2018 *Savannasaurus*, or *Australotitan* (see Fig. 14A, 14D, 14G, 14J and 14N; Hocknull et al.,

2019 2021; Poropat et al., 2015b, 2020). At its most complete point, the pubis of AODF 0032 is

2020 222 mm wide mediolaterally (Table S13). Measurements taken from the same approximate

2021 point for the Winton Formation holotypes are ~310 mm for *Diamantinasaurus*, ~400 mm for

2022 *Savannasaurus* and ~600 mm for *Australotitan* (Hocknull et al, 2021; Poropat et al., 2015a,

2023 2015b, 2020). By contrast, the proximodistal length of the pubis of AODF 0032 is 940 mm,

2024 whereas it is 1000 mm for *Diamantinasaurus*, 940 mm for *Savannasaurus* and 1263 mm for

2025 *Australotitan* (Hocknull et al, 2021; Poropat et al., 2015a, 2015b, 2020).

2026 The angle of the preserved portion of the iliac peduncle does not resemble that of

2027 *Diamantinasaurus*, *Savannasaurus* or *Australotitan* (Hocknull et al., 2021; Poropat et al.,

2028 2015b, 2020). The obturator foramen is located close to the junction between the acetabular

2029 margin and the ischiadic articulation, differing from *Diamantinasaurus*, *Savannasaurus* and

2030 *Australotitan* wherein the foramen is further from the acetabular margin (Hocknull et al.,

2031 2021; Poropat et al., 2015b, 2020). Despite being incompletely preserved, the obturator

2032 foramen is oval with its long axis dorsoventral, unlike that of *Diamantinasaurus*,

2033 *Savannasaurus* and *Australotitan*, which are all inclined (Hocknull et al., 2021; Poropat et al.,

2034 2015b, 2020).

2035 Distal to the obturator foramen, the anterior surface of the pubis is mediolaterally flat

2036 to shallowly concave, whereas the posterior surface is mediolaterally convex. The preserved

2037 lateral and medial margins are similarly anteroposteriorly thick, as in *Savannasaurus*

2038 (Poropat et al., 2020), but unlike *Diamantinasaurus* and *Australotitan*, which both possess an

2039 anteroposteriorly thicker lateral margin and an anteroposteriorly thinner medial margin

2040 (Hocknull et al., 2021; Poropat et al., 2015b). Nevertheless, the shaft is more similar in

2041 anteroposterior thickness to those of *Diamantinasaurus* and *Australotitan* than to the

2042 comparatively thinner *Savannasaurus* (Hocknull et al., 2021; Poropat et al., 2015b, 2020).

2043 Owing to the incompleteness of the element, it cannot be determined whether the pubes were

2044 fused along the midline.

2045

2046 ***Ischium***

2047   AODF 0032 preserves a partial left ischium (Fig. 14Q–U; Fig. S13) comprising the

2048 iliac peduncle, and the proximolateral and posterior margins of the shaft. The acetabular

2049 margin and the distal shaft of the ischium have been lost, and the incompleteness of the

2050 element precludes the determination of the degree of fusion between the paired ischia. The

2051 proximal iliac articular surface is subcircular, as in *Wintonotitan*, but unlike those of

2052 *Diamantinasaurus, Savannasaurus*, and *Australotitan* (Hocknull et al., 2021; Poropat et al.,

2053 2015a, 2015b, 2020, 2021). It is gently convex mediolaterally, like that of *Diamantinasaurus,*

2054 *Wintonotitan* and *Savannasaurus* (Poropat et al., 2015a, 2015b, 2020, 2021). The surface is

2055 undivided, unlike *Diamantinasaurus*, which is split into three separate surfaces (Poropat et

2056 al., 2021).

2057   Distal to the iliac articulation, the shaft of the ischium becomes transversely

2058 compressed. The proximal-most portion of the lateral surface is shallowly convex before

2059 becoming increasingly concave posteriorly, whereas the preserved portion of the medial

2060 surface is convex; this distinguishes AODF 0032 from *Diamantinasaurus* and

2061 *Savannasaurus*, wherein the lateral surface is convex and the medial surface is concave

2062 (Poropat et al., 2015b, 2020, 2021). The ischium of *Australotitan* has been crushed and

2063 distorted (Hocknull et al., 2021), thus the angle between the lateral and medial surfaces is

2064 difficult to establish. Nevertheless, it appears that the lateral and medial surfaces are flat to

2065 shallowly convex in that taxon. A posterolateral ridge that projects posterolaterally appears to

2066 be present at the base of the preserved ischium of AODF 0032 (Fig. 14U). This ridge was

84

2067 likely the attachment point for the *M. flexor tibialis internus III* muscle and is also present in

2068 *Diamantinasaurus* (Fig. 14D and 14G)*, Savannasaurus* (Fig. 14A), *Wintonotitan*, and

2069 *Australotitan* (Hocknull et al., 2021; Poropat et al., 2015a, 2015b, 2020, 2021). The posterior

2070 margin is proximodistally convex, at a similar angle to *Diamantinasaurus*, *Wintonotitan* and

2071 *Savannasaurus* (Poropat et al., 2015a, 2015b, 2020, 2021).

2072

2073 **Reassessment of the taxonomic assignment of material previously referred to**

2074 ***Australotitan cooperensis***

2075

2076   The holotype specimen of *Australotitan cooperensis* (EMF102) was described by

2077 Hocknull et al. (2021) and comprises a partial left scapula, a partial left and complete right

2078 humerus, a right ulna, left and right pubes and ischia, and partial left and right femora. Those

2079 authors referred three additional specimens (EMF105, EMF164 and EMF165) and

2080 provisionally referred three further specimens (EMF100, EMF106 and EMF109) to the taxon.

2081 Here, we re-evaluate those referrals owing to differences and/or a lack of anatomical overlap

2082 with the type material.

2083

2084 ***EMF164***

2085   Hocknull et al. (2021) reported that this large sauropod specimen preserves a

2086 fragmentary femur, which they figured, as well as fragments of presacral vertebrae and a

2087 fragmentary ulna, which they did not figure. Although Hocknull et al. (2021) did not

2088 explicitly outline which characters of EMF164 led them to refer it to *Australotitan*, they did

2089 describe the incomplete ulna as sharing the presence of an interosseous ridge. However, as

2090 outlined above, this can be recognised in *Diamantinasaurus*, *Wintonotitan*, *Australotitan*,

2091 AODF 0656, AODF 0665, and AODF 2296.

2092

EMF106

2093

2094   EMF106 was reported by Hocknull et al. (2021) to comprise an incomplete middle

2095 caudal vertebral centrum and a metapodial articular end, although only one partial caudal

2096 vertebral centrum was figured. Given that the holotype specimen of *Australotitan* preserves

2097 neither caudal vertebrae nor metapodials, the referral of EMF106 to *Australotitan* —

2098 provisional or otherwise — is difficult to justify. Hocknull et al. (2021) interpreted the only

2099 caudal vertebra they figured as a middle caudal vertebra, but herein it is regarded as an

2100 anterior caudal vertebra based on comparisons with the caudal vertebrae of *Wintonotitan*,

2101 *Savannasaurus* (Poropat et al., 2015a, 2020) and AODF 2296. The anterior surface *sensu*

2102 Hocknull et al. (2021: fig. 29G) is actually the posterior surface: the dorsal margin of the

2103 anterior articular surface is positioned further dorsally than that of the posterior articular

2104 surface, causing the ventral surface to be inclined anterodorsally–posteroventrally, as in

2105 *Savannasaurus* and AODF 2296. All that is observable in EMF106 is the left lateral half of

2106 the centrum and the base of the neural arch. The centrum is amphicoelous (Hocknull et al.,

2107 2021), with its anterior surface more strongly concave than the posterior surface, as in the

2108 anterior caudal vertebrae of *Wintonotitan* and AODF 2296, but unlike *Savannasaurus*

2109 (Poropat et al., 2015a, 2020). Unlike *Wintonotitan*, *Savannasaurus* and AODF 2296, the

2110 caudal vertebra is dorsoventrally tall and transversely compressed (Poropat et al., 2015a,

2111 2020). The articular surfaces do not undulate, instead being evenly concave, thereby

2112 distinguishing EMF106 from *Savannasaurus* (Poropat et al., 2020). The lateral and ventral

2113 surfaces lack the foramina seen in *Savannasaurus* (Poropat et al., 2020). Two faint

2114 longitudinal ridges are situated on the lateral surface at one-third and two-thirds the height of

2115 the centrum. In between the ridges, a shallow concavity is present. Dorsal and ventral to the

2116 ridges, the surface rounds onto the dorsal and ventral surfaces, respectively. Although

2117 transverse processes appear not to be present, it is probable that the more dorsal longitudinal

2118 ridge is the base of a broken transverse process: the surface dorsal to that longitudinal ridge

2119 presents internal bone, as in caudal vertebra C of AODF 2296. The presence of a longitudinal

2120 ridge at two-thirds the height of the centrum was proposed to be autapomorphic for

2121 *Wintonotitan* (Poropat et al., 2015a).

2122

2123 ***EMF109***

2124   EMF109 preserves distal middle and posterior caudal vertebrae. Consequently, it

2125 overlaps with *Wintonotitan* and AODF 2296. Although EMF109 was not fully prepared at the

2126 time of writing, Hocknull et al. (2021) published photographs and some brief notes of the

2127 specimen. Hocknull et al. (2021) ruled out the possibility of referral to *Wintonotitan* (the only

2128 Winton Formation sauropod species for which posterior caudal vertebrae had been described

2129 in 2021) because the posterior caudal centra of EMF109 are not biconvex. However, personal

2130 observation of the material demonstrates that they are in fact biconvex (S.L.B., *pers. obs.*

2131 2023).

2132   One middle caudal vertebra from EMF109 (Hocknull et al., 2021: fig. 29E) has a

2133 shallowly concave anterior articular surface, as in caudal vertebrae H and I of AODF 2296.

2134 Indeed, all distal middle caudal vertebrae of AODF 2296 are amphicoelous to amphiplatyan:

2135 only the posterior caudal vertebrae are incipiently biconvex, with the convexity restricted to

2136 the lateral edges and the median portion flat to concave. The articular surfaces of EMF109

2137 appear to share this morphology with AODF 2296 in right lateral view (Hocknull et al., 2021:

2138 fig. 29A and 29E [note that the latter image was stated by those authors to be in 'oblique

2139 cranioventral' view, but it is in oblique anterolateral view]). Like *Wintonotitan* and AODF

2140 2296, the caudal centra of EMF109 have rounded lateral surfaces that lack ridges and fossae

2141 (Poropat et al., 2015a). The lateral and ventral surfaces merge more or less smoothly, and the

2142 ventral surfaces are anteroposteriorly concave.

2143   The neural arch is generally situated closer to the anterior margin than the posterior

2144 one. However, in some specimens, the neural arch displays a central shift, as was considered

2145 autapomorphic for *Wintonotitan* (Poropat et al., 2015a). The lateral surface of the neural arch

2146 and neural spine is separated by a faint anteroposterior ridge, with the lateral surface of the

2147 neural arch vertical, whereas each side of the neural spine is inclined slightly dorsomedially

2148 to enable both to meet at the dorsal tip. The prezygapophyses extend either as far anteriorly,

2149 or slightly beyond, the anterior articular surface of the centrum.

2150

2151 ***EMF165***

2152   EMF165 constitutes an incomplete distal humerus, and as such it records little

2153 anatomical information. Comparison of EMF165 with *Diamantinasaurus* (AODF 0603

2154 [Poropat et al., 2015b] and AODF 0663 [Rigby et al., 2022]) indicates that it is a right

2155 humerus. Hocknull et al. (2021) stated that the proportions of this specimen align it more

2156 closely with *Australotitan* than *Diamantinasaurus*. EMF165 lacks a rounded ridge extending

2157 from the deltopectoral crest to the distal end, thereby contrasting with the humerus of

2158 *Australotitan*. The lateral distal surface of EMF165 appears to be inclined dorsomedially–

2159 posterolaterally, as in *Diamantinasaurus* and *Australotitan*, albeit to a lesser degree in the

2160 latter, likely owing to incomplete preservation. The shallow and broad anconeal fossa of

2161 EMF165 resembles those of both *Diamantinasaurus* and *Australotitan*.

2162

2163 ***EMF100***

2164   EMF100 comprises an incomplete right ulna. The small size of EMF100 implies that

2165 it represents a subadult specimen. As a preface to our re-evaluation of this element, we note

2166   that Hocknull et al. (2021: fig. 17 and fig. 28) used a mirrored right ulna of

2167   *Diamantinasaurus* and the left ulna of *Wintonotitan* in their comparisons with the right ulna

2168   of *Australotitan* and EMF100. Thus, the comparisons made by Hocknull et al. (2021) are

2169   problematic in that medial was mistaken for lateral and vice versa.

2170   Hocknull et al. (2021) described EMF100 as being mediolaterally compressed;

2171   however, the ulna is mediolaterally expanded and anteroposteriorly compressed, as in

2172   *Diamantinasaurus, Wintonotitan*, and *Australotitan.* Proximally, the anteromedial process is

2173   more elongate than the anterolateral process, as in *Diamantinasaurus*, *Wintonotitan*, and

2174   *Australotitan*. Because the proximal surface is incomplete, the relative expansion of these

2175   processes cannot be fully determined. The ulna of EMF100 does not appear to possess an

2176   accessory ridge on the distal anterolateral process, as was described as autapomorphic for

2177   *Australotitan* (Hocknull et al., 2021). It does, however, possess an interosseous ridge. The

2178   distal surface is approximately square-shaped in cross section, unlike *Diamantinasaurus*,

2179   *Wintonotitan* and *Australotitan*.

2180

2181   ***EMF105***

2182   This specimen, comprising a femur, was figured but not described by Hocknull et al.

2183   (2021: fig. 23 and 24); thus, the following comparisons are based solely on the figures. The

2184   anterior shaft of EMF105 possesses a proximodistal ridge (Hocknull et al. 2021: fig. 23) that

2185   is identical to that identified as the *linea intermuscularis cranialis* in *Diamantinasaurus* and

2186   *Australotitan* (Hocknull et al., 2021; Poropat et al., 2015b, 2023; Rigby et al. 2022). The

2187   proximolateral margin of EMF105 appears to be medially inclined in the same way as that of

2188   *Diamantinasaurus*, but unlike the medial deflection of *Australotitan* outlined by Hocknull et

2189   al. (2021). We suggest that the medially-bevelled distal condyles of EMF105 actually reflect

2190   misalignment of the element by Hocknull et al. (2021). When the shaft is instead aligned with

2191 its long axis more vertical, the distal condyles are similarly oriented vertically, as in

2192 *Diamantinasaurus*. The fibular condyle is divided in two, and a shelf connects the resultant

2193 condyles.

2194

Phylogenetic analysis

2196 *Phylogenetic results*

2197   Using equal weighting, the analysis produced 44,352 most parsimonious trees (MPTs)

2198 of length 2700 steps (Consistency Index = 0.219; Retention Index = 0.601). Under extended

2199 implied weighting, the analysis yielded 66,150 MPTs of length 116.4 steps (Consistency

2200 Index = 0.215; Retention Index = 0.591).

2201   In both analyses, the topologies are broadly congruent with those of Poropat et al.

2202 (2023), including the recovery of Diamantinasauria outside of Titanosauria (Fig. 21). Under

2203 both weighting strategies, all Winton Formation sauropods are recovered within

2204 Diamantinasauria, with the contemporaneous Argentinean taxon *Sarmientosaurus* placed as

2205 the earliest diverging member of the clade. Bremer supports are low, with Diamantinasauria

2206 characterized by a value of 2 and all internal clades supported by values of 1. Excluding

2207 *Sarmientosaurus*, Diamantinasauria consists of two main clades of OTUs: (1) *Australotitan*

2208 and *Diamantinasaurus*, along with AODF 0032 and AODF 0836; and (2) *Savannasaurus* and

2209 *Wintonotitan*, along with AODF 0590, AODF 0665, and AODF 0906. AODF 2296 is the

2210 most 'basal' member of the second clade under equal weights (Fig. 21A), but is part of the

2211 first clade under extended implied weighting (Fig. 21B).

2212

Discussion

2214   Four sauropod species have thus far been described from the Winton Formation.

2215 *Diamantinasaurus matildae* and *Wintonotitan wattsi* were the first to be described, with both

2216 named in the same paper (Hocknull et al., 2009). These taxa were subsequently redescribed

2217 and each considered valid by Poropat et al. (2015a, 2015b). Additional specimens have since

2218 been described and referred to *Diamantinasaurus matildae*, with amendments to its

2219 diagnosis, such that it has been considered to be characterized by fifteen autapomorphies and

2220 three local autapomorphies in recent assessments (Table 3; Poropat et al., 2021, 2023; Rigby

2221 et al., 2022). The most recent diagnosis of *Wintonotitan wattsi* identified eight

2222 autapomorphies and an additional four local autapomorphies (Table 3; Poropat et al., 2015a).

2223 A third species, *Savannasaurus elliottorum*, was described by Poropat et al. (2016), with a

2224 subsequent monographic treatment that supported its validity, recognising nine

2225 autapomorphies (Table 3; Poropat et al., 2020). Finally, Hocknull et al. (2021) described a

2226 fourth species, *Australotitan cooperensis*, for which they identified three autapomorphies, as

2227 well as a combination of eight characters that differentiate it from other sauropod taxa (Table

2228 3). Our description herein of new remains of Winton Formation sauropods demonstrates that

2229 some specimens exhibit proposed autapomorphies of more than one species. As such, here

2230 we reassess these previously proposed autapomorphies of the four species (excluding cranial

2231 autapomorphies, as only specimens currently assigned to *Diamantinasaurus* preserve these)

2232 and re-evaluate the validity of each taxon.

2233

2234 **Reassessment of the previously proposed autapomorphies of the four Winton**

2235 **Formation sauropod species**

2236

Dorsal vertebrae

Of the named Winton Formation sauropod species, *Diamantinasaurus*, *Savannasaurus* and *Wintonotitan* preserve dorsal vertebrae. The middle–posterior dorsal vertebrae of *Diamantinasaurus* have a dorsally bifurcated PCPL that was regarded as autapomorphic by Poropat et al. (2015b); this can only be compared with *Savannasaurus* presently, and the latter taxon lacks this characteristic (Table 4; Poropat et al., 2020). The middle–posterior dorsal neural spines of *Wintonotitan* are unbifurcated, with a rounded median ridge on the summit that links the PRSL and POSL, and this feature has been regarded as an autapomorphy (Poropat et al., 2015a). The dorsal neural spines of *Savannasaurus* are similarly unbifurcated, but do not possess such a median ridge (Poropat et al., 2020). No specimens of *Diamantinasaurus* preserve a complete dorsal neural spine summit. Until such time as a complete middle–posterior dorsal neural spine summit is preserved in specimens of *Australotitan* and *Diamantinasaurus*, this autapomorphy remains valid for *Wintonotitan*.

Caudal vertebrae

Among Winton Formation sauropods, autapomorphies pertaining to the caudal vertebrae have only been identified in *Savannasaurus* and *Wintonotitan*, but a caudal vertebra is preserved as part of the AODF 0906 specimen that was referred to *Diamantinasaurus* by Poropat et al. (2023). *Savannasaurus* possesses two putative caudal vertebral autapomorphies (Poropat et al., 2020): (1) an undulating anterior articular surface of the anterior caudal vertebral centra (concave dorsally and convex ventrally); and (2) anterior-most caudal centra with shallow lateral pneumatic fossae. *Diamantinasaurus* (AODF 0906), *Wintonotitan*, and the newly described specimens AODF 0032, AODF 0590 and AODF 2296 can all be assessed for both of these autapomorphies; these specimens do not possess either (Table 4).

2262   Before assessing the caudal vertebral autapomorphies of *Wintonotitan*, it is important

2263 to discuss the discrepancies in the literature over how many caudal vertebrae comprise the

2264 holotype specimen. Hocknull et al. (2009) reported 29 caudal vertebrae, whilst Poropat et al.

2265 (2015a) reported 25 locatable caudal vertebrae. Poropat et al. (2015a) noted the existence of

2266 an additional specimen designated 'U' that was figured by Coombs and Molnar (1981; plate

2267 I, U), but those authors could not locate the specimen in the QM collection (where the

2268 holotype specimen presides). Since the time of these publications, three caudal vertebrae

2269 pertaining to the holotype of *Wintonotitan* have been located in the MTQ collection (Fig.

2270 S14). Included in these three caudal vertebrae is specimen 'U' *sensu* Coombs and Molnar

2271 (1981; Fig. S14G–L). The other two specimens (Fig. S14A–F, M–R) have never been

2272 figured, but were presumably included in the count provided by Hocknull et al. (2009). Thus,

2273 the holotype skeleton of *Wintonotitan* is composed of 28 caudal vertebral centra and one

2274 caudal vertebral neural arch, with the majority of these elements accesioned in the QM

2275 collection, with the exception of the three centra located in the MTQ collection.

2276   The anterior and middle caudal vertebrae of *Wintonotitan* possess a proposed

2277 autapomorphic horizontal lateral ridge (Poropat et al., 2015a) that is also present in the

2278 middle caudal vertebra of the newly described AODF 0832, and some of the middle caudal

2279 vertebrae of AODF 2296 and EMF106. A horizontal ridge is absent from *Savannasaurus* and

2280 the newly described AODF 0032 and AODF 2306, as well as the single known caudal

2281 vertebra referred to *Diamantinasaurus* (AODF 0906; Poropat et al., 2023). However, the

2282 latter element is one of the anterior-most caudal vertebrae and as such, it might not directly

2283 overlap with the caudal vertebrae of *Wintonotitan*. The horizontal ridges of *Savannasaurus*

2284 that characterise the lateral surfaces are located dorsal to the autapomorphic lateral ridge of

2285 *Wintonotitan*.

2286   Two local autapomorphies have also been recognised relating to the caudal vertebrae

2287   of *Wintonotitan* (Poropat et al., 2015a): (1) a central shift of the neural arch in the middle and

2288   posterior caudal vertebrae (also recognised in the middle and posterior caudal vertebrae of

2289   AODF 2296 and EMF109); and (2) articular surfaces of the posterior caudal vertebrae being

2290   incipiently biconvex (also observed in AODF 0591, AODF 0832, AODF 2296, AODF 2851

2291   and EMF109). The caudal vertebrae of AODF 0032 do not possess any of the caudal

2292   vertebral autapomorphies of *Savannasaurus* or *Wintonotitan*.

2293

2294   ***Chevrons***

2295   The only sauropod specimens from the Winton Formation that preserve chevrons are

2296   *Wintonotitan* (Poropat et al. 2015a: fig. 6), a referred specimen of *Diamantinasaurus* (AODF

2297   0906; Poropat et al. 2023: fig. 23) and the newly described AODF 2296. *Wintonotitan*

2298   possesses two proposed autapomorphies relating to the chevrons (Poropat et al., 2015a): (1)

2299   anterior chevrons with proximal articular ends that are, in lateral view, narrower

2300   anteroposteriorly than are the proximal rami themselves at about mid-height of the haemal

2301   canal; and (2) anterior chevrons with dorsoventrally short haemal canals (local

2302   autapomorphy). The first proposed autapomorphy cannot be substantiated as there is no

2303   significant difference between the anteroposterior lengths of the proximal articular surfaces

2304   and the proximal ramus. Additionally, the proximal articular surfaces of the chevrons of

2305   *Wintonotitan* might be incomplete and thus might not display their true anteroposterior

2306   length. The second proposed autapomorphy can no longer be regarded as locally

2307   autapomorphic given that a short haemal canal also characterizes the chevrons of AODF

2308   0906, as well as numerous other somphospondylans (Poropat et al., 2023).

2309

Scapula

The Winton Formation sauropod species that preserve a scapula are *Australotitan*, *Diamantinasaurus* and *Wintonotitan*. The scapula of *Australotitan* does not have an associated proposed autapomorphy, but a feature listed in its diagnosis is that its blade is narrow and straight, with sub-parallel dorsal and ventral margins (Hocknull et al., 2021). However, this feature cannot be confirmed: the ventral-most preserved margin is a broken surface that has been effectively folded medially. Rigby et al. (2022) postulated that the scapula (including the acromion and blade) is missing its entire ventral margin; therefore, whether or not the dorsal and ventral margins are straight and sub-parallel cannot be assessed. In light of the reinterpretation that a substantial portion of the ventral margin of the scapula is missing in *Australotitan*, the second scapular feature proposed in the diagnosis of *Australotitan* by Hocknull et al. (2021: fig. 9A) of a ventral ridge is reinterpreted herein as a lateral ridge, with the same feature also present in *Diamantinasaurus* (AODF 0603: Poropat et al., 2015b; AODF 0663: Rigby et al., 2022), *Wintonotitan* (Poropat et al., 2015a), and the newly described AODF 0844; consequently, it cannot be regarded as diagnostic of *Australotitan*.

Two previously proposed autapomorphies of *Diamantinasaurus* pertain to the scapula (Poropat et al., 2015b; Rigby et al., 2022): (1) scapular blade lateral surface with an accessory longitudinal ridge and fossa at the mid-length, dorsal to the main lateral ridge; and (2) scapula medial surface with a distinct tuberosity just posterior to the junction of the acromion and the distal blade (local autapomorphy). However, the holotype right scapula of *Diamantinasaurus* has suffered substantial taphonomic deformation, and is also incompletely preserved (Poropat et al., 2015b). The newly described holotype left scapula of *Diamantinasaurus* does not possess an accessory longitudinal ridge or fossa on its lateral surface. Such a ridge or fossa is also absent in the two best preserved sauropod scapulae derived from the Winton Formation

95

2335   to date: a referred juvenile specimen of *Diamantinasaurus* (AODF 0663) and the newly

2336   described AODF 0844. As such, we regard this feature as a taphonomic artefact of the

2337   holotypic right scapula of *Diamantinasaurus*.

2338   Rigby et al. (2022) recognised the locally autapomorphic presence of a medial

2339   tuberosity in the holotype of *Diamantinasaurus* and two referred specimens (AODF 0663 and

2340   AODF 0836). This tuberosity is also present in *Wintonotitan*, the newly described AODF

2341   0844, and a similar feature appears to be preserved on the medial surface of the scapula of

2342   *Australotitan*, near the ventral-most preserved portion (Hocknull et al., 2021: fig. 9B). As

2343   such, this proposed autapomorphy appears to diagnose a more inclusive grouping of

2344   diamantinasaurian taxa.

2345   Poropat et al. (2015a) proposed that the scapula of *Wintonotitan* possesses an

2346   autapomorphic concavity on the medial surface near the acromion-blade junction. This

2347   feature was recently recognised in a juvenile specimen of *Diamantinasaurus* by Rigby et al.

2348   (2022; AODF 0663) and is also present in the newly described AODF 0844 (Table 4). In

2349   these two specimens, this concavity is located just ventral to the tuberosity discussed above,

2350   as appears to be the case in *Wintonotitan*. As with the latter feature, the medial concavity can

2351   no longer be regarded as an autapomorphy of *Wintonotitan* and is more widespread in

2352   Diamantinasauria.

2353

2354   ***Sternal plate***

2355   The sternal plate of *Savannasaurus* possesses two features proposed to be locally

2356   autapomorphic (Poropat et al., 2020): (1) the lateral margin is straight; and (2) the anterior

2357   portion of the ventral surface lacks an anteroposteriorly elongate ridge along the anterior

2358   portion. The sternal plate of the *Diamantinasaurus* holotype also appears to be D-shaped

2359   (Poropat et al., 2021). However, the sternal plate of an unpublished specimen from the

2360   Winton Formation (AODF 0888) is reniform (S.L.B., S.F.P., pers. obs., 2023). Until such

2361   time as the sternal plate of *Diamantinasaurus* is prepared and the sternal plate of AODF 0888

2362   is described, these autapomorphies can only be compared with the sternal plate of AODF

2363   2296, which possesses both features (Table 4).

2364   Poropat et al. (2021) established the clade Diamantinasauria with a characteristic of

2365   the clade being a D-shaped sternal plate. Therefore, this autapomorphy is formally removed

2366   from the diagnosis of *Savannasaurus*, given that it is also recognised in *Diamantinasauru*s.

2367   We also note that the second proposed autapomorphy might be reinterpreted as a

2368   synapomorphy of Diamantinasauria in the future, but this awaits the preparation and

2369   description of further specimens in order to be clarified. No specimens of *Australotitan* and

2370   *Wintonotitan* preserve sternal plates.

2371

2372   ***Humerus***

2373   All four Winton Formation sauropod species are known from humeri. Hocknull et al.

2374   (2021) did not identify any autapomorphies in the humerus of *Australotitan*, but those authors

2375   did include a feature in the diagnosis of the taxon relating to the humerus: a ridge that extends

2376   distally from the deltopectoral crest, terminating proximal to a trilobate distal articular end.

2377   The humeri of *Wintonotitan* and *Savannasaurus* lack such a ridge, as does the left humerus of

2378   *Diamantinasaurus*. However, the right humerus of *Diamantinasaurus* possesses a faint ridge

2379   that extends distally from the deltopectoral crest, terminating at the distal lateral condyle (Fig.

2380   20H). The humerus of *Australotitan* appears to have been taphonomically anteroposteriorly

2381   compressed either unevenly across its distal anterior face, or evenly but with some regions

2382   more resistant to said compression than others. Either way, the shape of the humerus of

2383   *Australotitan* cannot be taken at face value as being representative of the humerus *in vivo*,

2384   and the trilobate distal end is herein regarded as a taphonomic artefact.

2385   Two autapomorphies of the humerus have been proposed for *Diamantinasaurus*

2386   (Poropat et al., 2015b): (1) proximal shaft posterolateral margin formed by a stout vertical

2387   ridge that increases the depth of the lateral triceps fossa; and (2) a ridge that extends medially

2388   from the deltopectoral crest, then turns to extend proximally, creating a fossa lying medial to

2389   the dorsal part of the deltopectoral crest on the anterior face. The juvenile specimen referred

2390   to *Diamantinasaurus* (AODF 0663) possesses both autapomorphies (Table 4), although the

2391   features are less pronounced, likely owing to the ontogenetic immaturity of the specimen

2392   (Rigby et al., 2022). The first autapomorphy cannot be compared with humeri from other

2393   Winton Formation taxa because of their incomplete preservation of that section, but the

2394   second can be compared with *Australotitan*. A faint ridge that extends from the collapsed

2395   deltopectoral crest towards the anterior fossa, medial to the deltopectoral crest, is present in

2396   *Australotitan* (Hocknull et al., 2021: fig. 11D), and is almost identical to the corresponding

2397   area in *Diamantinasaurus* (Fig. 20B and 20H). The humerus of AODF 0032 cannot be

2398   assessed for the above discussed autapomorphies.

2399

2400   ***Ulna***

2401   *Savannasaurus* is the only Winton Formation sauropod species that is not known from

2402   an ulna. The figure caption for fig. 18C of Hocknull et al. (2021) reads *Savannasaurus*

2403   *elliottorum*; however, the element figured is, in fact, a reconstruction from both preserved

2404   ulnae of *Wintonotitan* (as reads the figure caption for fig. 18D of Hocknull et al. [2021]).

2405   Hocknull et al. (2021) proposed three autapomorphies on the ulna of *Australotitan* and listed

2406   one additional feature in their diagnosis of the taxon. This feature refers to reduced

2407   anterolateral and olecranon processes, with a large anteromedial process in comparison. We

2408   suggest that the proximal surface of this ulna is incompletely preserved and that the element

2409   has suffered taphonomic compression, as is evident in the figures presented by Hocknull et al.

2410   (2021: fig. 17A, 19A, 19C and 19E). The proximal surface lacks rugosity, but, given the size

2411   of the element and the mature nature of the individual to which it pertained, rugosity must

2412   have been present in life to facilitate strong adherence of the cartilaginous cap on the

2413   proximal end of the ulna. If the proximal end of the ulna of *Australotitan* has suffered

2414   taphonomic distortion or wear, then the olecranon process might have been more developed

2415   than it is as preserved, similar to that of *Diamantinasaurus*. Furthermore, the anterolateral

2416   and anteromedial processes of *Diamantinasaurus* are incorrectly labelled by Hocknull et al.

2417   (2021: fig. 17E), owing to the fact that they mirrored a right element (causing it to appear to

2418   be the left ulna). In light of this, the anterolateral process of *Diamantinasaurus* is actually

2419   heavily reduced relative to the large and elongate anteromedial process (Fig. 20A and 20G),

2420   meaning that it shows the same morphology as *Australotitan*, contra Hocknull et al. (2021).

2421   The incomplete preservation of the proximal surface of the ulna in *Australotitan*, coupled

2422   with the effectively identical relative proportions of the anterolateral and anteromedial

2423   processes in the ulnae of it and *Diamantinasaurus*, means that this feature of the ulna posited

2424   by Hocknull et al. (2021) is unsubstantiated.

2425   The first autapomorphy of the ulna of *Australotitan* proposed by Hocknull et al.

2426   (2021) is the presence of an interosseous ridge on the distal anterior surface. However, an

2427   interosseous ridge is now known to be present in the holotypes of *Wintonotitan* and

2428   *Diamantinasaurus*, AODF 0656, AODF 0665, AODF 2296, EMF100 and EMF164 (Table

2429   4); thus, we remove this feature from the diagnosis of *Australotitan* regard it as a probable

2430   synapomorphy of Diamantinasauria instead. The second autapomorphy of the ulna of

2431   *Australotitan* described by Hocknull et al. (2021) refers to an accessory projection on the

2432   distal anterolateral process. The anterolateral surface of the ulna is figured by Hocknull et al.

2433   (2021: fig. 17B), but the 3D model is not publicly available on MorphoSource (despite all

2434   other elements of *Australotitan* being so). This proposed accessory projection simply

2435 represents a distorted distal anterolateral process; in light of the above discussion re the

2436 taphonomy of the *Australotitan* holotype, it is highly likely that this characteristic has been

2437 exaggerated by taphonomic compression. The distortion of this element is best outlined in

2438 fig. 19A, 19C and 19E of Hocknull et al. (2021) wherein it is clear that significant

2439 anteroposterior crushing has occurred which has likely affected the true morphology of the

2440 anterolateral process. As such, this autapomorphy is regarded as a taphonomic artefact and

2441 we suggest that it is not diagnostic of *Australotitan*.

2442   The third autapomorphy of the ulna of *Australotitan* proposed by Hocknull et al.

2443 (2021) is the proximally bevelled distal articular surface. Firsthand observation of the ulna

2444 (S.F.P., 2014, S.L.B., 2023) suggests that the distal surface of the ulna is incompletely

2445 preserved along the anterior margin, where the putatively autapomorphic bevelling occurs

2446 (Hocknull et al. 2021: fig. 17D). Moreover, the ulna does not possess any rugosity on its

2447 distal articular surface despite it likely being present in life (for reasons outlined above in

2448 discussion of the proximal articular surface). Thus, the incompleteness of the distal articular

2449 surface of the ulna of *Australotitan* means that this feature is most likely a taphonomic

2450 artefact, and therefore we suggest that it is unlikely to be autapomorphic.

2451

2452 ***Radius***

2453   Radii are known for *Diamantinasaurus*, *Savannasaurus* and *Wintonotitan*. The radius

2454 of *Wintonotitan* was reported to have an autapomorphic subcircular proximal surface, with a

2455 medially oriented projection, by Poropat et al. (2015a). However, we suggest that the

2456 proximal end of the radius is incompletely preserved, and it is unlikely that this cross section

2457 is representative of its true morphology. In cross-section at approximately the same point, the

2458 radius of *Diamantinasaurus* has a semi-circular shape and a medial projection that

2459 contributes to the completely preserved elliptical proximal surface. Therefore, this putative

2460 autapomorphy of *Wintonotitan* is best explained as an artefact of incomplete preservation,

2461 and its radius is similar to that of the holotype of *Diamantinasaurus*. By contrast, the

2462 proximal surface of the radius of *Savannasaurus* is broadly wedge-shaped (Poropat et al.,

2463 2020).

2464

2465 ***Metacarpals***

2466 Of the Winton Formation sauropod species, *Diamantinasaurus*, *Savannasaurus* and

2467 *Wintonotitan* all possess a complete metacarpal series (with the exception of the distal half of

2468 metacarpal I of *Wintonotitan*). *Savannasaurus* possesses one proposed autapomorphy relating

2469 to the metacarpals: metacarpal IV with an hourglass-shaped distal end (Poropat et al., 2016).

2470 Presently, the newly described AODF 2854 is the only other specimen to also possess this

2471 feature (Table 4).

2472 The metacarpals of *Wintonotitan* possess three proposed autapomorphies (Poropat et

2473 al., 2015a): (1) metacarpus with a deep fossa on the proximal surface, at the intersections of

2474 metacarpals I, II and III; (2) metacarpal III with the distal end more expanded transversely

2475 than that of the proximal end; and (3) metacarpal IV with a medially projecting bulge on the

2476 dorsal surface, close to the shaft mid-length. The fossa on the proximal surface of the

2477 metacarpus of *Wintonotitan* appears to be artefact of incomplete preservation: the proximal

2478 surfaces of the metacarpals of *Wintonotitan* lack rugosities, unlike the metacarpals of

2479 *Diamantinasaurus* and *Savannasaurus*. It is postulated that the metacarpals of *Wintonotitan*

2480 have been worn or otherwise damaged. If the proximal surfaces are incomplete, the proximal

2481 fossa might not be a genuine character of, or an autapomorphic feature for, *Wintonotitan*. The

2482 validity of the putative autapomorphy relating to the proximal end of metacarpal III is

2483 similarly questionable for two reasons: (1) the possible incomplete preservation of the

2484 proximal end; and (2) the distal ends of metacarpal III of *Diamantinasaurus* and

2485 *Savannasaurus* are also mediolaterally wider than their corresponding proximal ends,

2486 meaning they share this feature with *Wintonotitan*. As such, we consider this morphology to

2487 be a potential synapomorphy of Diamantinasauria instead. Neither *Diamantinasaurus* or

2488 *Savannasaurus*, nor the newly described AODF 2296 and AODF 2854, possess a bulge on

2489 the anterior surface of metacarpal IV. As such, this feature remains unique to *Wintonotitan*.

2490

2491 ***Pubis***

2492   *Wintonotitan* is the sole Winton Formation sauropod species for which the pubis is

2493 unknown. Hocknull et al. (2021) proposed in their definition of *Australotitan* that the pubes

2494 and ischia are broad and contact one another medially to create a continuous pelvic floor. The

2495 pubes and ischia of *Diamantinasaurus* (AODF 0603 and AODF 0836) and *Savannasaurus*

2496 are similarly broad (especially in *Savannasaurus*) and also form a continuous pelvic floor

2497 (Fig. 14E, 14H and 14B, respectively). Therefore, it cannot be regarded as diagnostic of

2498 *Australotitan*. The single proposed autapomorphy of *Savannasaurus* that relates to the pubis,

2499 which is the presence of a ridge extending anteroventrally from the ventral margin of the

2500 obturator foramen on the lateral surface (Poropat et al., 2020), is not present in any other

2501 sauropod specimen from the Winton Formation (Table 4).

2502   The pubis of AODF 0032 is significantly mediolaterally narrower than the pubes of

2503 *Diamantinasaurus*, *Savannasaurus*, or *Australotitan*. This might mean that AODF 0032 was

2504 a narrower-gauge sauropod than *Diamantinasaurus*, *Savannasaurus*, or *Australotitan*; all of

2505 which possess the titanosaurian wide-gauge stance (most pronounced in *Savannasaurus*

2506 [Poropat et al., 2020]). The iliac peduncle, obturator foramen and ischiatic articulation are

2507 also situated and oriented differently in AODF 0032 than in the pubes of *Diamantinasaurus*,

2508 *Savannasaurus* and *Australotitan* (Fig. 14).

2509

Ischium

2510

2511   All four named Winton Formation sauropod species preserve ischia. The ischium of

2512 *Australotitan* was reported by Hocknull et al. (2021) in its diagnosis to possess a feature of

2513 the distal blade curving ventrally to produce a posteriorly oriented dorsal face. However, this

2514 feature is also present in *Diamantinasaurus* (AODF 0603 and AODF 0836: Fig. 14F and 14I,

2515 respectively), *Savannasaurus* (Fig. 14C) and *Wintonotitan*. Consequently, it cannot be

2516 regarded as diagnostic of *Australotitan*.

2517   The ischium of *Savannasaurus* possesses a potentially autapomorphic morphology,

2518 with a proximal plate anteroposterior length > 40% the overall proximodistal length of the

2519 element (Poropat et al., 2020). This ratio is 0.31 for *Australotitan* and *Diamantinasaurus*, and

2520 0.36 for the ischium of *Wintonotitan* (Poropat et al., 2020; Hocknull et al., 2021). Given the

2521 difference between the ratio of *Savannasaurus* and the other named Winton Formation

2522 sauropod species, this autapomorphy remains valid (Table 4).

2523   Poropat et al. (2015a) proposed a local autapomorphy on the ischium of *Wintonotitan*:

2524 a posterolaterally projecting flange-like ridge, which is the attachment site for the *M. flexor*

2525 *tibialis internus III*, that is visible in medial view. Such a ridge can be recognised to varying

2526 degrees in *Diamantinasaurus* (Poropat et al., 2021, 2023), *Savannasaurus* (Poropat et al.,

2527 2020), *Australotitan* (Hocknull et al., 2021) and the newly described AODF 0032. However,

2528 the ridge is not visible in medial view for any of these specimens. Therefore, this proposed

2529 local autapomorphy remains valid for *Wintonotitan* (Table 4).

2530

Femur

2531

2532   Of the Winton Formation sauropod species, only *Australotitan* and *Diamantinasaurus*

2533 preserve femora. Three femoral features were listed by Hocknull et al. (2021) in their

2534 diagnosis of *Australotitan*: (1) a medially sloping proximolateral margin; (2) an

2535   anteroposteriorly narrow proximal articular end; and (3) anterolaterally–posteromedially

2536   oriented distal condyles. Both the figures and the 3D model of this element (available through

2537   MorphoSource) indicate that the femur has undergone substantial anteroposterior taphonomic

2538   compression, presumably a consequence of dinoturbation and extensive deformation, as

2539   outlined by Hocknull et al. (2021: fig. 8). In any case, the proximolateral margin of the femur

2540   is incompletely preserved, meaning that the orientation of the projection of the proximolateral

2541   margin cannot be objectively assessed. The proximal articular end is indeed anteroposteriorly

2542   narrow, but this has likely been exaggerated by taphonomic compression (compare with

2543   AODF 0663 [Rigby et al., 2022], AODF 0665 [Fig. 15S–X] and AODF 0906 [Fig. 15M–R]).

2544   Following the deformation alignment performed by Hocknull et al. (2021: fig. 8), the distal

2545   medial condyle of *Australotitan* is oriented anteroposteriorly, not anterolaterally–

2546   posteromedially. The lateral condyle is indeed oriented anterolaterally–posteromedially, but

2547   the element has suffered such distortion that the validity of this feature as diagnostic is

2548   questionable (again, compare with AODF 0906 [Fig. 15M –R]). Therefore, all three

2549   aforementioned defining characters are likely taphonomic artefacts and cannot be used to

2550   diagnose *Australotitan*.

2551   The femur of *Diamantinasaurus* has a proposed autapomorphic shelf with linking

2552   posterior ridges on the fibular condyle (Poropat et al., 2015b), a feature that is also present in

2553   AODF 0665, AODF 0832 and *Australotitan* (Hocknull et al. 2021: fig. 23E). However, this

2554   feature is more widespread and characterises most eusauropods (Sekiya, 2011; Carballido et

2555   al., 2017). Therefore, we remove this autapomorphy from the diagnosis of *Diamantinasaurus*.

2556

2557   ***Tibia***

2558   Three autapomorphies have been proposed for the tibia of *Diamantinasaurus* (Poropat

2559   et al., 2015b): (1) proximal lateral face with a double ridge extending distally from the lateral

2560 projection of the proximal articular area; (2) posterolateral fossa posterior to the double ridge,

2561 containing a lower tuberosity and an upper deep pit; and (3) shaft anterolateral margin, distal

2562 to the cnemial crest, forms a thin flange-like projection extending proximodistally along the

2563 central region of the element. None of the other Winton Formation sauropod holotypes

2564 preserve a tibia. However, AODF 0590, AODF 0665 and AODF 666 possess tibiae.

2565 The tibia of AODF 0590, AODF 665 and AODF 666 each possess one of three of the

2566 autapomorphies of the tibia of *Diamantinasaurus*: a proximodistally oriented anterolateral

2567 ridge, lateral to the base of the cnemial crest (Table 4). The other two autapomorphies of the

2568 tibia of *Diamantinasaurus* relate to the proximolateral surface, which is somewhat damaged

2569 and incompletely preserved in those specimens. AODF 0590 and AODF 666 do not possess a

2570 double ridge extending distal to the lateral projection of the proximal articular area; instead

2571 they each possess a single ridge.

2572

2573 ***Fibula***

2574 The previously proposed autapomorphy of the fibula of *Diamantinasaurus* relates to

2575 the medial surface of the shaft, which was reported to possess a vertical ridge separating the

2576 anterior and posterior grooves (Poropat et al., 2015b). However, the fibulae of other Winton

2577 Formation specimens (AODF 0906, AODF 0590, AODF 0591, AODF 0665 and AODF

2578 2296) do not possess a vertical ridge on the medial surface. The presence of a ridge in the

2579 holotype fibula appears to be a taphonomic artefact. Additionally, the holotype fibula is

2580 poorly preserved and was found in several fragments (Poropat et al., 2015b). As such, we

2581 remove this autapomorphy from the diagnosis of *Diamantinasaurus*.

2582

2583   *Astragalus*

2584   *Diamantinasaurus* and *Savannasaurus* are the only two Winton Formation sauropod

2585   species for which the astragalus is known. *Diamantinasaurus* possesses two proposed

2586   autapomorphies relating to the astragalus (Poropat et al., 2015b): (1) lateral fossa divided into

2587   upper and lower portions by an anteroposteriorly directed ridge; and (2) astragalus

2588   posteroventral margin, below and medial to the ascending process, with well-developed,

2589   ventrally projecting rounded process visible in posterior, lateral and ventral views. The lateral

2590   surface of the astragalus of the newly described AODF 0666 is more completely preserved

2591   than that of the holotype (on which internal bone can be seen), and it does not possess such a

2592   ridge. When proposing this autapomorphy, Poropat et al. (2015b) acknowledged that this

2593   character might have been a taphonomic artefact caused by another bone being pressed

2594   against the astragalus, and we agree that this is plausible. Thus, this autapomorphy is

2595   removed from the diagnosis of *Diamantinasaurus.* The second autapomorphy of a ventrally

2596   projecting rounded process is also present in AODF 0666 (Table 4). The astragalus of

2597   *Savannasaurus* possesses two proposed autapomorphies (Poropat et al., 2020): (1) astragalus

2598   taller proximodistally than wide mediolaterally or long anteroposteriorly; and (2) astragalus

2599   mediolateral width and anteroposterior length essentially equal. Both *Diamantinasaurus* and

2600   AODF 0666 lack these features.

2601

2602   **Character differences and taxonomic implications of the phylogenetic analysis**

2603

2604   To better understand the distinction between the four Winton Formation sauropod

2605   genera, we employ an autapomorphy count similar to that conducted by Tschopp et al. (2015)

2606   for diplodocids. Those authors established that a species-level separation consists of at least

2607   six changes in character counts, and 13 changes constitute a genus-level separation. Although

2608   these numbers of changes are somewhat arbitrary, and it is possible that an approach based on

2609   diplodocids is not necessarily suitable for other taxonomic groups, it at least provides a

2610   baseline for interpretation between our phylogenetic analysis (Fig. 21), our character counts

2611   (Fig. 22), and the overlap of autapomorphies between specimens (Table 4). Given the

2612   incompleteness of the newly described specimens, we only apply the specific level separation

2613   counts to the holotype specimens and instead employ a difference percentage to the newly

2614   described specimens.

2615

2616   ***Holotype specimens***

2617   Of the four Winton Formation sauropod holotypes, *Diamantinasaurus* and

2618   *Savannasaurus* are most dissimilar to one another, with 15 different character scores (16.9%

2619   difference in a count of 106 overlapping characters). Second to this are *Savannasaurus* and

2620   *Wintonotitan*, with ten different character scores (18.9% difference in a count of 65

2621   overlapping characters), whereas *Wintonotitan* shares fewer differences with

2622   *Diamantinasaurus* (three different characters in a count of 55, indicating a 5.5% difference)

2623   and *Australotitan* (two different characters in a count of 23, indicating an 8.7% difference).

2624   *Diamantinasaurus* and *Australotitan* have just one different character score in a count of 66.

2625   If we follow the protocol of Tschopp et al. (2015), *Diamantinasaurus* and

2626   *Savannasaurus* are the only two valid sauropod genera from the Winton Formation. These

2627   two taxa are clearly distinct at the genus level, *sensu* Tschopp et al. (2015), and our

2628   phylogenetic analysis supports this with the placement of the two holotype specimens in

2629   separate clades within Diamantinasauria. This approach indicates that *Australotitan* cannot be

2630   distinguished from *Diamantinasaurus* at the genus or species level, and, coupled with their

2631   recovery as close relatives in our phylogenetic analysis, supports their potential

2632   synonymisation (see below). The classification of *Wintonotitan* is less clear; based on its

2633 character count, it could also be synonymised with *Diamantinasaurus*, whereas our

2634 phylogenetic analysis supports a closer relation to *Savannasaurus*, with at least a species-

2635 level separation. Given these conflicting results, the fact that our sample size is much smaller

2636 than that of the diplodocid-focused analysis of Tschopp et al. (2015), and that their protocol

2637 for discriminating between genera and species is not necessarily applicable to Winton

2638 sauropods, we retain *Wintonotitan* as a valid genus.

2639

2640 ***Previously referred specimens***

2641   Perhaps the most surprising result of our phylogenetic analysis is the placement of

2642 AODF 0906 in a clade with *Savannasaurus* and *Wintonotitan*, rather than *Diamantinasaurus*,

2643 to which it has been previously referred. This specimen was only recently described by

2644 Poropat et al. (2023), whose phylogenetic analysis supported a closer relationship with

2645 *Diamantinasaurus* and AODF 0836 (another referred specimen of *Diamantinasaurus*), than

2646 to *Savannasaurus*. Of the named species in our analysis, AODF 0906 differs most from

2647 *Savannasaurus* (11.8% differences in a count of 19) and *Wintonotitan* (5% differences in a

2648 count of 21), and is most like *Diamantinasaurus* (0% differences in a count of 49) and

2649 *Australotitan* (0% differences in a count of 19). The other specimen of note here is AODF

2650 0836 (2.9% differences in a count of 36): AODF 0906 and AODF 0836 are the only two

2651 sauropod specimens from the Winton Formation to possess skull elements. Given the low

2652 amount of anatomical overlap with other OTUs, and the lack of score differences with

2653 *Diamantinasaurus*, we refrain from reclassifying AODF 0906 pending the discovery and

2654 description of more complete, overlapping material from the Winton Formation that should

2655 help to resolve these classification issues.

2656

2657 ***Newly described specimens***

2658   AODF 2854 possesses a proposed autapomorphy of *Savannasaurus* relating to

2659 metacarpal IV: presence of an hourglass-shaped distal end. Given this, we tentatively refer

2660 AODF 2854 to *Savannasaurus*, but make note of its similarities to metacarpal IV of

2661 *Diamantinasaurus*.

2662   AODF 2296 possesses two diamantinasaurian synapomorphies of a 'D' shaped sternal

2663 plate and an ulnar interosseous ridge, as well as three caudal vertebral autapomorphies of

2664 *Wintonotitan*, and a single sternal plate autapomorphy of *Savannasaurus* that might instead

2665 be a synapomorphy of Diamantinasauria. It lacks three autapomorphies of *Savannasaurus*

2666 relating to the caudal vertebrae and metacarpal IV, as well as a metacarpal autapomorphy of

2667 *Wintonotitan* (Table 4). Based on this, AODF 2296 is more likely a specimen of *Wintonotitan*

2668 or *Diamantinasaurus*. Our phylogenetic analysis resolves AODF 2296 as a close relative of

2669 *Diamantinasaurus* under extended implied weighting, but unites it in a clade with

2670 *Wintonotitan* and *Savannasaurus* using equal character weighting. In our character counts,

2671 AODF 2296 has a higher amount of overlap with *Wintonotitan* and *Savannasaurus* than it

2672 does with *Diamantinasaurus* and *Australotitan*. It differs most from *Savannasaurus* (40%

2673 differences in a count of 37), with little variation from *Australotitan* (0% differences in a

2674 count of two), *Diamantinasaurus* (0% differences in a count of 11) and *Wintonotitan* (2.7%

2675 differences in a count of 38). Given the low overlap with *Australotitan* and

2676 *Diamantinasaurus*, the more accurate comparison of characters is with *Wintonotitan* and

2677 *Savannasaurus*. We tentatively suggest that AODF 2296 might be referrable to *Wintonotitan*,

2678 but note that a lack of anatomical overlap with *Australotitan* and *Diamantinasaurus* could be

2679 skewing our results. As such, we more conservatively assign AODF 2296 to

2680 Diamantinasauria *incertae sedis*.

2681   The scapula of AODF 0844 possesses two diamantinasaurian synapomorphies and is

2682   most similar to the scapula of a referred juvenile specimen of *Diamantinasaurus* (AODF

2683   0663). Given that these two scapulae are by far the best preserved sauropod scapulae yet

2684   discovered from the Winton Formation, the characteristics they possess are the best indicators

2685   for the true morphology of diamantinasaurian scapulae. Thus, we tentatively refer AODF

2686   0844 to *Diamantinasaurus* but await the discovery of better-preserved Winton Formation

2687   scapulae and coracoids.

2688   AODF 0590 possesses one of the two tibial autapomorphies of *Diamantinasaurus* for

2689   which it can be assessed, and lacks the two autapomorphies relating to the caudal vertebrae of

2690   *Savannasaurus*. In our phylogenetic analysis, AODF 0590 is placed in a clade alongside

2691   *Wintonotitan*, *Savannasaurus*, AODF 0665 and AODF 0906. It shares the most overlap with

2692   AODF 0906 (7.7% differences in a count of 14) and AODF 0665 (0% differences in a count

2693   of 11), but it does not overlap significantly with *Wintonotitan* (0% differences in a count of

2694   five) or *Savannasaurus* (66.7% differences in a count of five). The overlap AODF 0590

2695   shares with *Wintonotitan* and *Savannasaurus* is only between a caudal vertebra, whereas the

2696   overlap it shares with *Diamantinasaurus* (22.2% differences in a count of 11) is between the

2697   tibia and fibula. Given the difference in character counts between AODF 0590 and

2698   *Savannasaurus*, coupled with AODF 0590 lacking two *Savannasaurus* autapomorphies,

2699   AODF 0590 is better placed within *Wintonotitan*. However, we note that it has a higher

2700   character count overlap with *Diamantinasaurus* and possesses a single autapomorphy for that

2701   taxon. For these reasons, we keep AODF 0590 in open nomenclature as Diamantinasauria

2702   *incertae sedis* until such time as tibiae and fibulae are discovered for *Savannasaurus* and

2703   *Wintonotitan*.

2704   AODF 0591 possesses a single autapomorphy of the caudal vertebra of *Wintonotitan*,

2705   relating to incipient biconvexity, but lacks a second relating to a horizontal ridge. However,

2706   this horizontal ridge is only present in some specimens of *Wintonotitan* (as well as AODF

2707   2296). Given this overlap, we tentatively refer AODF 0591 to *Wintonotitan* but recognise that

2708   no other Winton Formation sauropod holotype specimen preserves middle–posterior caudal

2709   vertebrae.

2710   AODF 2851 is referred to *Wintonotitan* based on the possession of a proposed

2711   autapomorphy relating to the caudal vertebra: articular surfaces incipiently biconvex. If

2712   substantiated, this referral places three sauropod species (*Savannasaurus* [AODF 2854],

2713   *Wintonotitan* [AODF 2851] and *Diamantinasaurus* [AODF 0836]) at the same locality (QM

2714   L1333), indicating possible cohabitation.

2715   AODF 0656 possesses an ulnar interosseous ridge, recognised herein as a

2716   diamantinasaurian synapomorphy. Given a lack of diagnostic features on the scapula, we

2717   leave AODF 0656 in open nomenclature as Diamantinasauria *incertae sedis*.

2718   AODF 0665 possesses a single autapomorphy for which it can be assessed, relating to

2719   the tibia of *Diamantinasaurus*. As discussed above for AODF 0590, AODF 0665 is placed

2720   within the clade comprising *Savannasaurus* and *Wintonotitan* in our phylogenetic analysis. It

2721   shares the most overlap in character count with *Diamantinasaurus* (6.1% differences in a

2722   count of 35), *Australotitan* (0% differences in a count of 23) and AODF 0906 (4.5%

2723   differences in a count of of 23). Despite being placed in a clade with *Wintonotitan* and

2724   *Savannasaurus*, AODF 0665 only shares a character count of three and nine, respectively

2725   with those specimens, but has no differences. Additionally, these counts each pertain to

2726   overlap of a single element: AODF 0665 and *Wintonotitan* both preserve an ulna, whereas

2727   AODF 0665 and *Savannasaurus* both preserve a pubis. In comparison, AODF 0665 has an

2728   overlap of all five elements with *Diamantinasaurus* and three elements with *Australotitan*.

2729   Given this, a lack of overlap with *Savannasaurus* and *Wintonotitan* could be skewing these

2730 results. As such, we leave AODF 0665 in open nomenclature as Diamantinasauria *incertae*

2731 *sedis*.

2732   AODF 0666 possesses the two autapomorphies relating to the astragalus of

2733 *Diamantinasaurus*, and lacks the two astragalar autapomorphies of *Savannasaurus*. The tibia

2734 of AODF 0666 can only be assessed for one *Diamantinasaurus* autapomorphy: a double

2735 ridge. Although AODF 0666 lacks this autapomorphy, the surface where this ridge would be

2736 expected is damaged. On balance, we refer AODF 0666 to *Diamantinasaurus*.

2737   AODF 0832 possesses two of three caudal vertebral autapomorphies relating to

2738 *Wintonotitan*. It lacks a central shift of the neural arch; however, this shift could have

2739 occurred on a caudal vertebra situated distal to AODF 0832. As such, we tentatively refer

2740 AODF 0832 to *Wintonotitan* on the basis of the caudal vertebra alone, and make note of the

2741 similarities between the femur of AODF 0832 and the femora of *Diamantinasaurus* and

2742 *Australotitan*.

2743   The ventral half of the newly described, isolated caudal vertebra of AODF 2306 is

2744 incompletely preserved; consequently, it cannot be determined whether or not the anterior

2745 articular surface is undulatory. It is possible that the lateral surface possesses a shallow

2746 pneumatic fossa, as the lateral surfaces are dorsoventrally flat but anteroposteriorly concave.

2747 Other *Savannasaurus* characters that AODF 2306 possesses include: centrum with posterior

2748 articular surface more concave than the anterior one; articular surface hosting a distinct

2749 median bulge; centrum lateral surface hosting two longitudinal ridges; and reduced transverse

2750 processes. The aEI of the caudal vertebra of AODF 2306 differs from *Wintonotitan*, and the

2751 lateral surface of *Wintonotitan* only possesses a single horizontal ridge, unlike the two lateral

2752 ridges of AODF 2306. AODF 2306 is provisionally referred to *Savannasaurus* based on these

2753 comparisons, but further discovery of more diagnostic material is awaited in order to fortify

2754 this referral.

2755   AODF 0032 lacks two autapomorphies of *Wintonotitan* relating to the caudal vertebra

2756   and ischium, as well as three *Savannasaurus* autapomorphies relating to the caudal vertebrae

2757   and pubis. In our phylogenetic analysis, AODF 0032 clusters with *Diamantinasaurus* (7.1%

2758   differences in a count of 15), AODF 0836 (a referred specimen of *Diamantinasaurus*; 0%

2759   differences in a count of 14), and *Australotitan* (22.2% differences in a count of 11). AODF

2760   0032 has a higher overlap of characters with *Savannasaurus* (20% differences in a count of

2761   31) and *Wintonotitan* (19% differences in a count of 27) than it does with *Diamantinasaurus*

2762   and *Australotitan*. We suggest that AODF 0032 might represent a distinct diamintinasaurian

2763   species given the notable differences in its pelvic region to *Diamantinasaurus*,

2764   *Savannasaurus* and *Australotitan*, but we herein assign it to Diamantinasauria *incertae*

2765   *sedis* pending the discovery and description of more completely preserved material with the

2766   same morphology.

2767

2768   ***Material previously referred to* Australotitan cooperensis**

2769   Of the southern Winton Formation specimens referred to *Australotitan* by Hocknull et

2770   al. (2021), we refer EMF165 to ?Diamantinasauria indet. owing to a lack of uniting features

2771   with any of the named Winton Formation sauropod species; EMF100, EMF105, and EMF164

2772   to Diamantinasauria indet., given that each specimen possess one diamantinasaurian

2773   synapomorphy (EMF100 and EMF164: ulnar interosseous ridge; and EMF105: femur with

2774   *linea intermuscularis cranialis*); and EMF106 and EMF109 to *Wintonotitan*, as EMF106

2775   possesses one caudal vertebral autapomorphy of *Wintonotitan* (the only one for which it can

2776   be assessed) and lacks two *Savannasaurus* autapomorphies, and EMF109 possesses two

2777   autapomorphies of *Wintonotitan* relating to the caudal vertebrae.

2778

Possible synonymisation of *Australotitan cooperensis* with *Diamantinasaurus matildae*

In light of the analysis presented herein of the putative autapomorphies and defining characteristics of *Australotitan*, we consider it likely that *Australotitan cooperensis* is a junior synonym of *Diamantinasaurus matildae*. The holotype specimen of *Australotitan* does not possess any autapomorphic features that distinguish it as a valid taxon, and it shares numerous similarities with multiple specimens of *Diamantinasaurus*, despite the significant taphonomic compression to which it has been subjected. However, given the results of our phylogenetic analysis and the fact that the holotype of *Australotitan* only possesses a single putative autapomorphy of *Diamantinasaurus*, which cannot be assessed in several other diamantinasaurian specimens, we conservatively regard it as an indeterminate member of Diamantinasauria based on the presence of three synapomorphies of this clade.

Systematic palaeontology

Sauropoda Marsh, 1878

Macronaria Wilson & Sereno, 1998

Titanosauriformes Salgado, Coria & Calvo, 1997

Somphospondyli Wilson & Sereno, 1998

Diamantinasauria Poropat, Kundrát, Mannion, Upchurch, Tischler & Elliott, 2021

Characteristics. (1) Supratemporal fenestrae wider mediolaterally than the intervening space between them (plesiomorphic); (2) laterosphenoid–prootic with ossified canals for at least two branches of CN V (trigeminal); (3) cervical centra with prominent lateral pneumatic foramina; (4) TPOLs absent in dorsal vertebrae, resulting in confluence of the SPOF and CPOF; (5) hyposphene–hypantrum articulations absent throughout dorsal vertebral series; (6)

2803 caudal centra amphicoelous; (7) scapular blade with fossa on medial surface close to

2804 acromion–distal blade junction; (8) scapula medial surface with tuberosity posterior to

2805 acromion and distal blade junction; (9) sternal plate D-shaped rather than reniform; (10) ulna

2806 with prominent interosseous ridge on distal anterior surface; (11) manual phalanges present;

2807 (12) metacarpal III with distal end more expanded transversely than proximal end; and (13)

2808 femur with *linea intermuscularis cranialis* on anterior surface of shaft.

2809 **Included Taxa**. *Diamantinasaurus matildae*, *Savannasaurus elliottorum*, *Wintonotitan wattsi*

2810 and *Sarmientosaurus musacchioi*.

2811 **Comments.** With the exception of the first three listed synapomorphies, the remaining

2812 features cannot be assessed for *Sarmientosaurus* and this might only characterize the

2813 Australian diamantinasaurians.

2814

2815 ***Diamantinasaurus*** Hocknull, White, Tischler, Cook, Calleja, Sloan & Elliott, 2009

2816 ***Diamantinasaurus matildae*** Hocknull, White, Tischler, Cook, Calleja, Sloan & Elliott, 2009

2817

2818 **Holotype Specimen.** AODF 0603, AODL 0085 ('Matilda'): dentary fragment; tooth; three

2819 partial cervical ribs; three incomplete dorsal vertebrae; dorsal ribs; fragmentary gastralia; five

2820 coalesced sacral vertebrae; isolated sacral processes; left and right scapulae; right coracoid;

2821 partial right sternal plate; left and right humeri; left and right ulnae; right radius; left and right

2822 metacarpals I–V; eight manual phalanges (including right manual ungual I-2); left and right

2823 ilia; left and right pubes; left and right ischia; right femur; right tibia; right fibula; right

2824 astragalus, and associated fragments (Hocknull et al., 2009; Poropat et al., 2015b, 2021,

2825 2022).

2826 **Previously Referred Specimens.** AODF 0836, AODL 0127 ('Alex'): left squamosal; left

2827 and right quadrates; tooth (AODF 2298); left frontal; left and right parietals; left squamosal;

2828   left and right quadrates; braincase (comprising supraoccipital, left and right exoccipital–

2829   opisthotics, basioccipital, partial basisphenoid, left and right prootics, left and right

2830   laterosphenoids, left and right orbitosphenoids, and left and right possible sphenethmoids);

2831   left surangular; atlas intercentrum; axis; cervical vertebrae III–VI; middle/posterior cervical

2832   vertebral neural arch; three dorsal vertebrae; dorsal ribs; two co-ossified sacral vertebrae;

2833   right scapula; left and right iliac preacetabular processes; left and right pubes; left and right

2834   ischia; and abundant associated fragments, many representing ribs or partial vertebrae

2835   (Poropat et al., 2016, 2021, 2022). AODF 0663, AODL 0122 ('Oliver'): one left cervical rib;

2836   two dorsal vertebral centra; three dorsal neural arches; several dorsal ribs; left scapula; right

2837   humerus; right manual phalanx I-2; right femur; and associated fragments (Rigby et al.,

2838   2022). AODF 0906, AODL 0252 ('Ann'): left premaxilla; left maxilla; left lacrimal; left

2839   frontal; left parietal; left and right postorbitals; left and right squamosals; left and right

2840   quadratojugals; left and right quadrates; left and right pterygoids; left ectopterygoid;

2841   braincase (comprising supraoccipital, partial left and right exoccipital–opisthotics,

2842   fragmentary basioccipital, left and right prootics, left and right laterosphenoids, left and right

2843   orbitosphenoids, and a possible right sphenethmoid); left and right dentaries; left surangular;

2844   ?left ceratobranchial; four dorsal ribs; five sacral centra; several sacral processes; one anterior

2845   caudal vertebra; one chevron; left ilium; left pubis; left and right ischia; left and right femora;

2846   left and right tibiae; left and right fibulae; a probable right astragalus fragment; right

2847   metatarsals I–V; right pedal phalanges III-1–3 and IV-1–2; and associated fragments (Poropat

2848   et al., 2023).

2849   **Newly Referred Specimens.** AODF 0666, AODL 0128 ('Devil Dave'): right tibia; right

2850   fibula; right astragalus; and surface fragments. AODF 0844, AODL 0215 ('Ian'): right

2851   scapula; and right coracoid.

Localities. AODL 0085, AODL 0122, AODL 0215 and AODL 0252, Elderslie Station

(22°17'26.02"S, 142°28'18.83"E), ~60 km west of Winton, Queensland, Australia. AODL

0127 and AODL 0128, Belmont Station (22°4'46.27"S, 143°30'37.60"E), ~60 km northeast

of Winton, Queensland, Australia.

Horizon and Age. Winton Formation, lower Upper Cretaceous (Cenomanian–?lowermost

Turonian).

Revised Diagnosis. *Diamantinasaurus matildae* can be diagnosed on the basis of the

following autapomorphies: (1) endosseous labyrinth with lateral and posterior semicircular

canals defining an angle of 130°; (2) quadratojugal and quadrate with horizontal ridge present

across both elements anterior to their articulation point (lateral surface of quadrate, medial

surface of quadratojugal; (3) cervical axis with average elongation index < 1.5; (4) cervical

rib distal shafts without dorsal midline trough, instead possessing a laterodistally directed

ridge on the dorsal surface; (5) middle–posterior dorsal vertebrae with dorsally bifurcated

PCPL; (6) humerus proximal shaft posterolateral margin formed by stout vertical ridge that

increases the depth of the lateral triceps fossa; (7) humerus with ridge that extends medially

from deltopectoral crest, then turns to extend proximally, creating a fossa lying medial to the

dorsal part of the deltopectoral crest on the anterior face; (8) tibia proximal lateral face with

double ridge extending distally from lateral projection of proximal articular area; (9) tibia

with a posterolateral fossa posterior to the double ridge, containing a lower tuberosity and an

upper deep pit; (10) tibia shaft anterolateral margin, distal to cnemial crest, forms a thin

flange-like projection extending proximodistally along the central region of the element; and

(11) astragalus posteroventral margin, ventral and medial to the ascending process, with well-

developed, ventrally projecting rounded process visible in posterior, lateral and ventral views.

Local autapomorphies of *Diamantinasaurus* are: (1) parietal dorsal surface with anteriorly

crescentic, concave medial half and anteroposteriorly convex lateral half (potentially a

synapomorphy of Diamantinasauria); and (2) otoccipital with small depression situated lateral
to proatlantal facet.

Savannasaurus Poropat, Mannion, Upchurch, Hocknull, Kear, Kundrát, Tischler, Sloan,
Sinapius, Elliott & Elliott, 2016

Savannasaurus elliottorum Poropat, Mannion, Upchurch, Hocknull, Kear, Kundrát, Tischler,
Sloan, Sinapius, Elliott & Elliott, 2016

Holotype Specimen. AODF 0660, AODL 0082 ('Wade'): one posterior cervical vertebra;
several cervical ribs; dorsal vertebrae III–X; several fragmentary dorsal ribs; at least four
coalesced sacral vertebrae with processes; at least five partial caudal vertebrae; fragmentary
scapula; left coracoid; left and right sternal plates; incomplete left and right humeri;
fragmentary ulna; left radius; left metacarpals I–V; right metacarpal IV; two manual
phalanges; iliac fragments; co-ossified left and right pubes and ischia; left astragalus; right
metatarsal III; and associated fragments (Poropat et al., 2016, 2020).

Newly Referred Specimens. AODF 2306, AODL 0137: anterior–middle caudal vertebra.
AODF 2854, AODL 0001: right metacarpal IV.

Locality. AODL 0001 and AODL 0082, Belmont Station (22°4'46.27"S, 143°30'37.60"E),
~60 km northeast of Winton, Queensland, Australia. AODL 0137, Elderslie Station
(22°17'26.02"S, 142°28'18.83"E), ~60 km west-northwest of Winton, Queensland, Australia.

Horizon and Age. Winton Formation, lower Upper Cretaceous (Cenomanian–?lowermost
Turonian).

Revised Diagnosis. The following characters are considered to be autapomorphies of
Savannasaurus elliottorum: (1) undulating anterior articular surface of anterior caudal
vertebral centra (concave dorsally and convex ventrally); (2) anterior-most caudal centra with

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2902 shallow lateral pneumatic fossae (local autapomorphy); (3) sternal plate lacking

2903 anteroposteriorly elongate ridge along the anterior portion of the ventral surface (local

2904 autapomorphy); (4) metacarpal IV distal end hourglass-shaped; (5) pubis with ridge

2905 extending anteroventrally from ventral margin of obturator foramen on lateral surface; (6)

2906 ischium with proximal plate anteroposterior length > 40% the overall proximodistal length of

2907 the element; (7) astragalus taller proximodistally than wide mediolaterally or long

2908 anteroposteriorly; and (8) astragalus mediolateral width and anteroposterior length essentially

2909 equal.

2910 **Comments.** If the referral of AODF 2306 is substantiated, it expands the known geographical

2911 range of *Savannasaurus* by more than ~150 km.

2912

2913 ***Wintonotitan*** Hocknull, White, Tischler, Cook, Calleja, Sloan & Elliott, 2009

2914 ***Wintonotitan wattsi*** Hocknull, White, Tischler, Cook, Calleja, Sloan & Elliott, 2009

2915

2916 **Holotype Specimen.** QM F7292, QM L313 ('Clancy'): fragmentary dorsal vertebral centrum

2917 and three neural arches; fragments of dorsal ribs; two fragmentary coossified sacral vertebrae;

2918 28 caudal vertebral centra; one caudal vertebral neural arch; five chevrons; incomplete left

2919 scapula; incomplete left and right humeri; fragmentary left and right ulnae; complete left and

2920 partial right radii; left metacarpus comprising the proximal end of metacarpal I and complete

2921 metacarpals II–V; partial left ilium; left ischium; and associated bone fragments.

2922 **Previously Referred Specimen.** QM F10916: four caudal vertebrae.

2923 **Newly Referred Specimens.** AODF 0591, AODL 0080 ('Bob'): two caudal vertebrae;

2924 partial left fibula; and additional surface fragments. AODF 0832, AODL 0160 ('Patrice'):

2925 middle caudal vertebra; right femur; and additional unprepared elements (possibly from more

2926 than one individual). AODF 2851, AODL 0001: caudal vertebra. EMF106, EML010

119

2927 (formerly provisionally assigned to *Australotitan cooperensis*): an incomplete middle caudal

2928 vertebral centra and a metapodial articular end. EMF109, EML012 (formerly provisionally

2929 assigned to *Australotitan cooperensis*): posterior middle and posterior caudal vertebrae.

2930 **Localities.** AODL 0001 and AODL 0080, Belmont Station (22°4'46.27"S, 143°30'37.60"E),

2931 ~60 km northeast of Winton, Queensland, Australia. QM L313, Elderslie Station

2932 (22°17'26.02"S, 142°28'18.83"E), ~60 km west of Winton, Queensland, Australia. AODL

2933 0160, Lovelle Downs Station (22°8'45.92"S, 142°32'10.39"E), ~60 km west-northwest of

2934 Winton, Queensland, Australia. QM F10916, Selwyn Park Station (22°45'37.59"S,

2935 143°15'3.34"E), south-east of Winton (southwest of Chorregon). EML010 and EML012,

2936 Plevna Downs Station (26°40'52.51"S, 142°35'39.65"E), 85 km west of Eromanga,

2937 Queensland, Australia.

2938 **Horizon and Age.** Winton Formation, lower Upper Cretaceous (Cenomanian–?lowermost

2939 Turonian).

2940 **Revised Diagnosis.** Autapomorphies of *Wintonotitan* are: (1) median ridge on the dorsal

2941 vertebra neural spine summit linking the PRSL and POSL; (2) anterior and anterior–middle

2942 caudal centra with a horizontal ridge at approximately mid-height that projects as far laterally

2943 as the lateral margins of the anterior and posterior articular surfaces of the centrum; and (3)

2944 metacarpal IV with medially projecting bulge on the dorsal surface, close to shaft mid-length.

2945 Local autapomorphies of *Wintonotitan* are: (1) middle–posterior caudal vertebrae neural

2946 arches only slightly anteriorly biased; (2) posterior caudal vertebrae articular surfaces

2947 incipiently biconvex; and (3) ischium with prominent posterolaterally projecting flange-like

2948 ridge for the attachment of *M. flexor tibialis internus III*, visible in medial view.

2949 **Comments.** The referral of EMF106 and EMF109 to *Wintonotitan* expands the known

2950 geographical range of *Wintonotitan* from the northern Winton Formation to the southern-

2951 central Winton Formation.

2952

2953 **Diamantinasauria** *incertae sedis*

2954

2955 **Newly referred specimens.** AODF 0032, AODL 0049 ('Mick'): three incomplete cervical

2956 vertebrae; eight incomplete caudal vertebrae; left humerus; left pubis; left ischium; and

2957 associated fragments. AODF 0590, AODL 0079 ('McKenzie'): fragmentary caudal vertebra;

2958 femur distal condyles; right tibia; right fibula; and proximal and distal ends of the left tibia

2959 and fibula. AODF 0656, AODL 0117 ('Dixie'): cervical vertebra; partial left scapula; right

2960 ulna; and additional unprepared elements. AODF 0665, AODL 0125 ('Trixie'): dorsal ribs;

2961 right ulna; phalanx; right and left pubes; right femur; right tibia; right fibula; and additional

2962 unprepared elements. AODF 2296, AODL 0247 ('Leo'): dorsal ribs; 20 caudal vertebrae; five

2963 chevrons; left coracoid; left sternal plate; left ulna; right radius; left metacarpal IV; proximal

2964 right fibula; and associated fragments.

2965 **Localities.** AODL 0079, AODL 0117 and AODL 0125, Elderslie Station (22°17'26.02"S,

2966 142°28'18.83"E), ~60 km west of Winton, Queensland, Australia. AODL 0247, Belmont

2967 Station (22°4'46.27"S, 143°30'37.60"E), ~60 km northeast of Winton, Queensland, Australia.

2968 AODL 0049, unidentified property west of Winton, Queensland, Australia.

2969 **Horizon and Age.** Winton Formation, lower Upper Cretaceous (Cenomanian–?lowermost

2970 Turonian).

2971

2972 **Diamantinasauria indet.**

2973

2974 **Newly referred specimens.** QM F43302, QM L1333 ('Elliot'): partial right femur. EMF100,

2975 EML01 (formerly provisionally assigned to *Australotitan cooperensis*): incomplete right

2976 ulna. EMF102, EML011(a) (formerly *Australotitan cooperensis* holotype): partial left

2977 scapula; partial left and complete right humerus; right ulna; left and right pubes and ischia;

2978 and left and partial right femora. EMF105, EML013 (formerly referred to *Australotitan*

2979 *cooperensis*): a complete femur. EMF164, EML010 (formerly referred to *Australotitan*

2980 *cooperensis*): presacral vertebral centrum fragments and rib fragments; fragmented ulna; and

2981 fragmented femur.

2982 **Locality.** QM L1333, Belmont Station (22°4'46.27"S, 143°30'37.60"E), ~60 km northeast of

2983 Winton, Queensland, Australia. EML01, EML010, EML011(a), EML013, Plevna Downs

2984 Station (26°40'52.51"S, 142°35'39.65"E), 85 km west of Eromanga, Queensland, Australia.

2985 **Horizon and Age.** Winton Formation, lower Upper Cretaceous (Cenomanian–?lowermost

2986 Turonian).

2987

Conclusions

2989   The lowermost Upper Cretaceous Winton Formation of Queensland, Australia, has

2990 produced more evidence of sauropod dinosaurs than any other stratigraphic unit on the

2991 Australian continent. In this paper, we describe and present digital scans of specimens

2992 representing twelve sauropod individuals from the Winton Formation that are reposited in the

2993 collections of the Australian Age of Dinosaurs Museum of Natural History. Of these, two

2994 specimens are assigned to *Diamantinasaurus matildae*, two to *Savannasaurus elliottorum*,

2995 three to *Wintonotitan wattsi*, and five are retained in open nomenclature as Diamantinasauria

2996 *incertae sedis*. The description of additional specimens prompted a re-examination of the

2997 validity of all of the named sauropod species from the Winton Formation. We conservatively

2998 regard *Australotitan cooperensis* as an indeterminate diamantinasaurian owing to a lack of

2999 autapomorphies that distinguish it as a valid taxon, but suggest that it is probably a junior

3000 synonym of *Diamantinasaurus matildae*. The validity of *Savannasaurus* as a separate genus

3001 from *Diamantinasaurus* is upheld. *Wintonotitan* is robustly recovered as a member of

3002 Diamantinasauria for the first time, although its stability as a valid genus requires future

3003 clarification. Discovery of additional sauropod material from the Winton Formation will help

3004 to resolve the taxonomic classification of specimens within Diamantinasauria and shed

3005 further light on the anatomy and phylogenetic relationships of Diamantinasauria.

3006

Acknowledgements

3024

Appendix

Characters 1–556 follow those of Poropat et al. (2023), although one character is modified herein:

C176: Anterior-most caudal centra, camellate internal tissue structure: absent (0); present (1).

Score changes were made to this character for various taxa. Below, the first value in the parentheses (before the arrow) indicates the original score, and the second value (after the arrow) in the parentheses denotes the new score:

Alamosaurus (1→0)

Malawisaurus (1→0)

Xianshanosaurus (1→?)

Savannasaurus (1→0)

We add the following new characters (C### denotes the character number):

C557: Anterior-most caudal neural arches, camellate internal tissue structure: absent (0); present (1) (new character).

C558: Humerus, ridge extends medially from deltopectoral crest, then turns to extend proximally, creating a fossa lying medial to the dorsal part of the deltopectoral crest on the anterior face: absent (0); present (1) (new character).

C559: Ulna, prominent interosseous ridge on distal anterior surface: absent (0); present (1) (new character).

C560: Tibia, proximal lateral face with double ridge extending distally from lateral projection of proximal articular area and posterolateral fossa posterior to the double ridge, containing a lower tuberosity and an upper deep pit: absent (0); present (1) (new character).

3048   Several character scores of *Australotitan*, *Diamantinasaurus* and *Wintonotitan* scored

3049 by Hocknull et al. (2021) and Poropat et al. (2015a), respectively, were changed. Below,

3050 C### denotes the character number:

3051   *Australotitan cooperensis* EMF102: C36 (0 →?); C37 (1 →?); C43 (0 →?); C50 (0

3052 →1); C51 (2 →1); C58 (1 →?); C62 (1 →0); C217 (0 →?); C223 (0 →?); C229 (1 →?);

3053 C258 (1 →?); C279 (0 →?); C364 (0 →?); C366 (0 →?); C372 (1 →0); C511 (? →0); C513

3054 (0 →1); C514 (1 →?); C516 (0 →?); C517 (0 →?); C535 (1 →?).

3055   *Diamantinasaurus matildae* AODF 0603: C394 (0→1).

3056   *Wintonotitan wattsi* QM F7292: C45 (0 →?); C46 (1 →?); C192 (1 →0&1); C206 (0

3057 →?); C217 (0 →1); C228 (0 →?); C236 (1 →?); C239 (1 →?); C249 (0 →?); C252 (0 →?);

3058 C282 (0 →?); C284 (0 →1); C358 (0 →?); C376 (0 →?); C513 (0 →1).

3059

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