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Art, Anatomy, and the Stars: Russell and Séguin's Dinosauroid

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Abstract: It takes a bold, innovative mind to publish an exercise in speculative evolution pertaining to an alternative timeline. Dale Russell's studies of the troodontid *Stenonychosaurus* and of ornithomimid theropods, published in 1969 and 1972, inspired him to consider the possibility that some theropod dinosaur lineages might have given rise to big-brained species had they never died out. By late 1980, Russell had considered the invention of a hypothetical descendant of *Stenonychosaurus* dubbed the 'dinosauroid'. There is likely no specific inspiration for the dinosauroid given Russell's overlapping areas of interest, but his correspondence with Carl Sagan and his involvement in the SETI programme were likely of special influence. The early-1980s creation of a life-size *Stenonychosaurus* model with Ron Séguin gave Russell the impetus to bring the dinosauroid to life. Authors have disagreed on whether the dinosauroid's creation was an exercise in scientific extrapolation or one of speculative fiction, and on whether its form reflects bias or an honest experiment: Russell justified his decisions on the basis of the dinosauroid's anatomy being adaptive and linked to efficiency, but he also stated or implied that the human form may be considered a predictable evolutionary outcome among big-brained organisms, and expressed a preference for directionist views which posit humans as close to the pinnacle of evolution. Both derided and praised at the time of its construction, the dinosauroid is undergoing a resurgence of interest. Given that its aim was to spark discussion and invite alternative solutions, it can only be considered an extraordinary success.

Introduction

> "Probably it's a real period piece, and full of mistakes. But whether it's completely wrong or not, it does somehow say what I feel at night when I look up into the boundless vault of a soft, star-filled prairie sky."
>
> - Dale Russell to Steven Mark, April 15th 1984[1]

These words, adapted from a talk given in 1983, conclude Dale Russell's reaction to the view of evolutionary history drawn using his 'dinosauroid' thought experiment (Fig. 1). Reading them, we can find the same combination of scientific rigour and imaginative bravado which made the dinosauroid itself both so controversial and so appealing. The first sentence worries, responsibly, about how quickly the work would date – not quite two years after the publication of the dinosauroid paper, which itself had stressed the tenuousness of the hypothesis (Russell and Séguin 1982, p. 35). In the second sentence, though, these scruples are laid aside through an appeal to the powerful if disreputable mechanism of *instinctive* truth: "what I feel at night", here, replaces the practice of science with the subjective, human experience of being a scientist (and, perhaps, of other worldviews). The passage usefully introduces some of the other keynotes of the dinosauroid project. Evoking the arts (through language like "period piece" as well as through the appeal to the Romantic image of the

[1] All dated correspondence cited in this article can be found in Russell's collection at the Archives of the Canadian Museum of Nature (CMN).

individual contemplating the universe) hints at Russell's firm belief in the value of collaborating with visual artists (espoused forcibly in several of Russell's works, most notably Russell 1987). The image of the "boundless vault" of the stars suggests the importance of exobiology and space exploration in the history of an idea supposedly "based entirely on 'endobiological' (terrestrial) evidence" (Russell to J. Kevin Ramos, Sept 14th 1984). This is bolstered by the word "prairie", which serves not only to place Russell in dinosaur country but, as part of the phrase "prairie sky", to superimpose the mysteries of deep space upon those of the fossil-bearing Albertan rocks.

Russell's correspondent Steven Mark was an entertainment lawyer and aspiring screenwriter and producer, and the two were writing about the project which would become *Dinosaur!* (1985), a documentary presented by Christopher Reeve and featuring animations by Phil Tippett, who had worked on *Star Wars* and would go on to oversee the dinosaurs of *Jurassic Park* (1993). Towards the end of that documentary, a discussion of the end-Cretaceous extinction segues into the question: "How might the dinosaurs have evolved if they hadn't disappeared?". Russell appears on screen, strolling from his (and Ron Séguin's) life-sized reconstruction of the Late Cretaceous theropod dinosaur *Stenonychosaurus* – featured against a scrubland diorama – to the sculpture of the humanoid reptile provocatively posed behind a normal office desk, a dartboard tucked discreetly behind its legs. "[I]n the sixty-five million years that separates the end of the dinosaurs from ourselves", Russell says to the camera, "it is quite legitimate to speculate that some of the largest-brained dinosaurs may have looked something like this creature here" (Guenette 1985).

It's always towards the end. In Russell's *An Odyssey in Time* (1989), the speculative evolution arrives on page 213, almost as a coda to the main discussion. In another documentary called *Dinosaur!*, this one a four-part 1991 series fronted by Walter Cronkite,

dinosauroids (portrayed by humans in costume) take over for a minute towards the close of the final episode; the accompanying book (Norman 1991) discusses the dinosauroid only on its very last page. In Louie Psihoyos and John Knoebber's popular *Hunting Dinosaurs*, the dinosauroid turns up in the last chapter, which is suggestively titled 'Picking Up the Pieces' (Psihoyos and Knoebber 1994, 251). A recent magazine piece called 'What if dinosaurs hadn't died out?', brings in Russell and Séguin's hypothesis, "which today looks like an alien from a dated sci-fi show", only in paragraph 29 of 34 (Pickrell 2017). Even in the original scientific paper – 'Reconstructions of the small Cretaceous theropod *Stenonychosaurus inequalis* and a hypothetical dinosauroid' – it's only the last four words of the title which introduce our protagonist, and after the abstract and introduction, the speculative evolution is not discussed or mentioned until the end of page 21 (Russell and Séguin 1982). The dinosauroid, it seems, is always an afterthought or, better, an envoi, a conclusion gesturing forwards, hinting at something which the form of the responsible textbook, documentary, or magazine article can only flirt with.

Precisely because of its place on the threshold of respectability, the dinosauroid project has been largely successful in achieving Russell's aim of galvanising wider conversation about speculative evolution. In this essay, we take stock of that success by describing the project itself, then by reviewing its intellectual origins (especially with reference to the SETI programme), and finally by sketching its influence on popular and scientific culture: an influence which continues (and is arguably rising) at the time of writing. The dinosauroid and its implications have already been the subject of substantial commentary and review (Hecht and Williams 1982; Raup 1985; Norman 1986, 1991; Dixon 1988; Paul 1988; Lambert 1990; Magee 1993; Psihoyos and Knoebber 1994; Mayor 2000; Debus and Debus 2002; Hecht 2007; Naish 2008; Shuker 2008; Socha 2008; Switek 2010; Losos 2017; Pickrell 2017; Burke

and Tattersdill in press); keen not to tread over old ground, our discussion explores several neglected aspects of its backstory, thanks in part to the access we have had to Russell's papers, archived at the Canadian Museum of Nature (CMN, formerly National Museum of Natural Sciences). It remains unclear whether all of Russell's correspondence relevant to the dinosauroid survived a cull which occurred once Russell left the CMN for North Carolina but we are pleased to introduce some new observations from what does survive, and also to include images of the dinosauroid project which have not previously seen print.

With regard to some necessary issues of technical terminology, the dinosaur which inspired the dinosauroid project is *Stenonychosaurus inequalis* from the Campanian Dinosaur Park Formation of Alberta (Russell 1969), though note that this unit had not been separated from the older Oldman Formation at the time Russell was working (Eberth and Hamblin 1993). Currie (1987) argued that *S. inequalis* should be absorbed into the synonymy of *Troodon inequalis*, a taxon based on a tooth but regarded as diagnosable and valid by Currie (1987). Most post-1987 discussions of the dinosauroid therefore refer to its ancestor as *Troodon*, not *Stenonychosaurus*. A nomenclatural outcome of the recognition of *Troodon* as a maniraptoran theropod is that the mostly Cretaceous theropod group which includes *Stenonychosaurus* is today termed Troodontidae, but it was known as Saurornithoididae when Russell was working, so a similar shift affected the name of the group regarded as ancestral to the dinosauroid (viz, from saurornithoidid to troodontid). Russell referred to the members of this group as 'saurornithoids' (Russell and Séguin 1982), perhaps – we speculate – because it complements 'dinosauroids'. It has more recently been argued that *Troodon* is best regarded as a *nomen dubium* since its supposedly diagnostic tooth characters have now been documented in more than one troodontid taxon (Evans *et al*. 2017; van der Reest and Currie 2017). This decision has led some authors (Evans *et al*. 2017; van der Reest and Currie 2017)

126 to revalidate *Stenonychosaurus* and advocate abandonment of *Troodon* for good North
127 American troodontid remains; a dissenting opinion, however, posits that *Troodon* should be
128 retained in view of its widespread use (Varricchio et al. 2018). Finally, it should be noted that
129 the relegation of *Troodon* to *nomen dubium* status does not, according to Article 35 of The
130 International Code of Zoological Nomenclature (International Commission on Zoological
131 Nomenclature 1999), nullify use of the family name Troodontidae.

132

133 **The anatomy, design, and construction of the dinosauroid**

134 The question which provoked the dinosauroid into existence is a simple and arresting one:
135 what if non-bird dinosaurs hadn't gone extinct? In their *Syllogeus* paper, the research organ
136 of the CMN which published new work rapidly and without peer review, Russell and Séguin
137 present the question as arising naturally from observations about saurornithoidid intelligence.
138 Having restored a specimen of *Stenonychosaurus inequalis* and noted that it lived about
139 twelve million years before the K-Pg mass extinction, they wrote:

140

141 > It would be fascinating to learn how the saurornithoid attributes of large brain
142 > size, stereoscopic vision, opposable fingers and bipedal stature changed, if at
143 > all, during the remainder of Mesozoic time. It might also be entertaining to
144 > speculate in a qualitative manner on how the descendants of *S. inequalis* might
145 > have appeared had they survived the terminal Mesozoic extinctions, and
146 > achieved an encephalization quotient similar to that of *Homo sapiens*…
147 > (Russell and Séguin 1982, p. 22).

This moment, at the halfway point of the paper, forms the hinge between rigorous scientific work and something more speculative: the question underlying the first sentence could conceivably be answered one day with the discovery of new remains (and, indeed, can now be considered answered given more recent finds of troodontids from the terminal Cretaceous; e.g., Kurzanov and Osmólska 1991; Fiorillo and Gangloff 2000; Averianov and Sues 2007), but in the second sentence we advance beyond the realm of the strictly empirical. The conditional language ("It would be", "It might be", "might have appeared") belies the very definite work which Russell and Séguin have already done, leaving the dinosauroid off-handed and provisional even as it moves to introduce carefully-figured details. The shift from "fascinating" to "entertaining" is also suggestive, a self-effacement anticipating likely objections to the unorthodox question and methodology. With these linguistic maneuvers, and the authority afforded by the *Stenonychosaurus* part of the paper, Russell and Séguin ease the reader into the dinosauroid hypothesis.

This, simply put, is that "the human form is not an evolutionarily surprising form. It may represent a target that is easy for natural selection to hit" (to quote Russell from his April 1984 correspondence to Steven Mark). Working towards this point – although never quite stating it outright – the *Syllogeus* article provides substantial insight on the dinosauroid's anatomical configurations and the speculative evolutionary back story to its design (Russell and Séguin 1982, pp. 22-26; some of this is summarized in Russell 1989). The dinosauroid, incidentally, was – at one point, at least – going to be labelled *Dinosauroides erectus*, the descendant of the less specialized *D. horizontalis* (according to text Russell sent to Steven Mark in April 1984).

Without downplaying the dinosauroid's novelty, it should be noted that the 'smart dinosaur' trope was already in the air during the 70s, in part because of Russell's (1969, 1972) comments on theropod brain size and encephalization, but also because of new ideas on dinosaur biology (including endothermy and nocturnal mammal-hunting) and extinction. Beyond the sciences, there are also considerable precedents for the dinosauroid in mid-twentieth century science fiction: a fact we return to later. First, though, we review some of the dinosauroid's immediate neighbours in the sciences.

A seminal work on the dinosaur renaissance – Adrian Desmond's *The Hot Blooded Dinosaurs* (Desmond 1975) – includes in its final chapter: "The potential inherent in dromaeosaurs and coelurosaurs for an explosive evolution as the Tertiary dawned cannot be doubted – who knows what new peaks the sophisticated 'bird-mimics' would have attained had they survived into the 'Age of Mammals'" (p. 185). Indeed, imaginary smart dinosaurs were, at about this time, developed simultaneously by several authors. Harry Jerison – whose data on encephalization in vertebrates (Jerison 1973) was integral to Russell's speculative thoughts on troodontids (Russell and Séguin 1982, p. 21) – floated the idea that brainy theropods were an evolutionary possibility in a Fellows' Address ('Smart dinosaurs and comparative psychology') given at the American Psychological Association meeting in Toronto in August 1978. Jerison's animals of choice were ornithomimids like *Dromiceiomimus* (coincidentally, a taxon named by Russell), and he postulated a hypothetical *D. sapiens*. These musings were never published, and Russell (1987, p. 127) noted that he was unaware of them "until several years later". McLoughlin (1984) devised a big-brained, post-Cretaceous theropod close in time to Russell and Séguin, likely being fully aware of Russell's work, a contention we make based on the contents of McLoughlin's later sci-fi works (McLoughlin 1983; McLoughlin 1987). We know that Russell was aware of

McLoughlin's article since he was sent a copy by Michael Morales of the Museum of Northern Arizona in September 1984. McLoughlin's (1984) big-brained theropod is a dromaeosaurid rather than a troodontid, and is long-tailed and not humanoid. In view of these alternative 'smart dinosaurs', it is worth pinning down the dinosauroid's 'date of origin' as precisely as possible. A December 1980 letter from Ralph Molnar, based at the time at the Queensland Museum, reveals that Russell was referring in correspondence to his dinosauroid project at this time or slightly before, but was being cryptic about it. In the letter, Molnar notes his keenness to see the reconstructed "hypothetical potential theropod" which Russell was working on (Molnar must have been referring to a physical model rather than an illustration since Russell's skeletal reconstruction of *Stenonychosaurus* was published in 1969; Russell 1969).

If the dinosauroid has come to eclipse its near-contemporaries, it has also in many senses eclipsed the other reconstruction which appeared alongside it: little commentary has appeared on the *Stenonychosaurus* model (Fig. 2) bar notes provided by Paul (1988). The *Stenonychosaurus* (which lacks feathers and is covered in scaly skin, as thought correct at the time) is accurate in posture, proportions and nuance, and mirrors the appearance of this dinosaur established in Russell's papers (Russell 1969). Its ribcage is broad and bulky relative to what is now considered accurate (based on articulated troodontids: Russell and Dong 1994; Tsuihiji *et al*. 2014); in the hand, it was constructed as if capable of manual pronation and of having a rotated digit III which was opposable to digit I (cf Russell 1969, p. 603). Neither of these forelimb features are consistent with articulated maniraptoran hands nor our understanding of digital movement in these dinosaurs (Gishlick 2001; Senter 2006), though it should be noted that this has only become obvious thanks to studies published post-2000. An interesting detail in the feet is that the hyperextendable digit II was shown as being

held in a flexed position on the right foot (a hyperextended posture expected for these dinosaurs was depicted on the left side): this is not an error, but is consistent with the extensive movement possible in this digit.

Paul (1988, p. 398) regarded the model as insufficiently muscled in the hindlimbs and "overly scrawny"; it should be noted that the 'shrink-wrapped' look of the animal is in keeping with the appearance of other dinosaurs supervised by Russell (viz, those of Ely Kish) and is not specific to this one in particular. Russell evidently liked his dinosaurs skeletally thin, lacking fat, and with minimal muscular bulk. Regardless, the fact that Séguin's *Stenonychosaurus* is accurate overall and – bar the specifics noted here, integument especially – not inconsistent with modern thinking on the life appearance of these animals, means that both it and the dinosauroid can be perceived as up to date views of their appearance, and not contingent on the traditions of the early 1980s.

Turning now to the form of the dinosauroid (Fig. 3), the evolution of an enlarged skull was suggested as the primary driver for the development of verticalized thorax and its centralized position on a shortened neck; additionally, the increased energetic efficiency of erect-bodied, human-style locomotion and the improvements it would allow in throwing projectiles and using tools were cited as reasons for a human-like form (Russell and Séguin 1982, p. 26). Several references to the literature on hominid evolution were made to provide justification for these proposals, including works by Roger Lewin, Peter Rodman and Henry McHenry, and Sherwood Washburn (Russell and Séguin 1982); of incidental interest is that Russell sometimes mentioned Louis Leakey, Donald Johanson and their work in connection with the *Stenonychosaurus* remains he described in 1969 (Hecht and Williams 1982, p. 50; Psihoyos and Knoebber 1994). In relating the time that Leakey examined the remains, Russell's implication was that Russell and Leakey both noticed, independently, the potential

243 *Stenonychosaurus* might have to give rise to bigger brained descendants (Psihoyos and
244 Knoebber 1994, p. 251).

245 The dinosauroid's endocranial volume is 1100 ml (derived by comparing the model skull
246 to that of a small female human); its encephalisation quotient (EQ) – a ratio of brain to body
247 size – was stated to be 7.1 (Russell and Séguin 1982, p. 27). It is clear from citations
248 throughout Russell and Séguin (1982) that Jerison's (1973) graph was relied on in order to
249 calculate the dinosauroid's EQ, and we assume that a human-like brain size was used such
250 that the dinosauroid would end up with a human-like EQ, stated by Russell and Séguin (1982,
251 p. 22) to be "about 7.5", following Jerison (1973). However, Jerison's (1973) EQ data
252 grouped vertebrates into 'higher vertebrate' and 'lower vertebrate' categories alone, his
253 assumption being that vertebrates of diverse and disparate groups should fit on the same
254 slope. This cannot be true given that average brain to body size ratios differ among vertebrate
255 groups. In recognition of this, Hurlburt (1996) developed revised EQ formulae for non-bird
256 reptiles (REQ), birds (BEQ) and mammals (MEQ) and used a much larger range of species
257 than Jerison (1973). We were interested in comparing the dinosauroid's EQ to that of 'real
258 timeline' dinosaurs and other animals in view of this revised, post-Jerison (1973) work, some
259 of which has already revised EQ data on Cretaceous theropods (Hurlburt et al. 2013). The
260 dinosauroid has an REQ of 244.08, BEQ of 22.12, and MEQ of 8.9555. For comparison, *H.*
261 *sapiens* has an REQ of 190.71, BEQ of 16.74, and MEQ of 5.8976 (G. Hurlburt, personal
262 communication, 2020). The dinosauroid, then, is not simply brainy; it is *astronomically*
263 brainy, well exceeding the EQs of all other analysed dinosaurs (including the highest-EQ
264 living birds, like parrots: the macaw *Ara* has a BEQ of 2.986) as well as humans (Hurlburt
265 1996; Hurlburt et al. 2013). It does not fit on the slopes established for non-bird reptiles, or
266 for birds (Fig. 4).

In addition to postulating enlargement of the endocranial volume, Russell and Séguin (1982) suggested the presence of anteromedially rotated orbits, a secondary palate, elevated external nostrils and toothlessness, the last feature being deemed advantageous to the avoidance of tooth decay (a rather teleological argument) and thought likely in view of the convergent evolution of toothlessness and "keratinous occlusal surfaces" in the related ornithomimids. An increase in endocranial volume was further suggested to be linked to reduction in the size of the face and jaw apparatus, the dinosauroid's skull proportions being based on those of a chick embryo.

The dinosauroid was thus intended to be paedomorphic in skull form. While not stated in the text, this was surely inspired by the proposal that humans are paedomorphic with respect to other hominids. Perhaps little-known is that a dinosauroid skull was reconstructed in addition to the life reconstruction (Fig. 5; Russell and Séguin 1982, pp. 24-25). This reveals that both the laterotemporal and mandibular fenestrae were reconstructed as secondarily closed, the quadratojugal eliminated, and the antorbital fenestra was reduced but still present.

The dinosauroid's neck is shortened relative to that of troodontids and human-like shoulders are present, these being braced against the sternum by coracoids as is the case in the animal's ancestors (Russell and Séguin 1982, p. 27). The forelimb proportions are similar to those of ornithomimids, but again the likely impetus for the length of the arm and its segments was that they should be human-like. The hand is tridactyl, the elongate, slender digit I opposing the other two, and all three digits possess nails rather than claws.

In the pelvis, the dinosauroid has broad iliac blades which project laterally, again with reference to the hominid condition. However, Russell and Séguin (1982, p. 26) noted the presence of deflected iliac blades in therizinosaurs as providing a precedent for this condition

290 in theropods, the 'need' for this condition being "the birth of highly encephalized young".
291 The presence of a navel was deemed evidence for the viviparous birth expected to be present
292 (Russell 1987), though it should be noted that an umbilical scar or similar feature is a
293 widespread trait in vertebrates. A tail is not absent in the dinosauroid but persists as a hyper-
294 shortened structure similar to the human coccyx and located between hemispherical buttocks
295 (a "gluteal-like muscle mass"; Russell and Séguin 1982, p. 35), a detail which is rarely
296 appreciated given that most published images of the dinosauroid only show its anterior aspect
297 (Russell and Séguin 1982; their Fig. 18 is the exception). The hindlimbs were again designed
298 after those of humans rather than the digitigrade organs of troodontids with their narrow
299 thighs, flexed knees and elongate metatarsi. The dinosauroid's plantigrade feet are
300 tetradactyl, with digits I and II reduced and III and IV longer; all are equipped with nails
301 (Russell and Séguin 1982).

302 On integument, the dinosauroid's exterior is not entirely smooth but intended to be
303 covered in tiny, non-overlapping scales. A dewlap was added as a secondary sexual
304 characteristic (Fig. 2). The colour was based on that of the *Stenonychosaurus*, probably so
305 that they should look as similar as possible.

306 Russell and Séguin (1982) ended their discussion of the dinosauroid's anatomy by noting
307 awareness of possible bias in its design. Their overwhelming emphasis was on the probability
308 of the evolution of a human-like form among *Stenonychosaurus*'s descendants and their
309 claim that "existing within the spectrum of morphologies represented by terminal Cretaceous
310 dinosaurs was a mosaic of characters which paralleled many seen in mammals and in the
311 phylogenetic precursors of man" (p. 35) is arguable and even objectionable given that we
312 have evidence that troodontids were more like turkeys or hornbills than hominids. Russell
313 and Séguin (1982), though, even wondered whether the dinosauroid might be "too reptilian",

and they noted that perhaps the eyes should be proportionally smaller, the ears surrounded by pinnae, the muzzle less elongate, the chest less deep and narrow (Russell (1987) noted that the chest should probably have been flatter; he pointed to Slijper's goat – a bipedal individual born without forelimbs – and tree kangaroos for possible confirmation). The *Syllogeus* paper also noted that other possible configurations for such a creature might exist. As discussed later, this invitation has not gone unexplored.

Building the dinosauroid

Despite its comprehensive discussion of *Stenonychosaurus* and dinosauroid anatomy, Russell and Séguin's (1982) *Syllogeus* paper is unfortunately devoid of data on how Russell and Séguin came to collaborate, and on the physical construction of the two models. Russell (1987, p. 103) includes comments on how the eyes were constructed, but little additional data is included. We are indebted to Ron Séguin for the following information.

From 1973 until the end of the 70s, Séguin was a museum taxidermist and model maker specializing on fish, reptiles and amphibians. The burgeoning popularity of dinosaurs meant that now was the time to consider the construction of 3D dinosaur models, and Séguin was the perfect person for the job: Louis Lemieux, then director of the National Museum of Natural Sciences, arranged an inter-departmental alliance, beginning in January 1980, between the Exhibits Section and the Research and Collections Department. Séguin's strengths included his knowledge of animal musculature, skeletal form and the overlying soft tissues, his skill in applying resins, paints and finishes in order to make models look like live animals; his sculptural skill; and his knowledge and expertise in the technology and material of molding and casting, this variously involving the creation of metal reinforcements, clear

337 resin eyes and so on. Accordingly, Séguin's initial meetings with Russell did not specifically
338 concern the dinosauroid, but the more general creation of dinosaur models. Russell already
339 had an alliance with artist Ely Kish and was thus well versed in working with artists (Kish
340 produced spectacular colour paintings for Russell's work – most memorably those first
341 appearing in *A Vanished World* (Russell 1977) and again (this time with other works) in *An*
342 *Odyssey in Time* (Russell 1989) and also produced scaled 3D clay miniatures in order to
343 understand the interplay between light and shadow on the subjects; see Russell 1987, p. 125).
344 Russell suggested in particular the construction of a *Stenonychosaurus* model and after the
345 creation of a small clay version, Séguin made it clear that producing one at full size would be
346 well within his capabilities. It would prove to be a two-year project.

347 It was toward the completion of the successful and pleasing course of the
348 *Stenonychosaurus*'s creation that Russell began to promote the construction of an
349 accompanying dinosauroid model too, though "he was particularly worried about how the
350 model would be received and the effects it might have on his reputation as a scientist" (R.
351 Séguin, pers. comm. 2020). It would appear that the model came to life through Russell's
352 description of what the anatomy might be like combined with Séguin's knowledge of model-
353 making and animal anatomy, and not – remarkably – via the creation of paper sketches or
354 scaled-down prototypes (Figs. 6, 7). The 'real-world' origins of the dinosauroid relate to an
355 aspect of it which is seldom discussed: its status as a museum object rather than a hypothesis
356 in the abstract (an area discussed more fully in Burke and Tattersdill, in press). The models
357 underwent several final rounds of revision, particularly with respect to the look of the
358 nostrils, which were initially more vertical than they are in the final product.

359 For Séguin, the creation of the models was very much a challenge, a great experience with
360 an exceptional person, and a career highlight of which he has fond memories. Following the

project's completion, Séguin returned to the museum's Exhibit Department and eventually became Head of the Display Preparation Section. Séguin and his team were behind the creation of the three woolly mammoth sculptures which still stand on the museum's grounds today. He left the museum during budget cutbacks in 1993 and succeeded in founding his own freelance model, diorama, and taxidermy company.

Russell and Carl Sagan

To our knowledge, the precise catalyst for Russell's speculations on dinosauroids has never been identified. Given Russell's parallel interests in the evolution and diversity of fossil vertebrates, encephalization and intelligence in the history of life, and the position of humankind in the history of the universe, though, there is likely no one single line of influence. This was an idea which required a combination of scientific arenas and artistic opportunities to come to fruition.

One event which must be considered influential was Russell's visit – presumably of 1965 (J. Mallon, pers. comm.) – to the American Museum of Natural History. This is where he became impressed with the large brain size coelurosaurian theropods (Psihoyos and Knoebber 1994, p. 251), a realisation which prompted him to spend six weeks during the summer of 1968 in Dinosaur National Park looking for new coelurosaur material (Russell 1969; Psihoyos and Knoebber 1994, p. 251). Russell's correspondence further reveals that his exchanges with Carl Sagan, initiated in September 1976, were integral to the development of the dinosauroid, Russell's reading of Sagan's *The Dragons of Eden* (Sagan 1977) being of special importance. *The Dragons of Eden* – subtitled *Speculations on the Evolution of Human Intelligence* – is a wide-ranging book, its primary thrust being that the complexity, anatomy

and function of the human brain is a consequence of our evolutionary history, and that culture, language, politics and human destiny are thus products of our evolution too. On the metaphorical dragons of the book's title, Sagan is vague, at one point stating – shortly after discussing the existence of big-brained theropods and the persistence of big reptiles like the Komodo dragon – "Is it possible that dragons posed a problem for our protohuman ancestors of a few million years ago, and that the terror they evoked and the deaths they caused helped bring about the evolution of human intelligence?" (Sagan 1977, p. 141), afterward noting that allegorical reptiles like the serpent in the Garden of Eden might have been references to "use of the aggressive and ritualistic reptilian component of our brain in the further evolution of the neocortex" (Sagan 1977, p. 141). On that last point, a pedantic reviewer might note that we synapsids do not descend from reptiles, though this convention had not been adopted when Sagan was writing.

Russell's correspondence from September 1976 includes his response to Sagan's request (a telephone call from Sagan's secretary, Christine Bingham) for more information on small theropods. Sagan had seemingly learnt of these animals from astrophysicist Melvin Ruderman. Russell provided a brief outline of his thoughts on saurornithoidids and ornithomimids; dromaeosaurids were mentioned in passing. Russell also provided Sagan with a technical paper on *Stenonychosaurus inequalis* (presumably Russell 1969), another on ornithomimids (Russell 1972), a graph (presumably Jerison's) on which the brain : body size ratios of *Stenonychosaurus* and *Dromiceiomimus* were plotted, and an illustration of *S. inequalis* (perhaps a life restoration). We infer that these data were integral to Sagan's discussion of Cretaceous theropods in *The Dragons of Eden* (Sagan 1977 pp. 135-6); Sagan (1977, 'permission acknowledgements' in unpaginated section) cites Russell (1969) for the life restoration of *Stenonychosaurus* included in the book, but does not list him in the overall

408 acknowledgements. It was also at this early point in their correspondence that Russell
409 provided Sagan with mostly unpublished data on the hypothesis – developed as a
410 collaborative project with ecologist Pierre Béland and a team of geologists, palaeontologists,
411 physicists and astronomers – that a supernova might be shown to be the cause of the end-
412 Cretaceous extinction event. Russell noted his interest in determining the energy and nature
413 of such an event and how it might impact Earth's atmosphere and biota. Besides hinting at
414 the idea that Sagan might be able to provide the answers himself (or suggest someone who
415 could), Russell also invited Sagan to a November 1976 meeting on the issue held in Ottawa.
416 Sagan was unable to attend, but in September 1976 and again in March 1977 he did at least
417 share some speculations on the supernova hypothesis: Sagan's main observation was that the
418 effects of any such event would be most impactful on micro-organisms, and that "benthic and
419 nocturnal animals would preferentially survive". Russell (in a letter of March 11th 1977)
420 noted that the fossil record was mostly in agreement with this pattern, but he also drew
421 attention to recently published and in-prep work which showed that extinctions across groups
422 had not occurred in synchrony, and that some stratigraphic data appeared inconsistent with
423 the concept of a sudden extinction event. Of incidental interest is that Sagan sent Russell
424 some of the Viking photos of Mars during September 1976, and that Russell requested a copy
425 of Sagan's *Nature* article on the Loch Ness monster (Sagan 1976) in February 1977.

426 By June 1977, Russell had received and read *The Dragons of Eden* (Sagan had mailed a
427 copy in May) and wrote to Sagan to congratulate him on the breadth and value of the text. He
428 asked what Sagan's thoughts were on the "evolutionary significance of a Creator as depicted
429 in scripture" and also wondered what Sagan's thoughts might be on whether dinosaur
430 populations were controlled by the availability of energy-rich foods (after all, he reasoned,
431 baby dinosaurs did not have access to the milk provided by mammalian mothers). Given the

details of the Russell-Sagan correspondence discussed so far, it is fair to say that the data provided by Russell was integral to Sagan's comments on the hypothetical, parallel timeline evolution of intelligent dinosaurs (Sagan 1977, pp. 135-6) in *The Dragons of Eden*, and such was confirmed by Sagan in a letter of August 1977. In turn, Sagan's statements likely gave Russell the impetus he needed to begin the dinosauroid experiment. In other words: Russell partially inspired Sagan's *The Dragons of Eden*, and Sagan's *The Dragons of Eden* partially inspired Russell's dinosauroid.

The dinosauroid, SETI, and alien evolution

Along with many other influential scientific names (including Stephen Jay Gould, Jonas Salk, and Freeman Dyson), Russell was a signatory to Sagan's 1982 open letter in *Science* advocating the continued funding of the SETI program. In that letter, Sagan notes that though the signatories come from a range of backgrounds, what unites them is the fact that they have all "considered the problem of extraterrestrial intelligence, some of us for more than 20 years" (Sagan et. al. 1982, p. 486). Russell's presence therefore implicitly aligns his palaeontological work with developing conversations on alien evolution; the next year, he would publish in *Advances in Space Research* on the subject of intelligent extraterrestrial life (Russell 1983). The SETI letter and the dinosauroid paper, both published in 1982, each propose to address an unmanageably vast, even philosophical problem – speculative evolution, alien intelligence – with the careful application of specific disciplinary expertise – palaeoartistic restoration and radio astronomy, respectively (for more on the philosophical implications of SETI, see Ćirković 2012). They also share, of course, a considerable

imaginative appeal which reaches far beyond the scientific institutions where they were developed.

"But SETI has turned me inside out like a sock!", Russell wrote to radio astronomer Charles Seeger in May 1981. "I used to be content to intimidate little kids with the awesome chasm of geologic time – then you people gently steered me around to fact the great gulf of the future!" (Russell to Seeger, May 4 1981). In the same letter, he offers to send Seeger "a crude plastic model of the skull of *Stenonychosaurus* as it might have been 76 million years later", this presumably being a version of the dinosauroid skull described and depicted in Russell and Séguin (1982). SETI's emphasis on the evolution of intelligence and the statistical likelihood of a human-like civilization evolving within communication range of Earth inevitably connected it to Russell's interests in the probability or otherwise of humanoids, and so to the dinosauroid project. Indeed, part of the dinosauroid's success in the public sphere might be linked to its superficial similarity to fictional aliens; Russell (1987) noted that the warm reception the model received in some quarters (including from children) may be partly explained to the proximity of the 1982 movie *E.T. the Extra Terrestrial*. To this day, if the observations of a casual half-hour are anything to go by, the dinosauroid currently on display in Lyme Regis's Dinosaurland Fossil Museum ('Saurian', which lacks details present in the original and is of inferior quality), is referred to by visiting families as an "alien" as a matter of routine.

Noble noted that the dinosauroid was "given considerable credence" (2016, p. 41) by the SETI program, but the archive suggests that SETI – itself new and vulnerable in 1982, as the need for Sagan's letter attests – likely influenced the development of the project as well as authorizing it after the fact. Russell was discussing the possible existence of intelligent aliens with NASA personally as early as January 1979, his letters to NASA's Mark Stull involving

478 discussions of brain size across vertebrates, the causes of mass extinction events ("obviously
479 of importance to SETI"), and dolphin intelligence. Of special interest is the mention that "it
480 may be possible to bring a model (flesh-reconstruction) of *Stenonychosaurus* to the June
481 meeting [presumably a SETI meeting], as well as a hypothetical reconstruction of what it
482 would have looked like now, had the terminal Cretaceous extinction event not occurred"
483 (Russell to Stull, Jan 19 1979). "Days have been for admin and manuscripts", he wrote later
484 in this same letter, "but evenings for SETI until I'm domesticated with a rolling pin".

485 Russell stated in his 1984 correspondence with Steven Mark that he had participated in
486 two NASA workshops on SETI, quoting his view that evolution may have a directionism
487 which would favour the development of human-like forms: "it could be expected that some
488 biospheres could produce something like what we have called a dinosauroid" (Russell to
489 Mark, April 15 1984). His view is echoed in Russell's (1987, p. 130) statement that "the
490 dinosauroid-humanoid form may have a nonnegligible probability of appearing as a
491 consequence of natural selection within the biospheres of earthlike planets". This, of course,
492 is the deeper link which – at least so far as Russell was concerned – connects SETI to the
493 dinosauroid project: convergence, and the idea that the humanoid form would have emerged
494 inevitably rather than by chance. This is, as we are not the first to observe (Raup 1985; Dixon
495 1988; Paul 1988; Hecht 2007; Naish 2008; Losos 2017), at the back of everything
496 dinosauroid-themed (an area we discuss further below). In August 1984, Russell wrote to
497 NYU anthropologist Noel T. Boaz that:

498

499 Cast in the background of the dinosauroid, it seemed like a valid endeavour might be
500 to see how the human form might be a natural target for selective pressures like a fish

> form, bird form, etc. rather than a configuration identified by accident in the great random walk that is organic evolution for some. Steven [*sic*] Gould debunked the former notion in a recent meeting (June '84) of astronomers interested in the Search for Extraterrestrial Intelligence in Boston. I think that this was a bit premature. (Russell to Boaz, Aug 3 1984)

Gould's position at this SETI meeting would famously be cemented by his 1989 *Wonderful Life*. Russell's critique, then, anticipates that which would later be made by Simon Conway Morris in 1998's *The Crucible of Creation* and subsequent works. Gould's primary argument was that evolutionary events operated via contingency and that outcomes would have been very different had history gone a different way (Gould 1989); Conway Morris's was that many events were, in fact, at least loosely pre-determined and that animal forms like the humanoid were inevitable (Conway Morris 1998, 2005). The debate between the two became acrimonious (see Conway Morris and Gould, 1998), and its scientific implications are explored at book length by Jonathan B. Losos (2017), who mentions both Russell and the dinosauroid in his introduction (a break with tradition) and conclusion – but nowhere else. Both Losos (2017, p. 8) and Noble (2016, p. 417 n.48) note that Conway Morris has endorsed the dinosauroid more fulsomely than most scientists (he was interviewed in the presence of one in an episode of the BBC documentary *Horizon*; Everest 2007) but it is important to remember that the issue of evolutionary determinism, in Losos's words, "had not yet been raised when Gould wrote *Wonderful Life*" (2017, p. 18). Indeed, during the years in which Russell was working on the sculpture, Conway Morris had not yet come to occupy his determinist position and was still writing the papers which Gould would quote in support of his "great random walk". The dinosauroid is, then, an implicit forerunner in the debate

around convergence and contingency, not a salvo in it. Russell's archive reveals that he did correspond with Conway Morris in September-October of 1980; however, the letters we have examined involve discussion of Burgess Shale organisms (especially *Pikaia*) and make no mention of the evolution of intelligence, speculative or otherwise.

Ethnology, religion and the dinosauroid

Conway Morris's interpretation of evolution explicitly affirms the existence of a creator. With the dinosauroid, Russell never went so far. He was, though, a committed Catholic, and according to Brian Noble (2016, p. 41), had "long admired the philosophy of Pierre Teilhard de Chardin, and consequently developed an intellectual frame […] where divinely sourced design in organic forms might very likely recur convergently in evolutionary history". Similar comments about Russell's interest in the writings of Teilhard were made by Robert Bakker in an interview about religiosity and science (Campagna 2001). Noble's and Bakker's accounts are based on having known Russell personally; Russell himself seems not to have left any trace of this intellectual frame either in his published scientific works (which, of course, could not support it) or in his archived documents. John Acorn (pers. comm., 2020) recalls Russell around 1992 working on an essay about alien-human hybrids which he intended to send to the Church. At the time of writing, though, we are unable to find this essay in print, or any mention of it in correspondence. Archives are as important for what they erase as for what they preserve: though many who remember Russell affirm the importance of his faith, cultural and spiritual motivations for scientific work often leave no paper trail, and so vanish.

Whilst we cannot report direct evidence of a religious motivation in the dinosauroid project specifically – and have already identified other influences which put it, perhaps, on the wrong side of Occam's razor – the archive does attest to Russell's interest in ethnology and anthropology. During the October of 1981, ethno-historian Rudolph Mitchell Uribe of Flagstaff, Arizona, wrote to Russell with his thoughts on the dinosauroid: he was reminded of a Navajo legend which told of a time when monsters (interpreted by Uribe as dinosaurs) were defeated by humans, and he emphasized the possibility that Russell's work may provide verification for the view that humans and dinosaurs had awareness of one another. In his response of August 1982, Russell noted how the legend might be "analogous to the parable form in Judeo-Christian tradition" and "could easily be interpreted as containing a deeper truth from the perspective of the current state of our understanding of Earth history". Clearly, he sought to treat an Indigenous position with fair consideration and due respect. But the fact that his immediate recourse was to compare it to the religion to which he was most attached – rather than temper or counter these suggestions with a scientific take – might, we suggest, be significant. In this instance, he sought to affirm his correspondent that: yes, it could be that our mythological tales of dragons and serpents might provide insight into a deeper truth, perhaps to our past. This notion is, as described above, hinted at in Sagan's *Dragons of Eden* (Sagan 1977), not least in its title, and also by Mayor (2000) in her implication that the dinosauroid might play into the mythic archetype exploited by the Ancients in their discussions of Tritons and Centaurs.

A criticism of the dinosauroid's design is that its hypothetical evolution does not appear to have been driven by an extrapolation of trends really seen in theropod dinosaurs but, rather, by the expectation that a humanoid form was the inevitable end point for a large-brained bipedal vertebrate. Here we return to Russell's admiration of Teilhard (Bakker, in Campagna

2001, p. 7; Noble 2016, p. 41). A prominent component of Teilhard's philosophy was directionality in evolution, that humans represent a point close to (but not at) the pinnacle of evolution, and that a humanoid stage was inevitable for those organisms approaching evolution's final stage: the field of collective consciousness termed the noosphere, the pinnacle of which was the Omega Point (Teilhard 1959). With admirable generosity to Russell, Losos (2017, pp. 7-8) states: "Remember, Russell did not set out to ask how a dinosaur could evolve into a humanoid. Rather, his goal was to think about how selection for increased brain size would lead to other anatomical changes. The end result of this project led to envisioning a creature strikingly similar to us, a reptilian humanoid". We submit that this may not be accurate – it seems to be contradicted, for example, by Russell's already-quoted intention "to see how the human form might be a natural target for selective pressures" (Russell to Boaz, Aug 3 1984) – and that the anatomy of the dinosauroid was indeed driven by bias, including that linked to Russell's spiritual perspective on the place of humanity in the universe. This is backed by Russell's implication that humans – and by extension other humanoids – are not simply additional animals (Russell 1987, p. 130; Psihoyos and Knoebber 1994, p. 252).

The dinosauroid and *WarGames*

Correspondence from Larry Lasker and Walter Parkes of Mandy Films Inc., dated to October 15th 1982, shows that Russell was approached by the makers of the 1983 United Artists movie *WarGames*. This highly successful and critically acclaimed Cold War movie (a classic of early 80s cinema) involves the protagonist – student and hacker David Lightman, played by Matthew Broderick – accidentally hacking the War Operation Plan Response

super-computer and inadvertently triggers it to run a simulated global nuclear conflict with the Soviet Union.

The final version of *WarGames* includes a segment where artificial intelligence researcher Dr Stephen Falken (played by John Wood) is asked by Lightman (and his female companion Jennifer Mack, played by Ally Sheedy) to return to his previous life at NORAD and help prevent the unfolding catastrophe which the protagonist has initiated. Falken, despondent due to the death of his son, has given up on his research and is not especially concerned to hear that humanity might be extinguished in nuclear conflict, his justification being that extinction is an inevitable part of life on Earth and that humans have had their shot, just as dinosaurs did. He has not just become a recluse, but is now interested in prehistoric animals and not much else: when we first meet him, he is flying a remote-controlled *Pteranodon* model, the living room of his house features a *Dimetrodon* skull, *Tyrannosaurus* and *Triceratops* models, a wooden plesiosaur skeleton, and more, and he plays a scene from the 1974 film *The Land That Time Forgot* on a projector screen.

Lasker and Parkes's letter reveal that initial plans were to feature the dinosauroid and *Stenonychosaurus* models in the movie, and to show Falken working on them as if they were his current area of interest. Ultimately, the movie did not include any such scene, though it is unknown to us when in the film-making process it was abandoned. It might be argued that the dinosauroid received more than its fair share of publicity and time in the limelight, but had it appeared in this successful, high-grossing film it would have been exposed to an even larger audience.

Correspondence also reveals that Russell was approached during August 1983 by Marsh Birchard of the Toronto-based company Enclosure, with plans to make a SciFi film featuring

617 animated versions (seemingly meaning CG animation) of the dinosauroid and
618 *Stenonychosaurus* in addition to "documentary footage of work in the laboratory and field".
619 An April 1985 letter also shows that Phillips-Mark Productions, in charge of making a CBS
620 documentary on dinosaurs, were hoping to borrow the dinosauroid in May of that year. The
621 relevant letter reveals that Russell met Phil Tippett in 1984; the precise circumstances of this
622 meeting are unknown to us but it is likely that they met to discuss the appearance and
623 behaviour of the stop-motion dinosaurs featured in the 1985 TV documentary *Dinosaur!*,
624 discussed earlier.

625

626 **The dinosauroid's legacy**

627 In January of 1998, palaeontologist and dinosaur specialist Terry Gates (at the time, an
628 undergraduate student) visited Russell in his office at North Carolina State University and
629 attempted to engage him in conversation on the dinosauroid. Russell politely, but firmly, shut
630 him down, indicated that the conversation was over, and gently encouraged Gates to leave the
631 office. Russell was done talking about the dinosauroid (T. Gates, pers. comm. 2018). By the
632 late 1990s, he was unhappy with the reception it had received and may even have been
633 embarrassed by it, so much so that he avoided it in discussion and stopped attending
634 conferences. Ten years earlier, it might have been obvious that things were headed this way.
635 A 1983 letter reveals that palaeoartists Sylvia and Stephen Czerkas suggested the creation of
636 a piece of art where 1980s-era dinosauroids were shown working on an artistic reconstruction
637 of their own Paleolithic-grade history. Russell liked this idea, and so did Ely Kish, and a
638 grand colour painting depicting exactly this scene was prepared for Russell's 1989 *An*
639 *Odyssey in Time* (Fig. 8); Kish also created clay miniatures during her research on the

640 interplay of light and shadow required for the piece (Fig. 9). But, alas, the painting was
641 excluded from the book and never published. Why not? We surmise that the community's
642 feelings about the dinosauroid had become clear to Russell by the late 1980s – Russell stated
643 exactly this in his contribution to *Dinosaurs Past and Present* (Russell 1987, p. 128) – and
644 that it was this which led him to pare down the book's dinosauroid-themed content.

645 Almost before the *Syllogeus* article had finished circulating, the dinosauroid had been
646 picked up by *Omni* (1978-1997), an American magazine which printed both scientific
647 nonfiction and fully-fledged sci-fi. Early in the piece, Russell is quoted saying that the
648 dinosauroid was "actually rather a mundane extrapolation. Meat and potatoes" (Hecht and
649 Williams 1982, p. 50). Despite the prominence afforded this point, Russell's correspondence
650 of 1983 reveals him agreeing with John E. Cronin that the *Omni* piece was "a bit
651 sensationalist" (Cronin to Russell, Aug 31 1983; Russell agreed in a reply dated September
652 16). These various attempts to downplay the boldness of the project could be part of Russell's
653 character – *Omni* calls him "self-deprecating" (Hecht and Williams 1982, p. 50) – but they
654 could also be part of the distancing strategy we find him adopting towards the dinosauroid
655 even in *Syllogeus* (where the dinosauroid is "tentative", Russell and Séguin 1982, p. 2).
656 Russell was honest in print about the criticism the idea attracted from scientific colleagues,
657 one of whom commented that "dinosaur studies today are already characterized by a
658 prominent science fiction component" (Russell 1987, p. 127).

659 Published in August 1984, Harry Harrison's alternate history epic *West of Eden* depicted a
660 war between stone age humans and the Yilané, technologically advanced reptiles who are the
661 dominant society on Earth. Though the Yilané are descended from mosasaurs rather than
662 troodontids, the founding conceit of the K-Pg extinction not happening and evolution
663 proceeding along different lines is one Harrison and Russell shared (Harrison's humans are

664 evolved from North American primates, not African ones; a fact which plays into Russell's
665 and Conway Morris's ideas of the inevitability of the human bauplan). The novel's artwork
666 (by Bill Sanderson) depicts a version of Yilané which viewers of the dinosauroid would find
667 familiar, although there are also significant differences. We do not, here, advance an opinion
668 as to whether Harrison was directly inspired by Russell's work or whether this is a case of
669 convergence. Though the timing is convenient, it is also true that Harrison had many
670 precedents in twentieth-century science fiction to draw on. The pterodactyl-descended
671 Mahars and lizard-man Horibs of Edgar Rice Burroughs's Pellucidar (beginning in 1914),
672 Jack Arnold's *Creature from the Black Lagoon* (1954), the Gorn of *Star Trek*'s 'Arena'
673 episode of January 1967, *Doctor Who*'s Silurians (first seen in 1970) and the Sleestaks of
674 *Land of the Lost* (first appearing in 1974) are just a few of the examples available to Harrison
675 (Debus 2016, p. 245 helpfully lists others). Perhaps of special potential interest to Russell are
676 the dinosauroid-like creatures of James Blish's 1958 *A Case of Conscience*, since this award-
677 winning story (originally a 1953 novella) pits a man of faith (a Jesuit explorer) against a non-
678 religious species with no concept of a god or gods.

679 Was Russell directly influenced by this text? Was the dinosauroid a conscious
680 participation in this sci-fi tradition? We have not seen anything in his archive to suggest that
681 it was, but at the very least we can say that the science fiction potential of his idea was noted
682 instantly both by his colleagues and the wider world. The idea that a scientist might support
683 such an idea in a technical study was remarkable and exciting for journalists and the public,
684 but – as demonstrated above – it was seen by some other scientists as lowest common
685 denominator stuff: unworthy, overly speculative, and, especially, unrealistic. The notion of
686 dinosaurs evolving into humanoids is, again, a trope of sci-fi, so it is not surprising that the

687 dinosauroid concept garnered “much friendly abuse from other dinosaurologists” (Paul 1988,
688 p. 397).

689 However, it is notable is that Russell did not respond to specific criticisms on the
690 dinosauroid’s form after the late 1980s. Nor did he ever publicly comment on ‘post-
691 dinosauroid’ speculative projects of the sort he and Séguin invited (Russell and Séguin 1982,
692 p. 36). As noted throughout our text, a common response to the dinosauroid’s existence is
693 that the underlying premise – that big-brained theropods might or would become humanoid –
694 is fundamentally flawed. This argument was expressed from the moment of the dinosauroid’s
695 initial outing (Lovejoy in Hecht and Williams 1982; Raup 1985; Paul 1988) and Russell was
696 aware of it, as demonstrated by his 1984 correspondence with Boaz. But he never responded
697 to it in print.

698 The dinosauroid was the first instance of a dinosaur-themed speculative zoology project to
699 appear within literature not regarded as sci-fi; while it can be argued that that other early
700 1980s non-sci-fi work of speculative zoology – Dougal Dixon’s *After Man* (Dixon 1981) –
701 also received an amount of discussion and media coverage similar to that of the dinosauroid,
702 this was effectively the first time that scientists, journalists and others were asked to comment
703 on a speculative endeavour *outside* the proposed existence of aliens. As emphasized above,
704 many have found great similarity in discussions about the possible existence of parallel
705 timeline big-brained post-Cretaceous dinosaurs and those about humanoid aliens, and we
706 know (e.g., from a 1979 article in the *Globe and Mail* (Sullivan 1979), which Russell kept)
707 that both occurred in parallel, sometimes at the same scientific meetings. Beyond the
708 dinosauroid, the next prominent speculative dinosaur-themed endeavour was the sequel to
709 Dixon’s *After Man*, *The New Dinosaurs*, of 1988. Dixon’s parallel-timeline post-Cretaceous
710 world lacks humanoids, nor indeed are there intended to be animals of human-level

711 intelligence (Dixon 1988), as is consistent with statements made about *After Man* (Dixon in
712 Todd 1981). *The New Dinosaurs* is, almost ironically, yet another work in which the
713 dinosauroid's appearance heralds the very end of the book, though in this case it would be
714 better argued that it is tucked away in an afterword ('The survival of dinosaurs in literature')
715 and specifically in a section which reviews the interminable 'smart dinosaur' trope of sci-fi:
716 the Yilané, Mahar, and Silurians are all name-checked in addition to the dinosauroid (Dixon
717 1988, p. 111). This in itself is interesting: where do you fit, dinosauroid? Are you part of
718 science or science fiction?

719 In internet forum discussions of the early 1990s and beyond, theropod expert Thomas R.
720 Holtz advised interested parties to "avoid the 'roid" (this being a pun based on a 1989 'Avoid
721 the Noid' computer game and advertising campaign used to promote Domino's pizza), and
722 such views were and are common among palaeontologists, palaeoartists and authors
723 specializing on dinosaurs. These were perhaps summarized most effectively by Paul (1988, p.
724 397) who noted that "There are serious problems with the idea", that the model "looks
725 suspiciously human", that the extrapolations about brain size and manual dexterity were
726 poorly founded and too speculative, and that "What bothers me is that dino-hominoid
727 speculation diverted public attention from what is really important about troodontids. These
728 dinosaurs were more birdlike than *Archaeopteryx*, and were part of the initial bird radiation.
729 They were not pseudo-human" (it should be noted that Paul was arguing for inclusion of
730 troodontids within the *Archaeopteryx* + modern bird clade, hence his reference to them as
731 part of the bird radiation). Consistent with Paul's claim that a supposed 'pseudo-human'
732 interpretation of troodontids might be the main take-home point to some is demonstrated by
733 at least one children's book which inaccurately explains that the dinosauroid represents "a
734 startling model of *Stenonychosaurus*. [Russell] showed it standing upright, like a human …

People were amazed by this dinosaur which seemed so advanced for its time" (O'Neill 1989. p. 24). Again, there is no record of Russell responding to these arguments online or in print, nor is it clear that he was aware of those which occurred outside the published literature (T. R. Holtz, personal communication, 2020).

A blog article on the dinosauroid, penned by one of us in 2006 (Naish 2006), inspired the speculative creation of a dinosauroid more in line with those of Paul and other dinosaur specialists, namely C. M. Kösemen's *Avisapiens saurotheos*, a horizontal-bodied, feathered maniraptoran with dexterous jaws. Nothing about it can be described as humanoid. Additional, superficially similar maniraptorans – not all that different in form and proportions from Cretaceous maniraptorans known as fossils – have since been created by other artists, including Simon Roy (Kösemen and Roy have, since around 2008, created an entire speculative world and series of stories about their big-brained dinosaurs) and Mette Aumala (Fig. 10). While these experiments have been discussed in print (Hecht 2007; Naish 2008; Losos 2017), they are predominantly denizens of the internet and have had nothing like the extensive, mass-media reach of Russell and Séguin's project. It should also be clear that these alternative takes on what dinosauroids might be like are not scientific projects, but exercises in speculative fiction, albeit conducted by artists highly literate in the scientific discussion. This point again brings us to the fact that it is simply not possible to compartmentalize the dinosauroid as either 'science' or 'science fiction': it is rooted equally in Russell's detailed work on encephalization and the tantalizing possibilities suggested by space; it was conducted in close collaboration with a fine artist and arrived almost simultaneously into both genre magazines and technical literature; and its legacy thrives both in fantasy art and nature documentaries. Any assessment of the project's worth, therefore, needs to consider the adroit combination of influences and disciplines, as well as the imaginative bravado, to which it

attests – not just the scientific credibility. If the dinosauroid has indeed fulfilled Russell's expectations and become "a period piece", we can also acknowledge that period pieces can be arresting, inspirational, and deeply instructive.

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915 **Figure captions**

916

917 **Fig. 1.** Dale A. Russell with the dinosauroid model, created in collaboration with Ron Séguin
918 between 1980 and 1982. The dinosauroid stands 135 cm tall. Dale Russell and Ron Séguin ©
919 Canadian Museum of Nature.

920

921 **Fig. 2.** Ron Séguin's full-sized model of *Stenonychosaurus inequalis*, created in collaboration
922 with Dale Russell and very literally the ancestor to the dinosauroid model created during the
923 same creative endeavour. Dale Russell and Ron Séguin © Canadian Museum of Nature.

924

925 **Fig. 3.** The dinosauroid. Dale Russell and Ron Séguin © Canadian Museum of Nature.

926

927 **Fig. 4.** Log brain (MBr) and body mass (MBd) of dinosaurs, plotted with slopes of brain-
928 body equations of non-bird reptiles (lower slope) and birds (upper slope). Polygons surround
929 brain-body point scatters of non-bird reptiles (N = 62) and birds (N = 174), as indicated.
930 Legend: filled triangles, tyrannosaurids; filled diamonds, other theropods; hollow circles,
931 other dinosaurs; ×, dinosauroid. Abbrevations: Al, *Allosaurus*; An, *Edmontosaurus*; Br,
932 *Brachiosaurus*; BAd, *Bambiraptor* (adult); BJ, *Bambiraptor* (juvenile); Dp, *Diplodocus*; N,
933 Cleveland "*Nanotyrannus*"*;* Orn, *Ornithomimus*; Tro, *Stenonychosaurus*; Trx,
934 *Tyrannosaurus*. Modified from Hurlburt et al. (2003, Fig. 6.3).

935

936 **Fig. 5.** Hypothetical skull of the dinosauroid, as developed by Ron Séguin under
937 collaboration with D. Russell, in lateral, dorsal, and anterior view. Dale Russell and Ron
938 Séguin © Canadian Museum of Nature.

939

940 **Fig. 6.** Behind-the-scenes photographs showing Ron Séguin and colleagues at work on the
941 construction of the *Stenonychosaurus* and its life-sized skeleton. A scaled-up version of the
942 skeletal reconstruction included in Russell (1969) is visible on the wall. Dale Russell and Ron
943 Séguin © Canadian Museum of Nature.

944

945 **Fig. 7.** Ron Séguin with the initial clay version of the dinosauroid, and Dale Russell and Ron
946 Séguin in discussion while the dinosauroid is being painted. Photos provided by kind
947 courtesy of Ron Séguin.

948

949 **Fig. 8.** A colour painting by Ely Kish, intended for use in Russell's 1989 book *An Odyssey in*
950 *Time*. It depicts a 1980s-era dinosauroid pointing to an artistic reconstruction of its own
951 Paleolithic-stage ancestors. This work was ultimately excluded from the book and has
952 remained in storage at CMN. Ely Kish © Canadian Museum of Nature.

953

954 **Fig. 9.** Clay miniatures of dinosauroids in the collection of the CMN, constructed by Ely Kish
955 in preparation for the painting depicted in Fig. 7. The miniatures depict a Paleolithic-stage
956 dinosauroid creating art on a cave wall, and dinosauroid parent and child. Ely Kish ©
957 Canadian Museum of Nature.

958

959 **Fig. 10.** Dinosauroids post-Russell and Séguin. C. M. Kösemen's *Avisapiens saurotheos*

960 (below) and Mette Aumala's *Paranthropoharpax naishi*. Both appear with permission of the

961 artists.

962