First soft-bodied fossil from the Ordovician of Peru

Article *in* Alcheringa An Australasian Journal of Palaeontology · September 2008

DOI: 10.1080/03115510802096309

3 authors:

Diego C García-Bellido
University of Adelaide
78 PUBLICATIONS **790** CITATIONS
SEE PROFILE

Juan Carlos Gutiérrez-Marco
Spanish National Research Council
230 PUBLICATIONS **1,897** CITATIONS
SEE PROFILE

César Chacaltana
Instituto Geologico Minero Metalurgico, Peru
20 PUBLICATIONS **45** CITATIONS
SEE PROFILE

First soft-bodied fossil from the Ordovician of Peru

DIEGO C. GARCÍA-BELLIDO, JUAN CARLOS GUTIÉRREZ-MARCO AND CÉSAR A. CHACALTANA

García-Bellido, D.C., Gutiérrez-Marco, J.C. & Chacaltana, C.A., September, 2008. First soft-bodied fossil from the Ordovician of Peru. *Alcheringa 32*, 313–320. ISSN 0311-5518.

Konservat-Lagerstätten are a source of insurmountable information on the diversity of fossil assemblages during the lower Palaeozoic. Soft-bodied fossils are especially rare in South America, but a new locality has been discovered from the Middle Ordovician of Peru that has produced the fairly well-preserved possible palaeoscolecidan *Juninscolex ingemmetianum* gen. et sp. nov. The distinctive characteristics of this worm make it similar to European taxa within the group.

Diego C. García-Bellido [Diego.GBC@geo.ucm.es] and Juan Carlos Gutiérrez-Marco [jcgrapto@geo.ucm.es], Departamento de Paleontología, Instituto de Geología Económica (CSIC-UCM), Facultad de Ciencias Geológicas, José Antonio Novais 2, 28040 Madrid, Spain. César A. Chacaltana [chacalt@ingemmet.gob.pe], INGEMMET, Avenida Canadá 1470, San Borja, Lima 41, Peru. *Received 27.7.2007; revised 1.11.2007.*

Key words: Palaeoscolecida, Priapulida, worm, soft-body preservation, *Konservat-Lagerstätte*, South America.

FOSSILS OF lower Palaeozoic soft-bodied organisms are relatively rare. Famous assemblages, such as those of the Burgess Shale in British Columbia, Canada (Briggs *et al*. 1994), Maotianshan Shale in Chengjiang, China (Hou *et al*. 2004) and Sirius Passet in Greenland, Denmark (Conway Morris *et al*. 1987), suggest that the fossils of animals with mineralized parts (shells, exoskeletons) represent a minority of the total biodiversity known for such exceptional Cambrian *Lagerstätten*; estimated to be as low as 14% of genera and 2% of individuals (Conway Morris 1986). Knowledge of the true invertebrate biodiversity is even poorer for the Ordovician, where few localities preserve soft-bodied fossils. These are mainly located in the Czech Republic (Kraft & Mergl 1989), Great Britain (Whittard 1953), Morocco (Van Roy *et al*. 2004), South Africa (Whittle *et al*. 2007), and the United States (Briggs *et al*. 1991, Liu *et al*. 2006), and their study lags behind that of equivalent Cambrian faunas.

ISSN 0311-5518 (print)/ISSN 1752-0754 (online)

DOI: 10.1080/03115510802096309

Here, we present the discovery of a fossil vermiform organism from Ordovician deposits of central Peru. It not only constitutes the first such finding from the Peruvian Palaeozoic, but is one of only three soft-bodied records for the whole South American Palaeozoic, after the arthropod described by Vaccari *et al*. (2004) and two priapulid worms described by García-Bellido & Aceñolaza (2005), all from the Cambrian of northwestern Argentina. However, the presence of similar invertebrates in the Ordovician of the Argentine Precordillera has already been documented by the discovery of microfossils of purported chaetognath eggs (Heuse *et al*. 1996) and polychaete jaw elements (Eriksson *et al*. 2002).

Locality and age

The studied fossil comes from a graptolitic dark shale exposed on the northwestern slope of Cerro Huancampa (Fig. 1; 10°57′31″S, 75°57′16″W), 12 km west-southwest of the town of Carhuamayo, Ulcumayo District (Department of Junín). These exposures were originally assigned to

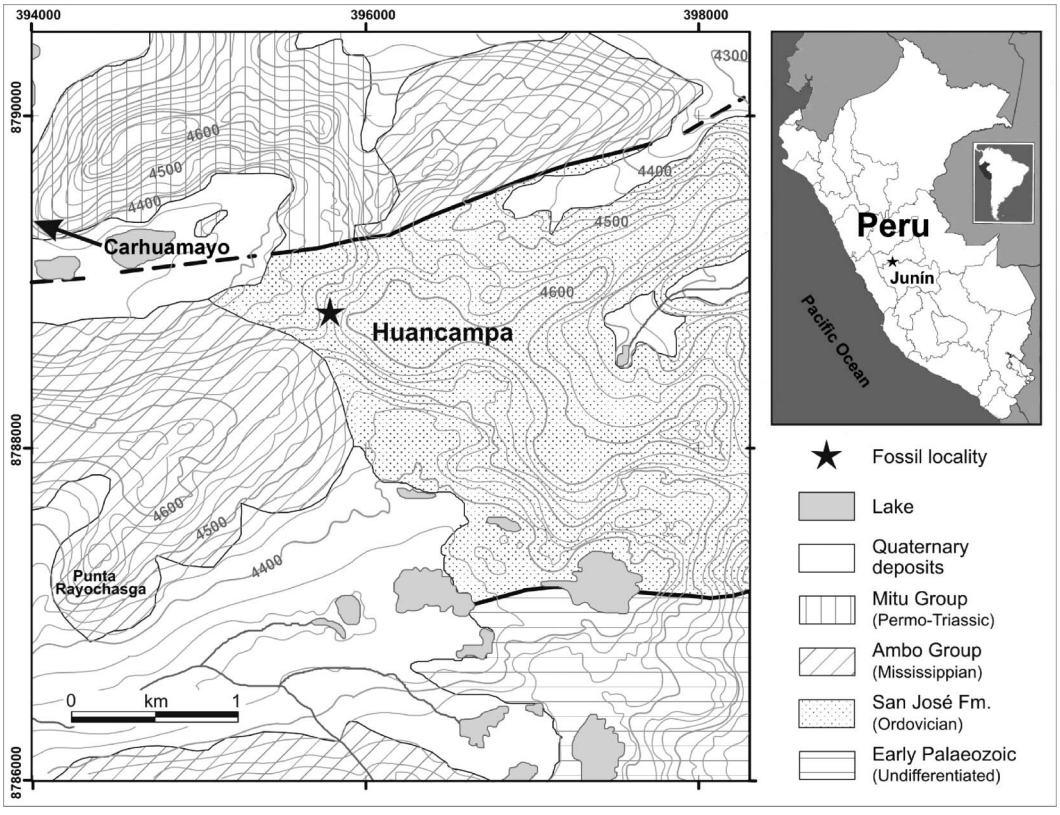
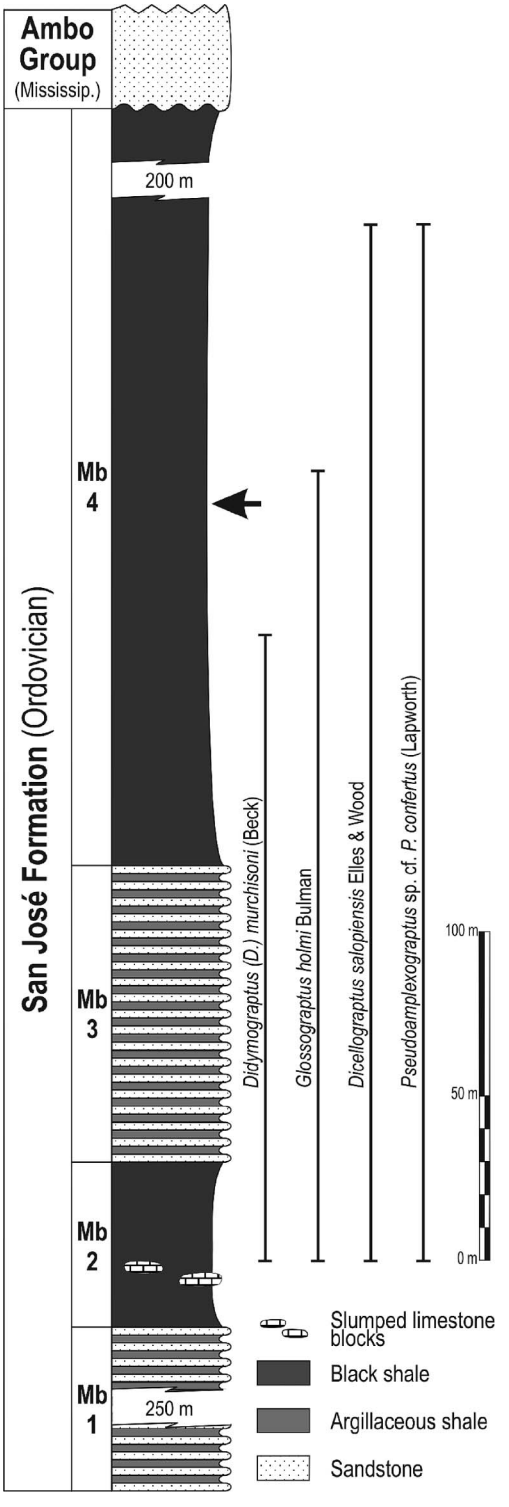


Fig. 1. Geological sketch map showing the position of the Huancampa locality, Junín Province, Peru. UTM projection; Datum: WGS84, Zone 18, South latitude. Contour interval=25 m. Modified from Díaz-Martínez *et al.* (2006).

the Neoproterozoic Maraynioc Complex, but recent detailed stratigraphic and sedimentological studies by Chacaltana *et al.* (2006) and Díaz-Martínez *et al.* (2006) have located 18 fossiliferous beds of Darriwilian age. These horizons yielded diverse graptolite assemblages that allowed correlation of the unit with the San José Formation (Floian to Sandbian age, or Arenig to Caradoc according to the British regional scale) of the Altiplano, and Eastern Cordillera regions (Laubacher 1974, Gutiérrez-Marco *et al.* 2004, and references therein).

The specimen described here was collected in fossiliferous horizon No. 14 (ECI-102) of the section described by Chacaltana *et al.* (2006), associated with an indeterminate biserial graptolite. The fossiliferous level (arrow, Fig. 2) is located in the lower portion of the upper shaly member (Mb. 4 of Díaz-Martínez *et al.* 2006) of the San José Formation, less than 40 m above the last record of *Didymograptus (D.) murchisoni* (Beck *in* Murchison, 1839), mid-Darriwilian in age, but still within the stratigraphic range of *Dicellograptus salopiensis* Elles & Wood, 1907. The two species consistently co-occur in the lower shaly beds of this section (Mbs 2 and 4) of the San José Formation. Since our specimen was found above the youngest pendent didymograptids, we cannot dismiss that its age might be late Darriwilian, considering that the global distribution of *D. salopiensis* corresponds to this age and locally persists into the earliest Late



Ordovician (Hughes 1989). Furthermore, some other graptolites in the *D. (D.) murchisoni* assemblage extend into levels of the upper member of the San José Formation hosting *D. salopiensis*.

The specimen's fossilization process is unknown in all its details. After rapid burial in dysaerobic to anaerobic bottom conditions, interpreted as a bathyal lithofacies of pelagic origin (F11 of Díaz-Martínez *et al.* 2006), the body probably underwent some early diagenetic mineralization that has since been lost, but which provided relatively good three-dimensional macroscopic preservation. The body is preserved as a negative relief (mould) albeit with extreme compression, which can be explained by the collapse of the top, slightly mineralized, body-wall over the cavity left by internal soft tissues, and accommodation to the shape of the bottom wall due to compaction (Fig. 3A, B). Close examination of the fossil indicates that in the areas where the top wall is broken, the underlying material, which lacks the texture and rings of the wall, corresponds to sediment infilling of the animal's internal cavity (Fig. 3C).

Systematic palaeontology

Phylum ?PRIAPULIDA Delage & Hérouard, 1897

Class ?PALAEOSCOLECIDA Conway Morris & Robison, 1986

Family indet.

Juninscolex gen. nov.

Fig. 2. Schematic stratigraphic log of the Ordovician sequence on Cerro Huancampa, Junín Province, Peru, showing the horizon from which *Juninscolex ingemmetianum* gen. et sp. nov. was collected (arrow) and the stratigraphic range of some selected Darriwilian graptolites. Data from Chacaltana *et al.* (2006) and Díaz-Martínez *et al.* (2006).

Type species. *Juninscolex ingemmetianum* sp. nov.

Etymology. Referring to its occurrence in Junín Department (Peru), *scolex* = worm (Greek).

Diagnosis. As for type and only species (see below).

Juninscolex ingemmetianum sp. nov. (Figs 4–5)

Type material. Holotype and only known specimen of the species (INGEMMET-5490) was collected on the western slope of Cerro Huancampa, southeast of the town of Carhuavnayo (Department of Junín), and is housed permanently in the Collections of the Geological Survey of Peru (INGEMMET, Instituto Geológico Minero y Metalúrgico), Lima, Peru.

Occurrence. Upper member of the San José Formation (Member 4 of Díaz-Martínez *et al*. 2006), of Darriwilian age (Middle Ordovician).

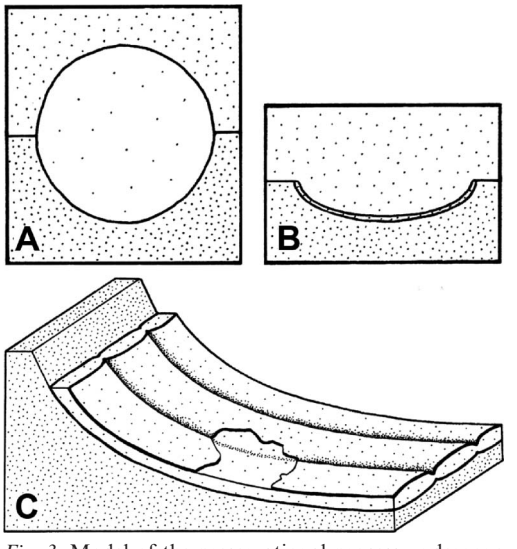


Fig. 3. Model of the preservational process undergone by the specimen, before (**A**) and after compaction (**B**). **C**, Schematic drawing of the observed section through the fossil to show the body-walls and the layer between them. Vertical scale is enhanced in B and C.

Etymology. Referring to the type specimen being collected under the auspices of the INGEMMET in Lima, Peru.

Diagnosis. Centimetric-sized worm with dense annulations (up to 5 rings/mm) of single inter-annular grooves, and very rare double grooves. Body cylindrical, slightly tapered distally, lacking dorso-ventral differentiation or longitudinal furrow. Ornamentation, in the form of phosphatized sclerites, and other cuticular structures unknown.

Description. The fossil corresponds to a compressed and coiled, incomplete specimen, 98 mm long, and slightly tapering towards the preserved end, from 9 to 6 mm (Figs 4A, 5). The tip of the coil is rounded and lacks any recognizable structures (Fig. 4B), and there is no indication whether this represents the anterior or posterior end. The annulated body-wall is very finely preserved in the coiled part, but has been lost in the widest part of the body. Over 125 transverse annulations are evident in the better-preserved portion of the specimen, the rings varying in width depending on the original contraction of the worm. The highest density of rings is present in the central part of the coil, with up to 5 rings/mm (Fig. 4C), whereas the portion closer to the preserved end shows rings over 1 mm wide. Due to coiling of the animal, most rings tend to be narrower on the inside of the spiral. The rings are smooth, despite the granular appearance of the matrix, and neither phosphatized sclerites nor plates of any kind can be recognized. Other cuticular structures, such as papillae, nipples or tubules, have not been recognized. The grooves separating rings are of similar depth throughout the fossil, with slightly deeper grooves in the portion with narrower rings

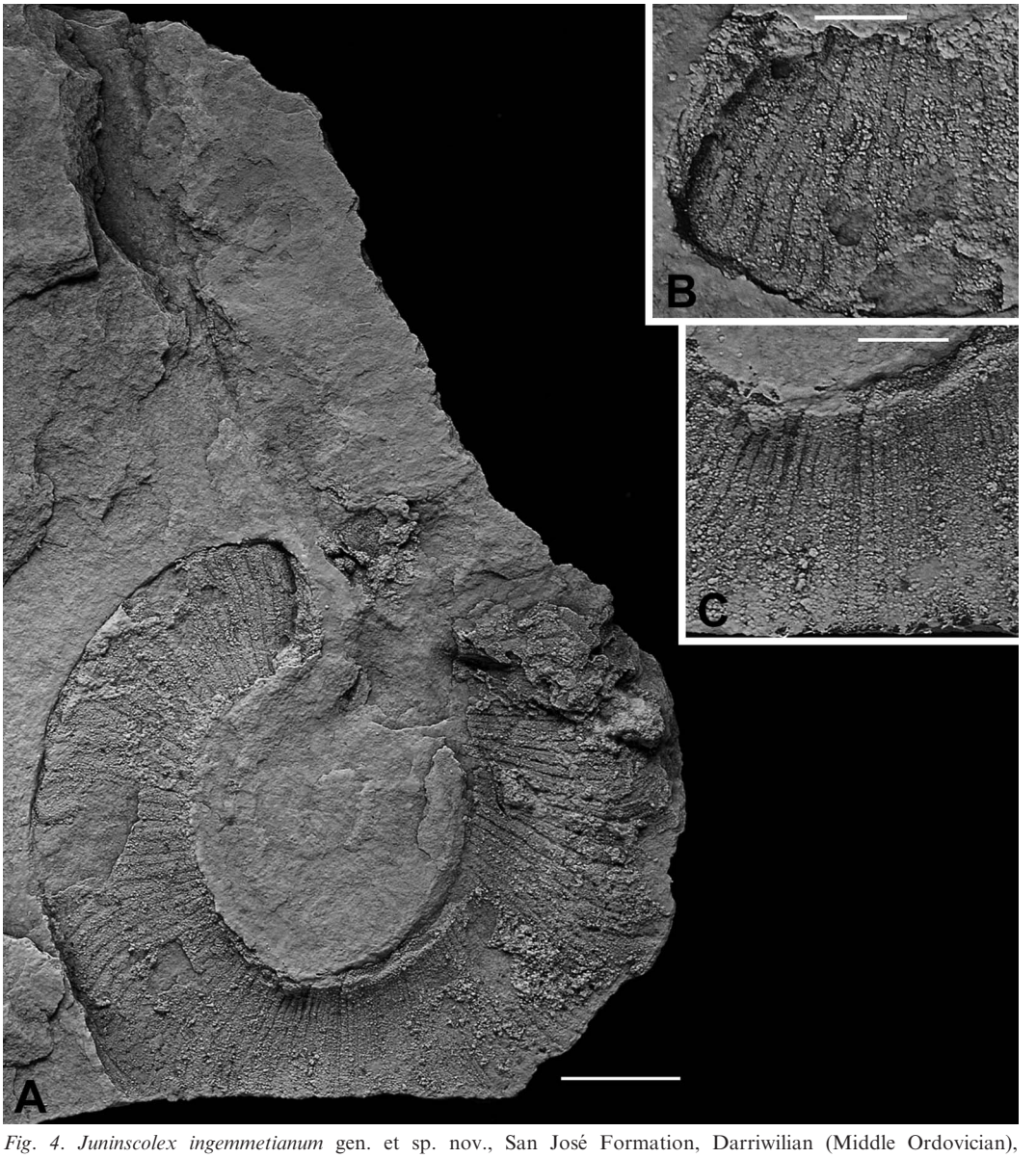


Fig. 4. Juninscolex ingemmetianum gen. et sp. nov., San José Formation, Darriwilian (Middle Ordovician), Huancampa, Junín Province, Peru. Holotype, INGEMMET-5490. **A**, Gross view. **B**, Detail of the best-preserved end. **C**, Detail of the area with the closest annulations. Specimen whitened with magnesium oxide. Scale bars: **A** = 5 mm, **B**–**C** = 2 mm.

(Figs 4C, 5). In three areas where the top body-wall has been lost, the grooves have left a trace in the underlying material filling the body cavity (Fig. 5). Some grooves are flanked by thinner, shallower parallel grooves that possibly enhanced the telescopic abilities of the organism.

Discussion of the genus and species. The size, fine annulations, and coiling in a 'six' shape

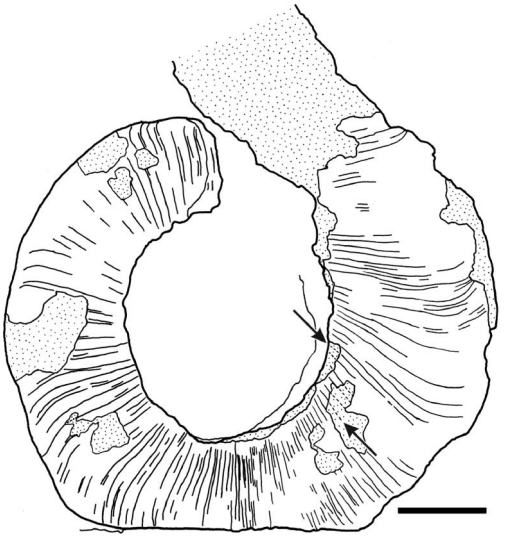


Fig. 5. Juninscolex ingemmetianum gen. et sp. nov., San José Formation, Darriwilian (Middle Ordovician), Huancampa, Junín Province, Peru. Camera lucida drawing of the best preserved area of the specimen. Stippling indicates areas where the upper body-wall is missing. Dashed lines (arrows) in the stippling area indicate impression of grooves in underlying material. Scale bar = 5 mm.

of this fossil worm more closely resemble Cambrian palaeoscolecidan fossils described from Chengjiang (Hou *et al.* 2004) and other Burgess Shale-type deposits (Conway Morris & Robison 1986, Gámez Vintaned 1995, Lin 1995) than any other coeval worms, but discovery of more specimens will help verify this assignment. Palaeoscolecidans are considered to be an extinct class ('lower' Cambrian to Ludlow) of vermiform organisms related to either nematomorphs (Hou & Bergström 1994) or priapulids (Müller & Hinz-Schallreuter 1993), and are characterized by an annulated cuticle with rows of phosphatic sclerites. An extended commentary on the affinities of the group is beyond the scope of this brief report, and a complete discussion was provided by Conway Morris (1997). Articulated palaeoscolecidans are rare in the Ordovician; their fossil record is limited to four or five genera, mostly from British and Czech localities (Whittard 1953, Owens *et al.* 1982, Kraft & Mergl 1989, Conway Morris 1997), plus a similar number of microsclerite morphogenera (Kraft & Lehnert *in* Hints *et al.* 2004, Lehnert & Kraft 2006). The main difference between the Peruvian specimen and most palaeoscolecidans is the absence of sclerites. Among the worms of the lower Palaeozoic, the taxa that most resemble our specimen are *Bohemoscolex* Kraft & Mergl, 1989 from the Lower Ordovician of Bohemia (Czech Republic), and *Goettingenia* Zhang & Hua, 2005 from the 'lower' Cambrian of Hubei (China), due to their narrow annulations and smooth surface. However, *Juninscolex* does not possess the longitudinal furrow of the former or the transverse annular ridges of the latter. Some species of *Protoscolex* Ulrich, 1878, from the Ordovician of Kentucky (USA), have a non-papillate cuticle, and, as with the new taxon described here, the relatively thick cuticle of this genus is broken in some cases to reveal a sediment-filled interior. The absence of dermal sclerites in *Juninscolex* is also reminiscent of a microscopic specimen of Palaeoscolecida gen. et sp. indet. from the Cambrian of Australia, illustrated by Müller & Hinz-Schallreuter (1993, fig. 4b). The Australian specimen, like an unidentified microscopic worm from the Middle Cambrian Burgess Shale (García-Bellido Capdevila 2000, fig. 4), lacks ornamentation, yet has a longitudinal furrow like the Czech specimen. It is possible that based on the lack of phosphatic sclerites, these taxa could constitute a new family with unknown affinities to the remaining members of the Class Palaeoscolecida. Another Ordovician soft-bodied worm was described by Conway Morris *et al.* (1982) from Quebec. It lacked setae and cephalization, but was tentatively assigned to the annelids due to the presence of faint segmentation with possible serially repeated internal organs; neither of these characters is present in the Peruvian fossil.

Acknowledgements

We are grateful to the valuable reviews of P. Kraft, X. Zhang and editor S. McLoughlin, as well as to E. Díaz-Martínez (IGME, Spain) for the geological map and to C. Alonso (Universidad Complutense de Madrid, Spain) for photographic work. We would like to thank the 'Juan de la Cierva' Programme of the Spanish Ministerio de Investigación y Ciencia for its financial support to DCGB. This work was carried out through a cooperative agreement between the Spanish and Peruvian geological surveys (IGME and INGEMMET), as part of the activities of the Precambrian and Palaeozoic Group of the Universidad Complutense de Madrid, and constitutes a contribution to IGCP Project 503 (IUGS-UNESCO).

References

Briggs, D.E.G., Bottrell, S.H. & Raiswell, R., 1991. Pyritization of softbodied fossils: Beecher's Trilobite Bed, Upper Ordovician, New York State. *Geology 19*, 1221-1224.

Briggs, D.E.G., Erwin, D.H. & Collier, F.J., 1994. *The fossils of the Burgess Shale*, Smithsonian Institution Press, Washington, DC, xvii + 238 pp.

Chacaltana, C., Valdivia, W., Carlotto, V., Sánchez, J. & Gutiérrez-Marco, J.C., 2006. Nuevas evidencias de graptolitos en el Perú central: implicancias estratigráficas. In *XIII Congreso Peruano de Geología*, V. Carlotto, J. Cárdena, P. Soler & J. Jacay, eds, *Sociedad Geológica del Perú, Publicación Especial 7*, 611–614.

Conway Morris, S., 1986. The community structure of the Middle Cambrian Phyllopod Bed (Burgess Shale). *Palaeontology 29*, 423-467.

Conway Morris, S., 1997. The cuticular structure of the 495-Myr-old type species of the fossil worm *Palaeoscolex, P. piscatorum* (?Priapulida). *Zoological Journal of the Linnean Society 119*, 69-82.

Conway Morris, S., Peel, J.S., Higgins, A.K., Soper, N.J. & Davies, N.C., 1987. A Burgess Shale-like fauna from the Lower Cambrian of North Greenland. *Nature 326*, 181-183.

Conway Morris, S., Pickerill, R.K. & Harland, T.L., 1982. A possible annelid from the Trenton Limestone (Ordovician) of Quebec, with a review of fossil oligochaetes and other annulate worms. *Canadian Journal of Earth Sciences 19*, 2150-2157.

Conway Morris, S. & Robison, R.A., 1986. Middle Cambrian priapulids and other soft-bodied fossils from Utah and Spain. *The University of Kansas Paleontological Contributions 117*, 22 pp.

Delage, Y. & Hérouard, E., 1897. *Les Vermidien. Traité de Zoologie concrete, 5*, B. Clément Editeurs, Paris, 372 pp.

Díaz-Martínez, E., Carlotto, V., Chacaltana, C., Rodríguez, R. & Valdivia, W., 2006. Estratigrafía y sedimentología del Ordovícico entre Junín y Cerro del Pasco, Perú central. In *XIII Congreso Peruano de Geología*, V. Carlotto, J. Cárdena, P. Soler & J. Jacay, eds, *Sociedad Geológica del Perú, Publicación Especial 7*, 533-536.

Elles, G.L. & Wood, E.M.R., 1907. A monograph of British graptolites, Pt. 6. *Monographs of the Palaeontological Society 61* (297), 217-272.

Eriksson, M., Albanesi, G.L. & Hünicken, M.A., 2002. Early Middle Ordovician scolecodonts from the Argentine Precordillera: the oldest known scolecodonts from South America. *Ameghiniana 39*, 427-432.

Gámez Vintaned, J.A., 1995. Nuevo hallazgo de un anélido (?) paleoscolécido en el Cámbrico Medio de Murero (Cadena Ibérica Occidental, NE de España). In *La expansión de la vida en el Cámbrico. Libro Homenaje al Prof. Klaus Sdzuy*, J.A. Gámez Vintaned & E. Liñán, eds, Institución Fernando el Católico, Zaragoza, Spain, 205-218.

García-Bellido Capdevila, D., 2000. The Burgess Shale fossils at the Natural History Museum, London. *Geological Curator 7*, 141-148.

García-Bellido, D. & Aceñolaza, G.F., 2005. Organismos de cuerpo blando en los estratos cámbricos del Noroeste Argentino. *Actas XVI Congreso Geológico Argentino, La Plata*, 467-474.

Gutiérrez-Marco, J.C., Carlotto, V., Cárdenas, J., Finney, S.C., Rábano, I., Villas, E. & Herrera, Z., 2004. Paleontología y rasgos paleobiogeográficos del Ordovícico del sur de Perú. In *XII Congreso Peruano de Geología*, V. Carlotto, J. Cárdena, P. Soler & J. Jacay, eds, *Sociedad Geológica del Perú, Publicación Especial 6*, 455-458.

Heuse, T., Lehnert, O. & Kraft, P., 1996. Organic-walled microfossils *incertae sedis* from the Ordovician of the Argentine Precordillera and Bohemia. *Acta Universitatis Carolinae, Geologica 40*, 425-439.

Hints, O., Eriksson, M., Högström, A.E.S., Kraft, P. & Lehnert, O., 2004. Worms, wormlike and sclerite-bearing taxa. In *The Great Ordovician Biodiversification Event*, B.D. Webby, F. Paris, M.L. Droser & I.G. Percival, eds, Columbia University Press, New York, 223-230.

Hou, X.G., Aldridge, R.J., Bergström, J., Siveter, D.J. & Feng, X.H., 2004. *The Cambrian Fossils of Chengjiang, China: the Flowering of Early Animal Life*. Blackwell Science, Oxford, 233 pp.

HOU, X.G. & BERGSTRÖM, J., 1994. Palaeoscolecid worms may be nematomorphs rather than annelids. *Lethaia 27*, 11-17.

HUGHES, R.A., 1989. Llandeilo and Caradoc graptolites of the Builth and Shelve inliers. *Palaeontographical Society Monograph, 141* (577), 1-89.

KRAFT, P. & MERGL, M., 1989. Worm-like fossils (Palaeoscolecida; ?Chaetognata) from the Lower Ordovician of Bohemia. *Sborník Geologických Věd, Paleontologie 30*, 9-36.

LAUBACHER, G., 1974. Le Paléozoïque inférieur de la Cordillère oriental du sud-est du Pérou. *Cahiers ORSTOM, série Géologique 6*, 29-40.

LEHNERT, O. & KRAFT, P., 2006. *Manitouscolex*, a new palaeoscolecidan genus from the Lower Ordovician of Colorado. *Journal of Paleontology 80*, 386-391.

LIN, T.R., 1995. Discovery of late Early Cambrian worm from Huainan, Anhui. *Acta Palaeontologica Sinica 34*, 505-508.

LIU, H.P., MCKAY, R.M., YOUNG, J.N., WITZKE, B.J., MCVEY, K.J. & LIU, X.Y., 2006. A new Lagerstätte from the Middle Ordovician St. Peter Formation in northeast Iowa, USA. *Geology 34*, 969-972.

MÜLLER, K.J. & HINZ-SCHALLREUTER, I., 1993. Palaeoscolecid worms from the Middle Cambrian of Australia. *Palaeontology 36*, 549-592.

MURCHISON, R.I., 1839. *The Silurian System*. John Murray, London, 768 pp.

OWENS, R.M., FORTEY, R.A., COPE, J.C.W., RUSHTON, A.W.A. & BASSET, M.G., 1982. Tremadoc faunas from the Carmarthen district, South Wales. *Geological Magazine 119*, 1-112.

ULRICH, E.O., 1878. Observations on fossil annelids and descriptions of some new forms. *Journal of the Cincinnati Society of Natural History 1*, 87-91.

VACCARI, N.E., EDGECOMBE, G.D. & ESCUDERO, C., 2004. Cambrian origins and affinities of an enigmatic fossil group of arthropods. *Nature 430*, 554-557.

VAN ROY, P., BOTTING, J., VANDENBROUCKE, T., VAN DAMME, D. & VAN DAMME, K., 2004. Konservat-Lagerstätten from the Arenig (Early Ordovician) of Morocco. *The Palaeontological Association Newsletter 57*, 186 (The Palaeontological Association 48th Annual Meeting, 17–20 December, 2004, Lille, Abstracts).

WHITTARD, W.F., 1953. *Palaeoscolex piscatorum* gen. et sp. nov., a worm from the Tremadocian of Shropshire. *Quarterly Journal of the Geological Society of London 109*, 125-135.

WHITTLE, R.J., GABBOTT, S.E., ALDRIDGE, R.J. & THERON, J.N., 2007. Taphonomy and palaeoecology of a Late Ordovician caryocaridid from the Soom Shale Lagerstätte, South Africa. *Palaeogeography, Palaeoclimatology, Palaeoecology 251*, 383-397.

ZHANG, X.L. & HUA, H., 2005. Soft-bodied fossils from the Shipai Formation, Lower Cambrian of the Three Gorge area, South China. *Geological Magazine 142*, 699-709.