Zootaxa 3785 (1): 038–044
www.mapress.com/zootaxa/

Article

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

http://dx.doi.org/10.11646/zootaxa.3785.1.3
http://zoobank.org/urn:lsid:zoobank.org:pub:B3E95C6A-2E9E-406C-8BA8-C9C1EFD6C98B

Paedomorphosis in the scolopendrid centipede genus *Asanada* (Chilopoda: Scolopendromorpha) explains incongruence between morphological and molecular data sets

JOHN G. E. LEWIS
Manor Mill Farm, Halse, Taunton, Somerset TA4 3AQ, UK. E-mail: johngelewis@realemail.co.uk

Abstract

The morphological characters of members of the scolopendrid genus *Asanada* Meinert, 1886 are reviewed. A number of these characters are only seen in embryonic or early adolescent stadia in other scolopendrids. This suggests that the centipedes of this genus are paedomorphic. Support for this thesis is provided by the very rare appearance (in only three specimens) of some otherwise "adult" characters. This paedomorphosis, in all probability neoteny, may account for the recently described incongruence between morphological and molecular data with respect to the position of the genus seen in cladistic analyses.

Key words: embryonic, adolescent, morphological characters

Introduction

Species of the genus *Asanada* Meinert, 1886, are unusual scolopendrids. In Northern Nigeria, *A. socotrana* Pocock, 1899, is characteristically found in deserted mounds of *Trinervitermes* sp. It disappears from that habitat in the dry season, presumably retreating in to the soil where growth continues. It is a slow moving species and a number of specimens may be found in close proximity. It shows no ritualized fighting reactions (Lewis, 1973). Other scolopendrids, for example *Scolopendra cingulata* Latreille, 1829, are generally solitary and exhibit ritualized fighting reactions when they meet another individual of the same species (Klingel, 1960). *Cormocephalus anceps* Porat, 1871 (formerly *C. westwoodi anceps*) exhibits similar behaviour but despite this a large number of specimens are killed as the result of contact with other animals of the same species (Brunhuber, 1969).

Vahtera *et al.* (2013) noted that in conventional classification (Attems, 1930) the Scolopendrinae are divided into tribes Asanadini and Scolopendrini and that in their previous and present morphological cladistic analyses *Asanada* is resolved as a sister group to all other Scolopendridae or alternatively Scolopendrinae. However, their analyses of molecular and combined data sets show that *Asanada* is closely allied with *Scolopendra* Linnaeus, 1758 s.s. and that the tribe Asanadini nests within Scolopendrini. A similar pattern was observed by Joshi and Karanth (2011) using molecular data for different species, *Asanada* also grouping more closely with *Scolopendra* than with other Scolopendrini such as *Cormocephalus* Newport, 1844. Vahtera *et al.* (2013) added that the molecular grouping of *Asanada* and *Scolopendra* was probably the most striking incongruence with morphology detected in their study of the phylogenetics of Scolopendromorpha. It is here suggested that this incongruence may be due to the fact that *Asanada* is paedomorphic.

Evidence of paedomorphic characters is provided by detailed studies of scolopendrid development. Unfortunately there is a paucity of such work. Heymons (1901) described the early development of *Scolopendra dalmatica* C. L. Koch, 1847, and *S. cingulata*. He distinguished three embryonic stadia, the third termed the foetus, and an adolescens stadium at which the young leave the brood chamber. Lawrence (1947) distinguished three embryonic and three early adolescent stadia before they leave the brood chamber in *Cormocephalus multispinus* (Kraepelin, 1903). Brunhuber (1970) also described three embryonic stadia and three early adolescent stadia in *Cormocephalus anceps anceps* Porat. Lawrence's third embryonic stadium is equivalent to Heymons' second, his

 Accepted by A. Minelli: 24 Feb. 2014; published: 2 Apr. 2014

weakly supported (as measured by jack-knife frequencies and Bremer support), whereas there is much stronger support for the molecular and combined groupings for a clade that groups *Asanada* within *Scolopendra*.

Asanada includes small scolopendrids generally about 25–35 mm in length. Many scolopendrids are much larger, as much as 275 mm, frequently 70 to 80 although some are small. This small size might be seen to suggest progenesis. However, in *Scolopendra morsitans* the limited data show that characters change early in post-embryonic development. Thus specimens of 20 mm already show an increase in the number of antennal articles, forcipular coxosternal teeth and marginate tergites (Lewis, 1968). That such changes have not occurred in *Asanada*, except for the extremely rare increase in forcipular coxosternal teeth and appearance of tarsal spurs (see above) would suggest that the condition in *Asanada* is due to neoteny.

The arguments put forward in this paper are based on a very small number of detailed studies of the embryonic and postembryonic development of scolopendromorphs. There is a real need for further such studies and further studies of scolopendromorph behaviour, which are likewise rare. Detailed studies of variation in populations of *Asanada* species might also prove fruitful.

Acknowledgements

My thanks are due to Jan Beccaloni for arranging the loan of specimens of *Asanada brevicornis,* to Greg Edgecombe for spending so much time giving invaluable advice during the preparation of this paper and on the first and second drafts and to Alessandro Minelli for his helpful suggestions. Discussions with Laurence Cook were also very useful. An anonymous referee raised a number of thought provoking questions. My thanks are also due to Michael Baker for processing the figures.

References

Attems, G. (1930) Scolopendromorpha. *Das Tierreich*, 54, Walter de Gruyter & Co., Berlin-Leipzig, 308 pp.

Brunhuber, B.S. (1969) The mode of sperm transfer in the scolopendromorph centipede, *Cormocephalus anceps anceps* Porat. *Zoological Journal of the Linnean Society*, 48, 409–420. http://dx.doi.org/10.1111/j.1096-3642.1969.tb00720.x

Brunhuber, B.S. (1970) Egg-laying, maternal care and development of young in the scolopendromorph centipede, *Cormocephalus anceps anceps* Porat. *Zoological Journal of the Linnean Society*, 49, 225–234. http://dx.doi.org/10.1111/j.1096-3642.1970.tb00738.x

Chamberlin, R.V. (1914) The Stanford expedition to Brazil, 1911, John C. Branner, Director. The Chilopoda of Brazil. *Bulletin of the Museum of Comparative Zoology at Harvard College*, 58, 151–221.

Chamberlin, R.V. (1921) New Chilopoda and Diplopoda from the East Indian Region. *Annals and Magazine of Natural History*, Series 9, 7 (37), 50–87.

Edgecombe, G.D. & Koch, M. (2008) Phylogeny of scolopendromorph centipedes (Chilopoda): morphological analysis featuring characters from the peristomatic area. *Cladistics*, 24, 872–901. http://dx.doi.org/10.1111/j.1096-0031.2008.00220.x

Edgecombe, G.D. & Koch M. (2009) The contribution of preoral and foregut morphology to the phylogenetics of Scolopendromorpha (Chilopoda). *Soil Organisms*, 81, 295–318.

Edgecombe, G.D. & Bonato, L. (2011) Chilopoda – Taxonomic Review Scolopendromorpha. *In*: Minelli, A. (Ed.), *Treatise in Zoology – Anatomy, Taxonomy, Biology. The Myriapoda*. *Vol. 1*. Leiden, Brill, pp. 392–407.

Gravely, F.H. (1912) Two new species of Scolopendridae. *Records of the Indian Museum*, 7, 415–417.

Heymons, R. (1901) Die Entwicklungsgeschichte der Scolopender. *Zoologica, Stuttgart,* 13, 1–244.

Joshi, J. & Karanth, K.P. (2011) Cretaceous-Tertiary diversification among select scolopendrid centipedes of South India. *Molecular Phylogenetics and Evolution*, 60, 287–294. http://dx.doi.org/10.1016/j.ympev.2011.04.024

Klingel, H. (1960) Vergleichende Verhaltensbiologie der Chilopoden *Scutigera coleoptrata* L. ('Spinnenassel') und *Scolopendra cingulata* Latreille (Scolopender). *Zeitschrift für Tierpsychologie*, 17, 11–30. http://dx.doi.org/10.1111/j.1439-0310.1960.tb00191.x

Koch, M., Pärschke, S. & Edgecombe, G.D. (2009) Phylogenetic implications of gizzard morphology in scolopendromorph centipedes (Chilopoda). *Zoologica Scripta*, 28, 269–288. http://dx.doi.org/10.1111/j.1463-6409.2008.00372.x

Lawrence, R.F. (1947) Some observations on the post-embryonic development of the Natal forest centipede, *Cormocephalus multispinus* (Kraep.). *Annals of the Natal Museum*, 11, 139–56.

Lewis, J.G.E (1966) The taxonomy and biology of the centipede *Scolopendra amazonica* in the Sudan. *Journal of Zoology*, 149, 188–203.
http://dx.doi.org/10.1111/j.1469-7998.1966.tb03893.x

Lewis, J.G.E. (1968) Individual variation in a population of the centipede *Scolopendra amazonica* from Nigeria and its implications for methods of taxonomic discrimination in the Scolopendridae. *Journal of the Linnean Society* (*Zoology*), 47, 315–326.
http://dx.doi.org/10.1111/j.1096-3642.1968.tb00515.x

Lewis, J.G.E. (1973) The taxonomy, distribution and ecology of centipedes of the genus *Asanada* (Scolopendromorpha: Scolopendridae) in Nigeria. *Zoological Journal of the Linnean Society*, 52, 97–112.
http://dx.doi.org/10.1111/j.1096-3642.1973.tb00781.x

Lewis, J.G.E. (1991) Scolopendromorph and geophilomorph centipedes from the Krakatau Islands and adjacent regions, Indonesia. *Memoirs of the Museum of Victoria*, 52, 337–353.

Lewis, J.G.E. (2006) On the scolopendromorph centipede genus *Mimops* Kraepelin, 1903, with a description of a new family (Chilopoda: Scolopendromorpha). *Journal of Natural History*, 40, 1231–1239.
http://dx.doi.org/10.1080/00222930600861231

Lewis, J.G.E. (2007) Scolopendromorph centipedes from Seychelles with a review of previous records (Chilopoda: Scolopendromorpha). *Phelsuma*, 15, 8–25.

Lewis, J.G.E. & Daszak, P. (1996) On centipedes collected on the Raleigh International Expedition to Mauritius and Rodrigues 1993, with a description of a new species of *Scolopendra* (Scolopendromorpha; Scolopendridae). *Journal of Natural History*, 30, 293–297.
http://dx.doi.org/10.1080/00222939600771161

Lewis, J.G.E., Daszak, P., Jones, C.G., Cottingham, J.D., Wenman, E. & Maljkovic, A. (2010) Field observations on three scolopendrids centipedes from Mauritius and Rodrigues (Indian Ocean) (Chilopoda: Scolopendromorpha). *International Journal of Myriapodology*, 3, 123–137.
http://dx.doi.org/10.1163/187525410x12578602960425

Meinert, F. (1886) Myriapoda Musei Cantabrigiensis. *Proceedings of the American Philosophical Society*, 23, 161–233.

Muadsub, S., Sutcharit, C., Pimvichai, P., Enghoff, H., Edgecombe, G.D. & Panha, S. (2012) Revision of the rare centipede genus *Sterropristes* Attems, 1934, with description of a new species from Thailand (Chilopoda: Scolopendromorpha: Scolopendridae). *Zootaxa*, 3484, 33–52.

Pocock, R.I. (1899) The expedition to Sokotra. Descriptions of the new species of scorpions, centipedes and millipedes. *Special Bulletin of the Liverpool Museum*, 2, 7–9.

Schileyko, A.A. (1995) The scolopendromorph centipedes of Vietnam (Chilopoda Scolopendromorpha). Part 2. *Arthropoda Selecta*, 2, 73–87.

Vahtera, V., Edgecombe, G.D. & Giribet, G. (2012a) Evolution of blindness in scolopendromorph centipedes (Chilopoda: Scolopendromorpha): insight from an expanded sample of molecular data. *Cladistics*, 28, 4–20.
http://dx.doi.org/10.1111/j.1096-0031.2011.00361.x

Vahtera, V., Edgecombe, G.D. & Giribet, G. (2012b) Spiracle structure in scolopendromorph centipedes (Chilopoda: Scolopendromorpha) and its contribution to phylogenetics. *Zoomorphology*, 131, 225–248.
http://dx.doi.org/10.1007/s00435-012-0157-0

Vahtera, V., Edgecombe, G.D. & Giribet, G. (2013) Phylogenetics of scolopendromorph centipedes: can denser taxon sampling improve an artificial classification? *Invertebrate Systematics*, 27, 578–602.
http://dx.doi.org/10.1071/is13035

Waldock, J.M. & Lewis, J.G.E. (2014) Recent collections of centipedes from Christmas Island (Myriapoda: Chilopoda). *The Raffles Bulletin of Zoology*, in press.

Würmli, M. (1972) Chilopoden von Sumba und Flores 1. Scolopendromorpha. *Verhandlungen der naturforschenden Gesellschaft in Basel*, 82, 88–104.