

## GENERAL CHARACTERISTICS OF THE SUPERCLASS MYRIAPODA



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### Abstract

In spite of the fact that naturalists first started paying attention to Myriapoda in 1874, the contributions made by naturalists to our knowledge of the various places on the group are weak and deficient. Since that time, very little progress has been accomplished, which may be at least partially attributable to the fact that the group as a whole does not have any economic significance, the members of the group live extremely long lives, and their reatrioted occurrenue. Those of New Port (1&1) and Fabre are credited with having done the early studies on the male reproductive system of millipedes (1855). Fabre discussed a single species from each of the families Julidae, Glorneridae, Polyxenidae, and Polydesmidae, whereas New Port restricted his investigation to the family Julidae. The only aspect of the gonopods' exterior anatomy that was included in Fabre's description was that part. Von Rath added further details to the material that was already available on the masculine rnpmduti8 qatem of polvdeamur - u-a\* mb othor gods (1890). A+tr)mr (1894) provided a more in-depth description of the aal gonopod of a variety of millipedes; nevertheless, he did not go into sufficient detail about the internal anatomy of these structures. This was carried out not too much later on.

**keywords:** Superclass, Myriapoda

### INTRODUCTION

## GENERAL CHARACTERISTICS OF THE SUPERCLASS MYRIAPODA

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In spite of the fact that naturalists first started paying attention to Myriapoda in 1874, the contributions made by naturalists to our knowledge of the various places on the group are weak and deficient. Since that time, very little progress has been accomplished, which may be at least partially attributable to the fact that the group as a whole does not have any economic significance, the members of the group live extremely long lives, and their reatrioted occurrenue. Our grasp of the biology and ecology of this group, in especially the Diplopoda, is quite restricted, as is our knowledge of the morphology and taxonow of this specific group, in particular the Diplopoda. Among the earlier workers, Butler (1 8781, PoooQk (1 892, 199), and Silveatri (1916, '17, '20 and 19231, oonfined their attention to the morphological description of some of the oriental Diplopoda; however, they did not devote a great deal of attention to the There are still instances of some of these detours. In terms of the number of papers relevant to taxonomy and anatomy, Verhoeff has contributed more than any other author over a longer period of time than any other author has produced more than any other author has contributed. These contributions were made back when we were still in the first stages of the investigation. He has swmaarised the majority of the extant diplopod literature that pertains to those years (1926-301, Attern8 (1936), produced a rystematio and faunistic survey of the Indian Diplopoda, which is aa yet lneomplete - the many species that were identified and so well described were just all new to Soiente. However, over the course of the past few years, there have been a number of significant contributions regarding the various aspects of a huge number of different species of diplopods that originate from a variety of regions all over the world. These contributions have been published in a variety of scientific journals. lalong these contributors, a few interesting names may be associated with the characteristics of Diplopda. These contributors include J.M.Demmge and J.P.Mauries in France; Ulriah Hawker in Connecticut; C. A.M. Jeekel in Hollywood; J, L.CloudslepThola)son in Bermuda; R.L.Hoffmm, R.A.Hefner, and R.V.Chamb8rlain in the United Other important studies include those that were carried out by Verhoeff (1930), Blower (1955, '701, Blower md Falrhurst (1968), Dowdy (1968), and Haaoker (1968: 1969) on the subject of evolutionary biology; Hefner (1929: 19531, Warren (1 9341, West (1953), Chowdaiah (1966), and Krishnan (1967) on the subject of anatomy; CloudaleyThompson (1951, 15 Berna Haacker (1968, 1969a9b), Haackrr and Stefan Fuche (1970) on the mating behaviour; Bhatia and Chaudher). (1927), Miley Hugh (1927), and Hsfner (1g2gb) on the life history and developmental biochemistry; Michael end Keeton (1968), Gromysz-Kalkowska (1970), and Dwarakanath b,c,d (1971) on

the physiology; Bhati In addition, Sundara Rajulu (1962) and Sundara Rajulta a,b (1970 1) and Hairetale (1971) have contributed to the beginning of an understanding of histochemistry, and Sundara Rajulu (1962) has contributed to the beginning of an understanding of the biochemistry of some of the oriental diplogods. ndOu&ejans et 91, (1971). On the other hand, it is essential to keep in mind that the Cjtolaq of the Diplopoda has been largely ignored, and the ohmaosome oytology of just a select few peeiea of Diplopoda is known at this moment. This is something that has to be taken into consideration. This is noteworthy because it implies that the Cjtolaq of the Diplopoda has been largely ignored throughout the years. Previous scholars who have made significant contributions to this field of research include Oettbger (1909), Bokrloff (191b), and Urd Besaiere, all of whom are eligible for inclusion on the list (1948). Both of these individuals contributed to the project, which was referred to as a p)chriulua rariq md Polrrenw a respectively. It is unfortunate that they did not present a comprehensive list of the chromosomal patterns of these organisms. It would appear that they paid more attention to the analysis of the cellular inclusions that occurred during the process of reproduction than they did to the analysis of the chromosomal patterns. However, this does not excuse the fact that they did not present a comprehensive list. The results of these studies are historically significant, and they should be used as a basis for further research. Nevertheless, it is important to highlight that any reference of chromosomes in these studies is merely accidental. With the exception of a few recent contributions provided by Nirtarajan (1959), Chovdaiah (1966:9\* 1967, 1969), and Chovdpiah and Kanaka (1969), there does not seem to have been any consideration dedicated to the chromosomal cytology of Diplopoda (1969). Based on an analysis of the scientific literature that is currently available, it has been determined that research on the chromosomes of Diplopoda has only been carried out so far on a total of eighteen species, spread among sixteen genera and nine families. This does not include the results that were obtained from doing this specific investigation.

Yet, during the last several years, a few publications that apply to a wide range of different elements of embryological development have been published. These papers have been published. These papers primarily consist of those written by Nath and Shanra (1932) and mb Bath (1957), both of which describe the differentiation of cell inaltasions during rrpccrmatogenesie and apennateleoaiie, respectively, of gh'oulutw oalam; Sharma and Chhotani (1957), both of which describe the differentiation of 0.11; and so on. In the city of Kal.1, the et0log uul cjtchrmitry of rpetkatogewiis has been researched (1969). Horatmam (1970) hers documented the spennloAa in two separate species of millipedes: phy116nortnlha

drrolabiabua and Gonodesaus 819. wWa Regner dd cooper'(1968) have direribid the 'fine'athatwe of iperhatidr md s\$ermatoroa iron the millipede Polydesaus 819 In most regions of the world, there is a vast supply of the material; yet, only a relatively small number of farms have engaged in otological study and are aware of the fact that further information is required. The present research was carried out because it was important for a knowledge of the cytotaxonomic connections and the evolutionsrp patterns working in this fascinating but poorly known group of organisms. This comprehension was necessary for the work that was being done here. In the course of these research, it was also required to carry out a comparative study on the morphology of the male reproductive pattern of a few different apeoias belonging to the order Diplopoda. The findings of this research were recently published in the journal Zoomorphology. Each pattern that was reported in this article for the very first time is now considered to be a "type" for the group. Those of New Port (1&1) and Fabre are credited with having done the early studies on the male reproductive system of millipedes (1855). Fabre discussed a single species from each of the families Julidae, Glorneridae, Polyxenidae, and Polydesmidae, whereas New Port restricted his investigation to the family Julidae. The only aspect of the gonopods' exterior anatomy that was included in Fabre's description was that part. Von Rath added further details to the material that was already available on the masculine rnpmduti8 qatem of polvdeamur - u-a\* mb othor gods (1890). A+tr)mr (1894) provided a more in-depth description of the aal gonopod of a variety of millipedes; nevertheless, he did not go into sufficient detail about the internal anatomy of these structures. This was carried out not too much later on.

## **LITERATURE REVIEW**

Gonzalo Giribet (2017) Because of recent findings in the fields of morphology, systematics, and biogeography that relevant to centipedes, these predatory terrestrial arthropods are currently at the centre of evolutionary inquiry. In addition, centipedes have proven of crucial significance in shedding light on the hierarchy of high-level interactions among arthropods. Their lengthy evolutionary history, which can be tracked back 420 million years by fossil records, is the cause of its widespread distribution in the current day. Recent research that combines morphological and molecular data has produced a solid phylogeny that lays the groundwork for evolutionary interpretations of their biological structure. This phylogeny has been supplied as a result of these studies. The major focus of study on arthropod segmentation is the trunk of the centipede, which may contain anywhere from 15 to 191 pairs of legs

following the first pair of legs that have been turned into an organ that administers venom. Research on phylogenetics and gene expression has given insight on some of the most pressing topics in the field of evolutionary developmental biology. These questions concern the invariably odd number of leg-bearing trunk segments, the often group-specific fixed number of trunk segments, the process by which some centipedes add segments after hatching while others hatch with the complete segment count, the addition of segments through evolutionary processes, and the process by which some centipedes hatch with the complete segment count.

This article was written by William A. Shear (2021) In this article, we discuss several aspects of myriapod phylogeny, ranging from the placement of the Myriapoda within the arthropod family to the connections between the orders of the classes Chilopoda and Diplopoda. In particular, we focus on the placement of the Myriapoda within the arthropod family. This article provides a comprehensive examination of the fossil record of all myriapod classes, with a special emphasis on developments that have taken place since 1997. As our working hypothesis, we will use the following assumptions: (1) that Myriapoda is monophyletic and belongs in the Mandibulata; (2) that the classes of Myriapoda are monophyletic; and (3) that they are related as (Chilopoda (Symphyla (Diplopoda Pauropoda))). The molecular and developmental evidence that points to an alliance between myriapods and chelicerates is one of the most significant problems that these ideas have. Another significant issue is the attraction of symphylans to pauropods in certain molecular investigations. Both of these issues are problematic for the ideas. Each of these issues are quite significant in their own right. Despite the fact that the phylogeny of the orders of Chilopoda seems to be resolved, various layers of the linkages within the class Diplopoda are still not fully known. Nevertheless, the phyla Symphyla and Pauropoda are the only ones whose fossils have been discovered in Tertiary amber. Chilopoda and Diplopoda are only represented by a small number of fossils each. It is difficult to place fossils in trees based on living forms since many morphological traits have a low likelihood of being preserved in fossils. This makes it tricky to place fossils in trees. As a direct consequence of this difficulty, the vast majority of diplopod fossils have been assigned to higher taxonomic groups that have subsequently been extinct. Diplopod fossils have the potential to provide essential pieces of knowledge, such as the first known case of air-breathing and the first hint of the use of a chemical defence system. Myriapods must have formed in the Early Cambrian, with a large period of cladogenesis taking place in the Late Ordovician and early Silurian, according to the evidence. There is a lack of information on the stem group of myriapods; yet, this time period must have been when the group first appeared. By the middle

of the Silurian, enormous terrestrial myriapods had already appeared at this point at the very least.

### **RESEARCH MYTHOLOGY**

In most cases, the millipede known as *Spirostreptus asthenes*, which belongs to the family Spirostreptidae, may be found on moist soil. Millipedes are typically scavengers that feed on decaying matter; nevertheless, Baker (1974) found that they posed a significant risk to plants such as carrots, beet roots, and cabbage. The species *S. asthenes* is both sexually dimorphic and oviparous. In the female, there are several big eggs that are observed to be densely packed with yolk (fig. 4). According to the findings of Begum (1982), who investigated the male reproductive system of *S. asthenes*, fertilisation occurs as a result of the transfer of sperm from the male to the female during mating. *S. female during asthenes* only breeds at certain times of the year. *Athenes* emerge from their underground tunnels. Only during the monsoon and winter seasons do adults of this species appear.

### **COLLECTION AND REAR**

city. Collections were carried out on a weekly basis in the early morning hours, between the hours of 5.30 and 7.00 in the morning, since this is the time of day when the majority of them emerge from their burrows and crevices. The samples were sent to the research facility in glass bottles together with the soil and the figure of a mature female *S. asthenes* (Lateral view)

### **CANADIAN LABORATORY SUPPLIES**

taken from the location where it was collected. At the laboratory in ID, they were kept in circular glass tanks with a height of 30 centimetres and a diameter of 10 centimetres. The tanks contained damp garden soil with a moisture level of 25 to 30 percent. A tank had around five or six different persons. In order to preserve the level of moisture in the soil, it was turned over once every seven days and given a little misting of water every two days. In order to safeguard the millipedes, the tanks were outfitted with wire mesh covers. Each and every twenty-four hours, *S. the asthenes* was given fresh carrot slices to eat. The next day, the materials that had not been fed were removed, and new slices of carrot were provided once again. recorded. the millipedes, as measured by morphometric techniques, were as follows: The males were distinguished from the females as soon as they were brought into the laboratory by the presence of gonopods in the 7th segment of the male and their absence in the female. In each collection,

a recording of the sex ratio was also made. Before beginning to dissect the specimens, we made a note of the total number of segments that were present in each individual specimen. In addition to this, their entire length was measured. while being recorded at the same time.

## **FEMALE REPRODUCTIVE SYSTEM**

The female reproductive system of *S. asthenes* consists of a single median ovary, an oviduct, a pair of ovaries, and a pair of spermatophores.

A dorsal view of a female *S. asthenes* demonstrates that she does not possess gonopods. The presence of gonopods may be seen in this ventral view of a male *S. asthenes* (gp). A fully grown female *S. asthenes* that has been dissected so that the ovarian structure may be seen. do maturing oocytes; fb - fat body: io immature oocytes; mo: mature oocytes; od - oviduc 3 4 fb- od mo do 10 gp- 23 of uterus like pouches opening outside through vulva. do maturing oocytes. io immature oocytes. do maturing oocytes. do maturing oocytes. do maturing The ovary is located below the digestive tract and above the double ventral nerve cord in the female reproductive system. In an adult female, the ovary is comprised of a single central tubular sac. The ovary takes up about two thirds of the total length of the female. It is encircled by membranous fat body lobes in the female, which form a sheat around it, and it tapers down as it makes its way towards the posterior end of the female. wall surrounds the ovaries, which is covered by the membrane that makes up the ovisac. The ovary was sectioned off into three separate areas by the and Subramoniam (1984). The germarium, which is composed of oogonia and follicular cells, may be found in Zone I, which is located at Nadarajalingam at Zone II, the tapering end of the ovary. main vitellogenic oocytes are located in the zone of the ovary that is considered to be the middle zone. Oocytes that have reached maturity are located in zone III of the ovary. The anterior most section of the ovary leads to a single median oviduct, which then bifurcates and opens to the external via a pair of vulva. The remainder of the ovary is encircled by the fat body the whole length of its length. There is a pair of spermatheca located on the inner lateral location of the bifurcated oviducts in the female. Gonopores may be seen just below the base of the first segment of the body. 24 In the current examination, oocytes were divided into two groups, mature oocytes and total big oocytes, to explore the fecundity of *S. asthenes*. These categories were determined by adopting the categorization established by Heath et al. in 1974. These mature oocytes are the ones that ovisac extremely readily, and theoocytes are the entire huge aggregation of mature and maturing oocytes that detach from

the mature oocytes. In contrast, for the purposes of biochemical research, the oocytes were divided into three distinct categories: the immature oocytes, which are a translucent white colour and originate from zone I; the maturing oocytes, which are a creamy colour and originate from zone II; and the mature oocytes, which are a yellowish brown colour and originate from zone III. The breeding season was determined by the data received from the number of females, the sex ratio, the number of fertile eggs produced, and the number of successful matings. Isolating three different pairs of *S. asthenes* in order to study their mating behaviour was also done. These two couples were watched for a total of fifteen days. We also kept track of the frequency and length of mating for each couple over the course of 15 days.

## **DATA ANALYSIS**

Late in the monsoon season, between the months of October and March, is the best time to find *S. asthenes*. early summer (February and (December and The from January), and the first month of the year Throughout the time period covered by this particular research, the months of November through March saw the appearance of this particular species of millipede. In contrast, during the 1985-1986 school year, the availability of *S. asthenes* fluctuated between the months of September 1985 and May 1986. The fact that the monsoon season began in September 1985 is the most likely explanation for this phenomenon. In those years, by the end of October, the monsoon season had already begun, and it lasted until the beginning of November. Because of this, the data collected during the 1985–1986 academic year was not included in the current research in order to achieve consistency about the occurrence of *S. asthenes*.

## **DISCUSSION**

Myriapods are mandibulate arthropods like insects and crabs, except they don't have antennae. The classification of insects according to the stages of their embryonic development on the basis of these reasons, Manton The structural organisation of Myriapoda is quite similar to that of Tieggs and Manton (1958). Myriapods and insects were once classified as two different sub-phyla under the phylum Uniramia until the year 1974. (see also Dohle, 1974). In spite of the fact that myriapods have a close relationship with insects, Sareen and Adiyodi (1983) have suggested that myriapods and crustaceans have a similar life cycle in which moulting and reproduction occur in alternating cycles. It is possible to state here that the apterygote insects



display alternating moulting and reproduction in females. This is something that is unique to these insects (Chapman, 1969). Voluminous literature is available on crabs. that of a female However the gap reproduction of insects and reproduction of myriapods is investigated to a much smaller degree. This may be linked to the limited availability of these organisms and the reduced significance they have in terms of the economy. The current research, which was carried out with the intention of expanding our understanding of myriapod reproduction, sheds fresh insight on the female reproductive biology of the millipede *Spirostreptus asthenes*. The findings also imply that insects and myriapods are very similar with regard to certain elements of the process of oogenesis. 106 The structural organisation of the ovary of a myriapod is quite similar in many respects to that of the ovary of an insect. In myriapods, the ovary is a single, median sac-like structure. The insects serving as a contrast. Despite this, evidence from the paired, lateral ovary of the paired oviduct in myriapod ovary implies that the ovaries may have initially been linked with the oviduct (Sareen and Adiyodi, 1983). This theory is supported by the fact that Ovary *Strongylosoma* has two germ cell strips in both the adult and larval stages of the ovary (Kaestner, 1968), in addition to the occurrence of polydesmidmillipede in the millipede *Jonespeltis splendidus*.

The juvenile ovary has the appearance of bands in *J. splendidus* as it does in other species. Furthermore, in (Nair, paired Collembola, the ovary is sac-like of tissue 1981). as in Myriapoda (Tiegs and Manton, 1958). According to Nair (1981), the sac-like structure of the myriapod ovary is caused by the loss of symmetry that occurs over the course of embryonic development. inside a framework that Insects and centipedes are opisthogeneates, and the gonopore is a derivation of the coelomoducts. The organisation of the female reproductive system in all myriapods, with the exception of centipedes, varies from that of insects only in the origin and location of the gonopores.

In contrast, the Diplopoda, Pauropoda, and Symphyla are classified as progoneates, and the gonopores on their bodies are the result of epidermal ingrowth 107. (Tiegs and Manton, 1958). These scientists have hypothesised that the progoneate state of these myriapods may be because terminal segments are involved in the anamorphosis process. the outcomes of the According to the findings of the current research, the reproductive cycle of *S. asthenes* begins in November and continues until March. Due to the greater number of male *S. asthenes* that are present at the conclusion of the breeding season, the species' sex ratio is heavily weighted towards the male gender. It is possible that egg-laying females have moved below the surface of the earth

near the conclusion of the mating season, which has caused a fall in the ratio of females to males. In the current research, the sex-ratio of *S. asthenes* was determined using a collection of specimens obtained by hand-picking. These specimens were collected from various locations. Comparable fluctuations with the seasonal variations in the sex-ratio were seen in the illipede *Glomeris marginata* collected by pit-fall traps, but there was no change in the sex-ratio in the same species when hand-picking techniques were used (al., 1974).

The possibility exists that the shift in the sex-ratio of these millipedes reported (Heath et al.) is caused by a change in the relative activity of the two during the course of the year. Also, it was shown that the sex ratio shifts depending on the kind of collecting done. Blower (1970) also discovered that the sex-ratio was unity (1:1) in a collection of *Iulus scandinavians* by extraction of the 108 individuals, however it changed to 1.404 and 1.735 with reference to male per female when pitfall trapping was used. In the case of the myriapod species *Brachydesmus superus*, the drop in population was shown to be attributable to a greater death rate among males in the population. According to the findings of the current research, the quantity of mature oocytes in the ovary begins to decrease as the mating season draws to a close, which suggests that the beginning of egg laying occurs after the month of March. Several millipede species, such as *G. marginata* (Heath 1974) and *Isobates varicornis* (Brookes, 1974), were found to have their egg-laying season throughout the summer months from April to June, according to previous research. et al., 1974). The findings of the current analysis make it very evident, as a consequence, that seasonally, just as other millipedes do. Moreover, *S. asthenes* is capable of producing anterior Because of the progoneate nature of this millipede, the act of copulation takes place mostly in the area of the male and female. Communication between *S. mechanical* partners is an essential part of the mating process. This form of communication mechanism seems to be tactile and to be of a primitive type, both of which are displayed by other millipedes such as *Leptoiulus circulus* (Haacker, 1974). *simplex*, in addition to *Alloporus* 109 There are several eggs with yolk laid by the myriapods (Sareen and Adiyodi, 1983). (Heath et al., 1974) reported that each female *G. marginata* laid 31 eggs, but earlier research on the same species suggested that each female laid 50 eggs. The egg production for *G. marginata* was calculated at 31 eggs per female (Juberthie Jupeau, 1967). In addition, Sareen and Adiyodi (1983) provided a full description of egg production. Their research revealed that the number of eggs deposited by various myriapods ranged from 22 to 73. Sareen and Adiyodi's research was published in 1983. The actual process of egg laying was not seen in either the laboratory or the field, thus it is unknown how many eggs *S. asthenes* lays. Nonetheless, the species has been

observed in the wild. In addition, the places where specimens of *S. asthenes* are collected in the city of Madras have a greater number of structures in which this millipede finds refuge. As a result, it was difficult to keep track of where eggs were being laid in the field. The structure of the ovary of a myriapod is similar to that of the ovary of an insect. Morphologically speaking, the ovisac epithelium of *J. splendidus* is quite similar to the ovarian connective sheath of insects (Sareen and Adiyodi, 1983).

Based on the cytomorphology of the and Subramoniam, the ovary of *S. asthenes* may be lassified into four separate regions: the vitellogenic oocytes in the ermarium, the previtellogenic I and II zones, and the previtellogenic A and B zones, as well as the vitellogenic A and B zones (Nair, 1981). The lithobius oocyte exhibited four previtellogenesis stages, the forficatus oocyte also exhibited premeiosis, maturation classical phases vitellogenesis, and vitellogenesis and maturation (Herbaut, 1972a). The germarium is located at the narrowing end of the ovary in these species, with the exception of *L. forficatus*, in which the germarium is found in the ventromedial region of the ovary (Herbaut and Joly, 1972). There are similarities between the terminal germarium of diplopods and the germarium of insect ovarioles. It is possible to draw parallels between the ventromedian germinal zone of the centipede and the germarium that is found stuck in the lateral diverticula of the ovary of *Diplura* (Tiegs and Manton, 1958). The ovary of a diplopodan resembles the normal panoistic ovariole that is described in insects since it begins with an apical germarium and is then followed by growth. In addition to this, the panoistic ovariole does not include any nurse cells or trophocytes (Anderson, 1964).

## **CONCLUSION**

Most research on the segmentation process in centipedes stops at the stage when segment polarity genes begin to be expressed (14, 51a). More information is coming to light on additional upstream segmentation genes, including homologs of the pair-rule genes found in *Drosophila*. Clarification of the evolution of centipede segmentation might be achieved by more research on these critical pattern-formation genes as well as other relevant genes.

## **REFERENCES**

1. Adis J, Harvey MS. 2000. How many Arachnida and Myriapoda are there world-wide and in Amazonia? *Stud. Neotrop. Fauna Environ.* 35:139–411a. Anderson LI, Trewin NH. 2003. An Early Devonian arthropod fauna from the Windyfield Cherts,

Aberdeenshire, Scotland. *Palaeontology* 46:457–509

2. Arthur W, Foddai D, Kettle C, Lewis JGE, Luczynski M, Minelli A. 2001. Analysis of segment number and enzyme variation in a centipede reveals a cryptic species, *Geophilus easoni* sp. nov., and raises questions about speciation. *Biol. J. Linn. Soc.* 74:489–99
3. Arthur W, Kettle C. 2001. Geographic patterning of variation in segment number in geophilomorph centipedes: clines and speciation. *Evol. Dev.* 3:34–40
4. Attems CG. 1926. Chilopoda. In *Handbuch der Zoologie. Eine Naturgeschichte der Stamme des Tierreiches. Vol. IV. Progoneata - Chilopoda - Insecta*, ed. W Kuenthal, T Krumbach, pp. 239–402. Berlin: Walter de Gruyter
5. Bastianello A, Minelli A. 2001. engrailed sequences from four centipede orders: strong sequence conservation, duplications and phylogeny. *Dev. Genes Evol.* 211:620–23
6. Bastianello A, Ronco M, Burato PA, Minelli A. 2002. Hox gene sequences from the geophilomorph centipede *Pachymerium ferrugineum* (C. L. Koch, 1835) (Chilopoda: Geophilomorpha: Geophilidae): implications for the evolution of the Hox class genes of arthropods. *Mol. Phylogenet. Evol.* 22:155–61
7. Bitsch C, Bitsch J. 2002. The endoskeletal structures in arthropods: cytology, morphology and evolution. *Arthropod Struct. Dev.* 30:159–77
8. Bonato L, Foddai D, Minelli A. 2003. Evolutionary trends and patterns in centipede segment number based on a cladistic analysis of Mecistocephalidae (Chilopoda: Geophilomorpha). *Syst. Entomol.* 28:539–79
9. Bonato L, Minelli A. 2002. Parental care in *Dicellogophilus carniolensis* (C. L. Koch, 1847): new behavioural evidence with implications for the higher phylogeny of centipedes (Chilopoda). *Zool. Anz.* 241:193–98
10. Borucki H. 1996. Evolution und Phylogenetisches System der Chilopoda (Mandibulata, Tracheata). *Verh. Naturwiss. Ver. Hambg.* 35:95–226
11. Bush SP, King BO, Norris RL, Stockwell SA. 2001. Centipede envenomation. *Wilderness Environ. Med.* 12:93–99
12. Carcupino M, Fausto AM, Bernardino Ortega ML, Zapparoli M, Mazzini M. 1996. Spermatophore development and sperm ultrastructure in *Craterostigma tasmanianus* (Chilopoda, Craterostigmomorpha). *Zoomorphology* 116:103–10

