

# velvet worm anatomy

**velvet worm anatomy** is a fascinating subject that delves into the unique physiological structures and biological functions of these intriguing creatures. Velvet worms, belonging to the phylum Onychophora, are often referred to as "living fossils" due to their ancient lineage. Understanding their anatomy is crucial for studying their evolutionary significance, ecological roles, and adaptations. This article will explore the various components of velvet worm anatomy, including their body structure, locomotion mechanisms, respiratory and circulatory systems, and reproductive adaptations. Additionally, we will discuss the implications of their anatomy on their survival and ecological interactions.

- Introduction to Velvet Worm Anatomy
- External Anatomy of Velvet Worms
- Internal Anatomy and Organ Systems
- Locomotion and Movement
- Respiratory and Circulatory Systems
- Reproductive Anatomy
- Ecological Significance of Velvet Worm Anatomy
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## External Anatomy of Velvet Worms

The external anatomy of velvet worms is distinctive and serves several important functions. These creatures have a soft, elongated body covered in a velvety texture, which is where they derive their name. Their body is typically segmented, with approximately 13 to 43 segments, depending on the species. Each segment is equipped with a pair of lobopods, which are stubby, unjointed appendages that aid in locomotion.

## Body Structure

The body of a velvet worm is divided into three main regions: the head, trunk, and tail. The head features a pair of large, protruding eyes and mouthparts that are adapted for predation. The mouth has a pair of claw-like jaws that are capable of grasping and subduing prey, primarily soft-bodied invertebrates.

The trunk is the most significant part of the body and contains the segments that house the lobopods. The lobopods are covered in tiny, bristle-like structures called setae, which provide traction and assist in movement across various surfaces. The tail region is less pronounced and is primarily used for stability during locomotion.

## **Skin and Sensory Structures**

The skin of velvet worms is not only soft but also highly permeable, allowing for gas exchange with the environment. Its moist surface is essential for their survival, as they inhabit humid environments. Velvet worms also possess sensory structures that enhance their ability to detect changes in their surroundings, including chemoreceptors that help locate prey and navigate their habitat.

## **Internal Anatomy and Organ Systems**

Examining the internal anatomy of velvet worms reveals a complex system of organs that are adapted to their ecological niche. The internal structures include a digestive system, a circulatory system, a nervous system, and reproductive organs.

### **Digestive System**

The digestive tract of velvet worms is a straight tube that runs from the mouth to the anus, allowing for the efficient processing of food. After capturing prey with their jaws, velvet worms secrete digestive enzymes onto the prey to break it down externally before ingestion. This method of external digestion is a key adaptation that allows them to consume prey that might otherwise be difficult to handle.

### **Nervous System**

Velvet worms possess a simple nervous system that includes a ventral nerve cord and a series of ganglia. This arrangement allows for coordinated

movement and response to environmental stimuli. The ganglia are concentrated in the head region, where they process sensory information from the eyes and antennae, providing the worm with essential survival instincts.

## **Circulatory System**

The circulatory system of velvet worms is open, meaning that blood (hemolymph) is not confined to vessels. Instead, it flows freely through cavities called hemocoels, bathing the organs directly. This system is efficient for their size and lifestyle, allowing for effective nutrient distribution and waste removal.

## **Locomotion and Movement**

Locomotion in velvet worms is unique and showcases their evolutionary adaptations. They primarily move by alternating the contraction of muscles in their lobopods, which allows for both crawling and climbing. The soft-bodied nature of velvet worms enables them to navigate through leaf litter, soil, and other substrates efficiently.

## **Mechanisms of Movement**

Velvet worms utilize a combination of muscular contractions and hydrostatic pressure to facilitate movement. The lobopods extend and contract in a wave-like manner, providing both grip and propulsion. This method is particularly effective in moist environments where their soft bodies can easily navigate through foliage and underbrush.

## **Adaptations for Environment**

Additionally, their ability to secrete a sticky slime helps them capture prey while also assisting in movement across slippery surfaces. This slime is produced by glands located in the head region and serves multiple functions, including defense against predators, locomotion enhancement, and prey capture.

## **Respiratory and Circulatory Systems**

The respiratory system of velvet worms is adapted to their moist habitats.

They do not have specialized respiratory organs like lungs or gills; instead, they rely on cutaneous respiration, meaning that gas exchange occurs directly through their skin.

## **Gas Exchange**

The permeability of their skin allows oxygen to diffuse into their body while carbon dioxide is expelled. This process is efficient in humid environments where the moisture is abundant, but it limits their ability to thrive in drier conditions. Velvet worms must remain in moist habitats to prevent desiccation, which is fundamental for their survival.

## **Circulatory Function**

As previously mentioned, the open circulatory system enables the hemolymph to circulate freely throughout the body. This system not only transports nutrients and oxygen but also plays a crucial role in thermoregulation and immune responses. The hemolymph contains various cells that help fend off pathogens and provide the worms with necessary nutrients.

## **Reproductive Anatomy**

Reproduction in velvet worms is fascinating and showcases a variety of adaptations. Most velvet worms are dioecious, meaning they have distinct male and female individuals. The reproductive anatomy reflects their unique mating behaviors and strategies.

## **Mating Rituals**

During mating, males may utilize specialized appendages known as spermatophores to transfer sperm to females. This process can involve intricate courtship behaviors, where males may engage in displays to attract females. Once mating occurs, females may retain the sperm for a period before fertilization.

## **Development and Offspring**

Females typically give birth to live young rather than laying eggs, which is a significant adaptation that increases offspring survival in their moist

habitats. The young are born in a relatively advanced state, which enhances their chances of survival in the wild.

## **Ecological Significance of Velvet Worm Anatomy**

The anatomy of velvet worms plays a critical role in their ecological significance. As predators, they help regulate populations of smaller invertebrates in their ecosystems. Their unique adaptations allow them to occupy a niche that few other organisms can fill, particularly in humid forest environments.

Additionally, their role as both predators and prey contributes to the complex food webs in their habitats. The study of velvet worm anatomy not only enhances our understanding of their biology but also provides insights into the evolutionary processes that shape life on Earth.

## **Conclusion**

Understanding velvet worm anatomy reveals the intricate designs and adaptations that have allowed these ancient creatures to survive for millions of years. From their unique external structures to their complex organ systems, each aspect of their anatomy plays a vital role in their survival and ecological interactions. As we continue to study these fascinating organisms, we gain valuable insights into the evolutionary history of life on Earth and the interconnectedness of all living things.

### **Q: What are velvet worms, and where can they be found?**

A: Velvet worms, or onychophorans, are soft-bodied, segmented invertebrates found primarily in humid, tropical, and subtropical environments around the world, particularly in rainforests.

### **Q: How do velvet worms capture their prey?**

A: Velvet worms capture their prey using their claw-like jaws and sticky slime, which they can shoot out to ensnare soft-bodied invertebrates.

### **Q: What is unique about the locomotion of velvet**

## **worms?**

A: Velvet worms move using a combination of muscular contractions in their lobopods, allowing them to crawl effectively on various surfaces, aided by the traction provided by setae.

## **Q: Do velvet worms have lungs or gills?**

A: No, velvet worms do not have lungs or gills; they rely on cutaneous respiration through their moist skin for gas exchange.

## **Q: How do velvet worms reproduce?**

A: Velvet worms reproduce sexually, with males transferring sperm to females through specialized structures. Females give birth to live young, which is an adaptation to enhance offspring survival.

## **Q: What adaptations make velvet worms suitable for their moist habitats?**

A: Velvet worms have permeable skin for gas exchange, a unique locomotion mechanism, and the ability to produce slime, all of which are adaptations that help them thrive in humid environments.

## **Q: Are velvet worms considered endangered?**

A: While not all velvet worm species are endangered, habitat loss and environmental changes pose threats to their populations, particularly in their natural rainforest habitats.

## **Q: What evolutionary significance do velvet worms hold?**

A: Velvet worms are considered "living fossils" and provide insights into the evolution of arthropods and other invertebrates, showcasing traits that have persisted for hundreds of millions of years.

## **Q: How do velvet worms contribute to their ecosystems?**

A: Velvet worms play a crucial role as predators in their ecosystems, helping to control the populations of smaller invertebrates and contributing to the

balance of their ecological communities.

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**velvet worm anatomy: Structure and Evolution of Invertebrate Nervous Systems** Andreas Schmidt-Rhaesa, Steffen Harzsch, Günter Purschke, 2015-12-17 The nervous system is particularly fascinating for many biologists because it controls animal characteristics such as movement, behavior, and coordinated thinking. Invertebrate neurobiology has traditionally been studied in specific model organisms, whilst knowledge of the broad diversity of nervous system architecture and its evolution among metazoan animals has received less attention. This is the first major reference work in the field for 50 years, bringing together many leading evolutionary neurobiologists to review the most recent research on the structure of invertebrate nervous systems and provide a comprehensive and authoritative overview for a new generation of researchers. Presented in full colour throughout, *Structure and Evolution of Invertebrate Nervous Systems* synthesizes and illustrates the numerous new findings that have been made possible with light and electron microscopy. These include the recent introduction of new molecular and optical techniques such as immunohistochemical staining of neuron-specific antigens and fluorescence in-situ-hybridization, combined with visualization by confocal laser scanning microscopy. New approaches to analysing the structure of the nervous system are also included such as micro-computational tomography, cryo-soft X-ray tomography, and various 3-D visualization techniques. The book follows a systematic and phylogenetic structure, covering a broad range of taxa, interspersed with chapters focusing on selected topics in nervous system functioning which are presented as research highlights and perspectives. This comprehensive reference work will be an essential companion for graduate students and researchers alike in the fields of metazoan neurobiology, morphology, zoology, phylogeny and evolution.

**velvet worm anatomy: Evolutionary Developmental Biology of Invertebrates 3** Andreas Wanninger, 2015-08-10 This multi-author, six-volume work summarizes our current knowledge on the developmental biology of all major invertebrate animal phyla. The main aspects of cleavage, embryogenesis, organogenesis and gene expression are discussed in an evolutionary framework. Each chapter presents an in-depth yet concise overview of both classical and recent literature, supplemented by numerous color illustrations and micrographs of a given animal group. The largely taxon-based chapters are supplemented by essays on topical aspects relevant to modern-day EvoDevo research such as regeneration, embryos in the fossil record, homology in the age of genomics and the role of EvoDevo in the context of reconstructing evolutionary and phylogenetic scenarios. A list of open questions at the end of each chapter may serve as a source of inspiration for the next generation of EvoDevo scientists. *Evolutionary Developmental Biology of Invertebrates* is a must-have for any scientist, teacher or student interested in developmental and evolutionary biology as well as in general invertebrate zoology. This is the first of three volumes dedicated to animals that molt in the course of their lifecycle, the Ecdysozoa. It covers all non-hexapods and non-crustaceans, i.e., the Cycloneuralia, Tardigrada, Onychophora, Chelicerata and Myriapoda. While the Nematoda and all other phyla are treated in their own chapters, the remaining cycloneurals are presented jointly due to the dearth of available developmental data on its individual subclades.

**velvet worm anatomy:** Invertebrate Zoology Bernd Schierwater, Rob DeSalle, 2021-07-08

Invertebrate Zoology: A Tree of Life Approach is a comprehensive and authoritative textbook adopting an explicitly phylogenetic organization. Most of the classical anatomical and morphological work has not been changed – it established the foundation of Invertebrate Zoology. With the explosion of Next-Generation Sequencing approaches, there has been a sea-change in the recognized phylogenetic relationships among and between invertebrate lineages. In addition, the merger of evolutionary and developmental biology (evo-devo) has dramatically contributed to changes in the understanding of invertebrate biology. Synthesizing these three approaches (classical morphology, sequencing data, and evo-devo studies) offers students an entirely unique perspective of invertebrate diversity. Key Features One of the first textbooks to combine classical morphological approaches and newer evo-devo and Next-Generation Sequencing approaches to address Invertebrate Zoology Organized along taxonomic lines in accord with the latest understanding of invertebrate phylogeny Will provide background in basic systematic analysis useful within any study of biodiversity A wealth of ancillary materials for students and teachers, including downloadable figures, lecture slides, web links, and phylogenetic data matrices

**velvet worm anatomy: The Wasp That Brainwashed the Caterpillar** Matt Simon,

2016-10-25 “A bizarre collection of evolution tales . . . the weirder, the better.” —Entertainment Weekly A fascinating exploration of the awe-inspiring, unsettling ingenuity of evolution from Wired writer Matt Simon, author of *Plight of the Living Dead* (coming soon from Penguin Books) On a barren seafloor, the pearlfish swims into the safety of a sea cucumber’s anus. To find a meal, the female bolas spider releases pheromones that mimic a female moth, luring male moths into her sticky lasso web. The *Glyptapanteles* wasp injects a caterpillar with her young, which feed on the victim, erupt out of it, then mind-control the poor (and somehow still living) schmuck into protecting them from predators. These are among the curious critters of *The Wasp That Brainwashed the Caterpillar*, a jaunt through evolution’s most unbelievable, most ingenious solutions to the problems of everyday life, from trying to get laid to finding food. Join Wired science writer Matt Simon as he introduces you to the creatures that have it figured out, the ones that joust with their mustaches or choke sharks to death with snot, all in a wild struggle to survive and, of course, find true love. Winner of the American Library Association’s Alex Award

**velvet worm anatomy: Horseshoe Crabs and Velvet Worms** Richard Fortey, 2012-04-10

From one of the world’s leading natural scientists and the acclaimed author of *Trilobite!*, *Life: A Natural History of Four Billion Years of Life on Earth* and *Dry Storeroom No. 1* comes a fascinating chronicle of life’s history told not through the fossil record but through the stories of organisms that have survived, almost unchanged, throughout time. Evolution, it seems, has not completely obliterated its tracks as more advanced organisms have evolved; the history of life on earth is far older—and odder—than many of us realize. Scattered across the globe, these remarkable plants and animals continue to mark seminal events in geological time. From a moonlit beach in Delaware, where the hardy horseshoe crab shuffles its way to a frenzy of mass mating just as it did 450 million years ago, to the dense rainforests of New Zealand, where the elusive, unprepossessing velvet worm has burrowed deep into rotting timber since before the breakup of the ancient supercontinent, to a stretch of Australian coastline with stromatolite formations that bear witness to the Precambrian dawn, the existence of these survivors offers us a tantalizing glimpse of pivotal points in evolutionary history. These are not “living fossils” but rather a handful of tenacious creatures of days long gone. Written in buoyant, sparkling prose, *Horseshoe Crabs and Velvet Worms* is a marvelously captivating exploration of the world’s old-timers combining the very best of science writing with an explorer’s sense of adventure and wonder.

**velvet worm anatomy: Functional Surfaces in Biology III** Stanislav N. Gorb, Elena V. Gorb,

2018-03-23 This book is devoted to the rapidly growing area of science dealing with structure and properties of biological surfaces in their relation to particular functions. This volume, written by a team of specialists from different disciplines, covers various biological surface functions: sensing, coloration, attachment, drag reduction, moisture harvesting, etc. Because biological surfaces have a

virtually endless potential of technological ideas for the development of new materials and systems, inspirations from biology could also be interesting for a broad range of topics in surface engineering. This volume together with two previous volumes “Functional Surfaces in Biology” (vols. 1 & 2 published in 2009) taken together, present a good reference for a novice in the field. The book is intended for use by researchers who are active, or intend to become active, in the field. The appeal of this topic is expected to be broad, ranging from classical biology, biomechanics and physics to such applied fields as materials science and surface engineering.

**velvet worm anatomy: Strange Survivors** One R. Pagan, 2018-02-27 Life is beautiful, ruthless, and very, very strange. In the evolutionary arms race that has raged on since life began, organisms have developed an endless variety of survival strategies. From sharp claws to brute strength, camouflage to venom—all these tools and abilities share one purpose: to keep their bearer alive long enough to reproduce, helping the species avoid extinction. Every living thing on this planet has developed a time-tested arsenal of weapons and defenses. Some of these weapons and defenses, however, are decidedly more unusual than others. In *Strange Survivors*, biologist Oné R. Pagán takes us on a tour of the improbable, the ingenious, and the just plain bizarre ways that creatures fight for life. Inside this funny, fascinating field guide to nature’s most colorful characters, you’ll meet killer snails, social bacteria, and an animal with toxic elbows. But *Strange Survivors* is more than a collection of curiosities—it is a love letter to science and an argument for the continuing relevance of this evolutionary battle as we face the threat of resistant bacteria and the need for novel medical therapies. Whether discussing blood-thinning bats and electric fish or pondering the power of cooperation, Pagán reveals the surprising lessons found in some of life’s natural oddities and how the tactics they employ to live might aid our own survival.

**velvet worm anatomy: Life** Ricki Lewis, 1998 This text is aimed at students from a non-scientific background, and provides an accessible introduction to biology. It takes a comparative, concept-based approach and has a lively writing style. It has a new chapter on the origins and diversity of life, and there is also a new chapter on biomes. The behaviour and ecology unit has been expanded, as has the coverage of evolution. Ethical issues raised by biotechnology are also discussed; the coverage of chemistry is revised as well.

**velvet worm anatomy: The Animal Kingdom: A Very Short Introduction** Peter Holland, 2011-11-24 Molecular biology has revolutionized our understanding of animals and their evolution. In this *Very Short Introduction*, Peter Holland provides an authoritative summary of the modern view of animal life, its origins, and the new classification resulting from DNA studies.

**velvet worm anatomy: Ecology of North America** Brian R. Chapman, Eric G. Bolen, 2015-04-09 North America contains an incredibly diverse array of natural environments, each supporting unique systems of plant and animal life. These systems, the largest of which are biomes, form intricate webs of life that have taken millennia to evolve. This richly illustrated book introduces readers to this extraordinary array of natural communities and their subtle biological and geological interactions. Completely revised and updated throughout, the second edition of this successful text takes a qualitative, intuitive approach to the subject, beginning with an overview of essential ecological terms and concepts, such as competitive exclusion, taxa, niches, and succession. It then goes on to describe the major biomes and communities that characterize the rich biota of the continent, starting with the Tundra and continuing with Boreal Forest, Deciduous Forest, Grasslands, Deserts, Montane Forests, and Temperate Rain Forest, among others. Coastal environments, including the Laguna Madre, seagrasses, Chesapeake Bay, and barrier islands appear in a new chapter. Additionally, the book covers many unique features such as pitcher plant bogs, muskeg, the polar icecap, the cloud forests of Mexico, and the La Brea tar pits. “Info boxes” have been added; these include biographies of historical figures who provided significant contributions to the development of ecology, unique circumstances such as frogs and insects that survive freezing, and conservation issues such as those concerning puffins and island foxes. Throughout the text, ecological concepts are worked into the text; these include biogeography, competitive exclusion, succession, soil formation, and the mechanics of natural selection. *Ecology of North America 2e* is an ideal first

text for students interested in natural resources, environmental science, and biology, and it is a useful and attractive addition to the library of anyone interested in understanding and protecting the natural environment.

**velvet worm anatomy: The Annotated Old Four Legs: The story of the coelacanth** Mike Bruton, 2017-11-01 When the famous South African fish scientist Professor JLB Smith published *Old Fourlegs - The Story of the Coelacanth* in 1956 he created an international sensation. After all, this 400-million-year-old fish, known only from fossil remains, was thought to have become extinct around 66 million years ago! JLB Smith's dramatic account of the discovery of the first and second coelacanths in 1938 and 1952 turned him into a cult figure and put South African science on the world map. His book was eventually published in six English editions and translated into nine foreign languages. Mike Bruton's *The Annotated Old Fourlegs* includes a facsimile reprint of the original book, to which he has added notes and images in the margins that provide an interesting and revealing commentary on Smith's text, as well as new introductory and explanatory chapters that bring the coelacanth story up to date.

**velvet worm anatomy: Elements of general and pathological anatomy** David Craigie, 1851

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**velvet worm anatomy: The Nervous Systems of Invertebrates: An Evolutionary and Comparative Approach** O. Breidbach, W. Kutsch, 2013-03-07 In this volume outstanding specialists review the state of the art in nervous system research for all main invertebrate groups. They provide a comprehensive up-to-date analysis important for everyone working on neuronal aspects of single groups, as well as taking into account the phylogenesis of invertebrates. The articles report on recently gained knowledge about diversification in the invertebrate nervous systems, and demonstrate the analytical power of a comparative approach. Novel techniques in molecular and developmental biology are creating new perspectives that point toward a theoretical foundation for a modern organismic biology. The comparative approach, as documented here, will engage the interest of anyone challenged by the problem of structural diversification in biology.

**velvet worm anatomy: Animal** DK, 2017-09-12 View the animal kingdom up close as never before in this breathtaking title, which has already sold over 1.5 million copies. Written by 70 specialists, it features stunning wildlife photography of more than 2000 of the world's most important wild mammals, birds, reptiles, amphibians, and insects. With around two million species identified to date, animals are the dominant and most varied form of life on the planet. *Animal* presents a representative selection, ranging from the giant baleen whale, to fast-moving predators such as sharks, big cats, and birds of prey, as well as microscopic beetles barely 1mm long and other insects. It presents some of the latest species to be described: meet the cute but elusive olinguito from South America, which was only identified in 2013, or the skywalker hoolock gibbon that was named after a Star Wars character in 2017. *Animal* also explains how the earth's biodiversity is in sharp decline and the conservation projects underway to safeguard precious species. For each one, it gives a locator map and statistics, including its conservation status. For anyone who wants a reliable and enthralling reference, in which you can find the answers to everything - from why zebras are striped or how the sunbear got its name - *Animal* is your essential one-stop guide.

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book also looks at key behavioral concepts such as how animals learn to behave and the role of instinct in the learning process.

**velvet worm anatomy: Evolution or Creation?** Albert Debenedictis, 2014-04-02 This book is designed to share the research on the origins of the universe and the origins of life with those who are truly interested in making their decisions regarding origins as well as those who are simply curious about opposing views.

**velvet worm anatomy: *Assembling the Tree of Life*** Joel Cracraft, Michael J. Donoghue, 2004-07-22 This edited volume provides an authoritative synthesis of knowledge about the history of life. All the major groups of organisms are treated, by the leading workers in their fields. With sections on: The Importance of Knowing the Tree of Life; The Origin and Radiation of Life on Earth; The Relationships of Green Plants; The Relationships of Fungi; and The Relationships of Animals. This book should prove indispensable for evolutionary biologists, taxonomists, ecologists interested in biodiversity, and as a baseline sourcebook for organismic biologists, botanists, and microbiologists. An essential reference in this fundamental area.

**velvet worm anatomy: Principles of Evolution** Jonathan Bard, 2016-09-23 Principles of Evolution covers all aspects of the subject. Following an introductory section that provides necessary background, it has chapters on the evidence for evolution that cover the fossil record, DNA-sequence homologies, and protein homologies (evo-devo). It also includes a full history of life from the first universal common ancestor, through the rise of the eukaryote and on to the major groups of phyla. This section is followed by one on the mechanism of evolution with chapters on variation, selection and speciation. The main part of the book ends with a chapter on human evolution and this is followed by appendices that expand on the making of fossils, the history of the subject and creationism. What marks this book as different from others on evolution is its systems-biology perspective. This new area focuses on the role of protein networks and on multi-level complexity, and is used in three contexts. First, most biological activity is driven by such networks and this has direct implications for understanding evo-devo and for seeing how variation is initiated, mainly during embryogenesis. Second, it provides the natural language for discussing phylogenetics. Third, evolutionary change involves events at levels ranging from the genome to the ecosystem and systems biology provides a context for integrating material of this complexity. The book assumes a basic grounding in biology but little mathematics as the difficult subject of evolutionary population genetics is mainly covered qualitatively, with major results being discussed and used rather than derived. Principles of Evolution will be an interesting and thought-provoking text for undergraduates and graduates across the biological sciences.

**velvet worm anatomy: Functional Morphology and Diversity** Les Watling, Martin Thiel, 2012-12-14 Crustaceans are increasingly used as model organisms in all fields of biology, including neurobiology, developmental biology, animal physiology, evolutionary ecology, biogeography, and resource management. One reason for the increasing use of crustacean examples is the wide range of phenotypes found in this group and the diversity of environments they inhabit; few other taxa exhibit such a variety of body shapes and adaptations to particular habitats and environmental conditions. A good overview of their functional morphology is essential to understanding many aspects of their biology. This volume is the first in The Natural History of Crustacea series, a ten-volume series that will treat all aspects of crustacean biology, physiology, behavior, and evolution. The series updates and synthesizes a growing wealth of information on the natural history of this remarkable group. Functional Morphology and Diversity explores the functional morphology of crustaceans, which cover the main body parts and systems. The book brings together a group of internationally recognized and up-and-coming experts in fields related to systematics and morphology. Contributing authors study a range of crustacean taxa and topics, and thus the volume provides a compact overview of the great phenotypic diversity and their function found among crustaceans. The first broad treatment of Crustacea in decades, the book will be invaluable for researchers and students in this and related fields.

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