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珍贵的小龙虾蜕皮化石*

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提要　淡水小龙虾化石在世界上十分少见。龙虾蜕皮的化石还未曾有过记录。文中讨论热河生物群上侏罗统义县组发现的、保存十分完好的蜕皮化石。判断其蜕皮标本的 3 个理由是：没有保存头胸甲；步足与体节之间的关节膜很薄以及几乎看不到磷酸盐化的软组织。

关键词　小龙虾　蜕皮　热河生物群　辽宁

辽宁凌源附近上侏罗统义县组富产淡水小龙虾化石，是热河生物群中引人注目的无脊椎动物。Taylor 等(1999)对部分化石进行了研究。在继而获得的众多化石中，其中有的具有特殊的生物学意义，在此专门予以讨论报道。

标本 126345 看来是一个个体蜕皮的外骨骼(图版Ⅰ)。以往颇多研究涉及甲壳类埋藏学(Hof and Briggs，1997)。在任何情况下，化石埋藏都要经历整个动物体的死亡和保存。细菌起磷酸盐化的过程几乎都是在动物死亡之后，这个过程可以分辨动物体的外表皮和软组织。真正蜕皮标本的化石记录实属罕见。一个节肢动物外骨骼的所有矿物质和大部分有机质都在蜕皮前被重新吸收。那些蜕下来的膜薄而软，很容易破裂。此外，甲壳类经常吃脱落的外骨骼，把不能消化的物质再循环返回到新骨骼层中。因此，蜕皮的骨骼如能被埋葬和石化，它不可能在环境中保留很长时间。

我们判断它是蜕皮标本根据以下 3 个理由：1)这块标本很明显没有保存头胸甲。淡水小龙虾蜕皮时，外骨骼都从背部中线位置滑落出来，使动物逐渐脱离壳体。头胸甲是通过鳃盖区和头的前部薄的关节状膜附着于外骨骼上，它们很容易沿腹面与腹甲和外骨骼分离。2) 胸肢节部分是非关节状的，蜕皮时张开，部分胸节缝合线便是证据。在蜕去的骨骼上，步足与体节之间的关节膜很薄，很容易分离。3)当前标本几乎看不到有什么磷酸盐化的软组织，而热河生物群的小龙虾化石几乎都保存了软组织的残留体，尽管对这些石化构造的解释很复杂。本标本只是表皮有星点状磷酸盐化的迹象。

蜕皮标本的个体长度约有 11.5 cm，在已知这一化石群中可谓是佼佼者。在腹部第 4、第 5 胸足之间显示了腹环沟构造，因此，可以推断这是一个老年期雌性个体蜕下来的外骨骼。其腹足显示呈鞭节状痕迹，因此，将其归于奇异环足虾(*Cricoidoscelosus aethus*)。对蜕皮标本的认识，使我们进而了解到热河生物群化石库中必然还会发现精美的标本。

AN UNUSUAL SPECIMEN OF FOSSIL CRAYFISH MOLT

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Key words：crayfish，molt，Jehol biota，Liaoning

Taylor *et al*·（1999）studied the fossil crayfish from the Upper Jurassic Yixian Formation of Jehol Group，Liaoning Province，China·Very recently more specimens were found from these sites·One of these is worthy of special remark and illustration·

Specimen 126354 appears to be a molted exoskeleton（Plate Ⅰ）·Much research has been conducted on the taphonomy of crustaceans（e·g·，see Hof and Briggs，1997）·In all cases，these experiments have involved the death and preservation of intact animals·The processes of bacterially modulated phosphatization commence almost immediate after death，and distinctive stages in the process have been recognized for both the cuticles and soft tissues therein·Actual molts in the fossil record are rare·The entire mineral and much of the organic material of an arthropod exoskeleton are reabsorbed prior to ecdysis·What is cast off then is very thin and friable，and these breakdown very readily·Furthermore，crustaceans often eat the shed exoskeleton to recycle the unabsorbed materials back into laying down the layers of the new skeleton·Consequently，molted skeletons do not remain in the environment for long in order to be buried and fossilized·

This specimen appears to us to be a molt for three reasons·First is its apparent lack of a carapace·As crayfish molt，the exoskeleton typically splits down the dorsal midline to allow the animal to step out of the shell·The carapace is attached to the rest of the exoskeleton by thin arthrodial membranes in the branchiostegal region and at the front of the cephalon·These readily separate from the remains of the sternites and endoskeletal apodemes along the ventral surface·

Second，the thoracic limbs are partially disarticulated and splayed in a manner of a molt，and the fractosternal suture rather evident·The arthrodial membranes between leg and body segments are very thin in a molted skeleton and can easily part·

Third，there is little or no evidence of internal phosphatized soft tissue in the specimen at hand·Crayfish of the Jehol biota almost always have remains of the soft tissue preserved，and indeed presence of this material often complicates interpretation of the fossilized structures on these animals·There is some indication of spot phosphatization of the cuticle in this specimen，akin to that documented by Hof and Briggs（1997），but we see no remnants of phosphtized muscles beneath the cuticle·

This specimen probably is a post-adult individual some 11.5 cm in length，and may be a female with an annulus ventralis·It may belong to *Cricoidoscelosus æthus* rather than *Palaeocambarus licenti* based on its flagellate pleopods·The recognition of these molts adds to the unusual and distinctive preservation now becoming recognized from the various localities and strata of the Jehol biota of northeastern China·

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图版Ⅰ（Plate Ⅰ）说明

标本保存在中国科学院南京地质古生物研究所（The specimens studied here are kept in Nanjing Institute of Geology and Palaeontology，Chinese Academy of Sciences）

1·*Cricoidoscelosus æthus* Taylor，Schram and Shen

一个淡水小龙虾蜕皮标本的正模及外模，雌性；部分外骨骼，可见第二触角及鞭节、鳞片、一对第三颚足、1—5 对步足、第 4 和第 5 胸足之间的腹环沟、腹足、腹肋叶、尾节、尾肢内、外肢以及消化道。标本来源于辽宁凌源县大王杖子村附近，上侏罗统义县组。×1.14，登记号：126354（1a，1b·Specimen 126354 part and counterpart of a molted crayfish exoskeleton，female；showing antennae，flagellum，scaphocerite，a pair of 3rd maxillipeds，1—5 pereipods，probably annulus ventralis，pleura，pleopods，telson，exopod and endopod of the uropod，and alimental canal·The specimen came from Upper Jurassic Yixian Formation，Dawangzhangzi village，Lingyuan County，Liaoning Province；natural size）。