Lengthening of embolus and copulatory duct: a review of an evolutionary trend in the spider family Sparassidae (Araneae)

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Dedicated to Dr Manfred Grasshoff on occasion of his 70th anniversary and in memory of his contributions to the functional morphology of the spider family Araneidae

Abstract: The phenomenon of lengthening copulatory structures in the spider family Sparassidae is reviewed. One can distinguish between a diversifying type and a lengthening type, but admitting that there may be combinations and transitions between these cases. Some 55% of 662 species examined show clearly that the embolus and/or copulatory ducts are lengthened in comparison with the ancestral species, whereas only in 8% there is no noteworthy lengthening of these structures. Different types of lengthening are recognised: ‘tegular coil’, ‘distal coil’, ‘distal screw’, the irregular or combination type, and the so-called ‘functional lengthening’. In these types uniformity of the copulatory structures prevails, although diversifying elements may occur albeit rarely. Combined morphological changes, occurring in the course of evolutionary lengthening, are considered as being dependent on functional constraints. The position of the embolus’ tip may play an important role in this context. Understanding of functional and evolutionary aspects may enlighten possible mechanisms which trigger the phenomenon.

Key words: spider genitalia, copulatory organs, tip of embolus, evolutionary mechanisms, types of lengthening, functional constraints, huntsman spiders

Introduction

In spiders, as in other terrestrial arthropods, copulatory structures have been developed which allow direct sperm transfer (in contrast to indirect sperm transfer in marine or fresh water organisms). Male spiders exhibit copulatory organs on their second pair of appendages: the pedipalpi are modified as gonopods. Females have either rather simple receptacula seminis (Mygalomorphae and haplogyne Araneomorphae) or frequently a complex duct system in front of the genital opening (entelegyne Araneomorphae). Considering the fact that copulatory organs are present only in the last stage of an individual and used for a short time only, and for a restricted purpose, it seems to be most likely that the evolution of these structures may be largely independent from external conditions, e.g. such as climate, habitat, prey animals or others. Both structures in males and females are acting during copulation as one functional unit and are therefore dependent on each other with respect to evolutionary changes of their parts (as in upper and lower jaws in vertebrates) (Grasshoff 1975; see also Kraus 1995, 1998). Apparently, this also seems to be true, if the structures (embolus, copulatory ducts) are in the process of changing their length in the course of evolution, as the lengths of these structures in males and females are changed accordingly. This length-changing occurs, among others, in the spider family Sparassidae, which is represented by about 1000 species worldwide (Platnick 2005). Representatives of one subgroup of this family, the Deleninae from the Australasian region, exhibit extremely long emboli and copulatory