

j12 Life style of the first land arthropods < initially jawless; HF >

Ants, bees and wasps with overlapping generations, reproductive division of labor, and sterile worker castes exhibit “eusociality” —Wilson, *Sociobiology*, 1975.¹

Differently, the structure of non-eusocial insects and other arthropod societies, as well as details of their systematics, natural history, ecology and anatomy, is better addressed under the headings of: maternal and biparental care, paternal care, ‘fortress defenders,’ and ‘larval societies.’

—James T. Costa, *The Other Insect Societies*, 2006.²

When did insects, to borrow Paula Fox’s image,³ begin to move on land “with their hideous broken speed”?⁴

Six legs good⁵ The Carboniferous forests teemed with insects. In some places, drifts of the bodies of sap-sucking ticks and mites now constitute thick measures of coal. In the Pennsylvanian, winged insects were present. Common arthropod predators were gliding dragonflies (*Megasecoptera*) with 30 inch wingspans. Their possible prey were wingless cockroaches 4 inches long.

Also eight legs Chelicerates, which Edward Ray Lankester (1847-1929) first recognized to be a coherent evolutionary group,⁶ include spiders, scorpions, horseshoe- or soldier-crabs (with Cu-blue blood), and amblypygids that contravene Williston’s law by having in their evolved whips (modified forelegs) up to 148 joints!⁷ Land chelicerates are first abundantly represented in Pennsylvanian forests by spiders. These (but not all) lack the typical spider adaptations of poison fangs and spinnerets (small, modified abdominal appendages that bear the silk-gland spigots).

The eaten margin of leaves is evidence of animals eating living plants. Such evidence of herbivorous insects first appeared in the middle Carboniferous Period. This was nearly 50 million years after the first land forests (as found at Gilboa) had come to be in the Devonian Period. In Middle Devonian Gilboa fossil shales (Catskill fm), the earliest evidence (of microscopic size) of some of the major groups of land animals have been found by partly dissolving samples of it in hydrofluoric acid (HF). This *extremely* dangerous fuming acid dissolves siliclastics (as clay or quartz) but not organics (as wax or chitin) from which it (for correct disposal!) can be washed with water. In the Gilboa shale, William Shear has found in HF residues the earliest unequivocal evidence of spiders; an isolated spinneret beautifully preserved in one specimen (pushing back the age at which this advanced structure debuted).⁸ Other Gilboa firsts are *Dracochela* (means *dragon pincer*), a predator identified as a false scorpion (previously described from rocks 300 million years younger) that looks like a microscopic scorpion without a stinger. The big pincers of *Dracochela* are studded with sensory hairs called *trichobothria*, which can only function in air and so indicate a fully terrestrial life style. Prey found are mites. These have primitive features of claws and body hairs.⁹

The Devonian land animal communities at Ludford Lane, Rhynie, and Gilboa, span nearly 100 million years.¹⁰ These few sites are dominated by predatory and detritivorous arthropods.¹¹ The latter, which eat dead plant matter, are mostly what we find today if we sample only fungiferous soil and litter communities.¹² Some enigmatic wounds in Rhynie plants are pegged as damage from sap sucking arthropods by some¹³ or by others as mechanical injuries such as might have been caused by volcanic cinders or boiling-spring spatter.¹⁴ A long transition to true herbivory is interpreted for early land arthropods. Richard Beerbower’s “litter box” hypothesis is that in Paleozoic terrestrial ecosystems, nearly all potential food from plants had to be at least partly decayed and broken down by detritivores before becoming available to larger animals.

Land and freshwater hexapod (insect) fossil record is to 410 million years ago (Lower Devonian). Their absence before is indicative of their derivation from among freshwater branchiopod crustaceans (familiar today of these are: fairy shrimps, water fleas, and tadpole shrimps). Freshwater branchiopods could have evolved during the Late Silurian from marine decapod crustacean ancestors for which there is a fossil record to 511 million years ago (Upper Cambrian).¹⁵ □