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RESEARCH NOTE

NOMENCLATURE OF THE ORB-WEB

In science, we have to know what we are talking about when we say something. Unfortunately, in the literature about orb-webs and orb-web construction, different terms are used for the same part of the web and—even worse—the same term is used by different authors for different parts of the web. The present note tries to improve the situation by proposing a nomenclature for the different parts of the orb-web (Fig. 1). At the same time, an overview of the terms used by various other authors is given in English, German and French.

Anchor threads and frame threads.—The web is supported by anchor threads attached to the supporting structure at anchor points. The thread along the outside of the web is called the frame. The primary frame (thread) is attached on both ends to anchor threads and forms the outermost outline of the web. A secondary frame (thread) is attached to two primary frame threads that form a corner with each other (Mayer 1952). The point where two primary frame threads connect to an anchor thread is called a frame point. The (primary) frame thread along the top of the web is also called bridge thread—not to be confused with the bridging line, the thread the spider lets float in the breeze to cross open gaps (Peters 1989).

Radii.—The threads running more or less straight from the center of the web to the circumference are called radii. There are different kinds of radii, but not all authors make the same distinction among them. In the normal orb-web, as exemplified by that of *Araneus diadematus*, I propose to distinguish between proto-radii, primary radii and secondary radii. Some species additionally have subsidiary radii and others have accessory radii.

Proto-radii only exist during the early stages of web construction. They are threads between the proto-hub (hence the name for the proto-radii) and the supporting structure. During the web building process, proto-radii are usually converted into (and partially replaced by) anchor threads (Eberhard 1990; Zschokke 1996). Primary radii are radii that are constructed simultaneously with a frame thread (primary or secondary); secondary radii are constructed without building a frame thread at the same time. When looking at a finished web, primary and secondary radii cannot readily be distinguished, although Wirth (1988) has been able to tell the difference by studying the fine structure of the connection between the radius and the frame thread. In Fig. 1, the distinction was based on the recording of the construction of the web. If the distinction between primary and secondary radii is not possible or not necessary, both can simply be named 'radius.'

Some spiders build subsidiary radii. Subsidiary radii are radii that do not start at the hub but somewhere further out: they are either attached to another radius (*Cyrtophora* sp.) or to the auxiliary spiral (*Nephila* sp.). Finally, some symphytognathoid spiders build accessory radii. Accessory radii are made after sticky spiral construction but before hub modification (Coddington 1986b; pers. comm.). They are distinct from normal radii by not being connected to the sticky spiral.

In the past, there has been a certain confusion about the use of the terms 'primary radius,' 'secondary radius' and 'tertiary radius'. 'Primary radius' has been used to designate what I call a proto-radius (Tilquin 1942; Coddington 1986a), to designate a radius constructed together with a primary frame thread (Mayer 1952), or—as proposed here—to designate a radius constructed simultaneously with a (primary or secondary) frame thread (Peters 1937b; Wirth 1988). The term 'secondary radius' has been used by several authors (Tilquin 1942; Mayer 1952; Savory

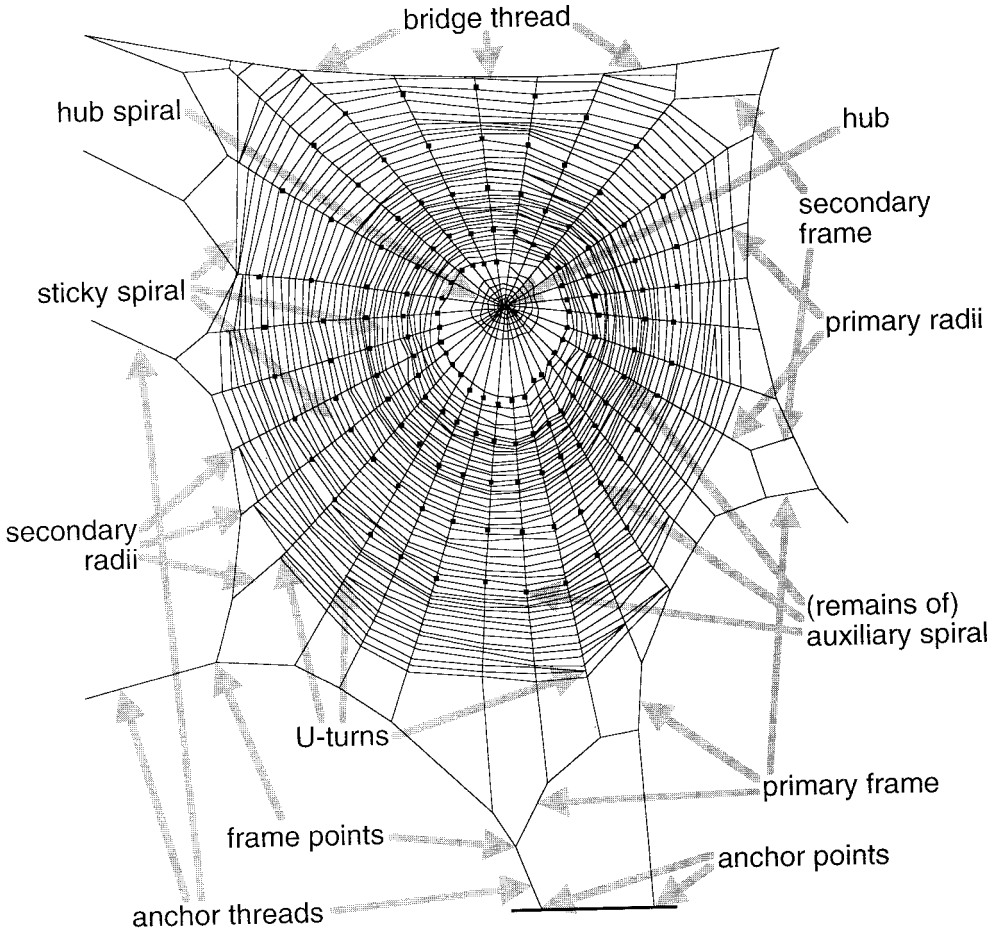

Figure 1.—Web of *Araneus diadematus* with the terms for its parts. See text for names of structures not found in the web of *Araneus diadematus* (e.g., retreat, stabilimentum).

1952) to designate a radius built at the same time as a (secondary) frame thread. Many authors (Peters 1937b; Wirth 1988; Vollrath 1992) have—as proposed here—used it to describe a radius built without a frame thread and some other authors (e.g., Shear 1986) have used it to describe what I call a subsidiary radius. The term 'tertiary radius' has been used to describe what I call secondary radius (Tilquin 1942; Mayer 1952; Vollrath 1992) or to describe what I call subsidiary radii (Eberhard 1972).

Jackson (1973) has devised an entirely different terminology to distinguish between different radii. His distinction is not based on the mode of construction but on the position in the web, allowing the identification of each radius.

Spirals.—Spirals are the distinctive feature of orb-webs. Most orb-webs contain two major spirals: a spiral made out of sticky silk, the sticky spiral, and a spiral made out of non-sticky silk, the auxiliary spiral. The auxiliary spiral is removed by most spiders during construction of the sticky spiral and all that is left are small balls of silk along the radii (*cf.* Fig. 1). There are, however, webs of a few spiders (e.g., *Nephila* sp. and in parts of the web of *Scoloderus* sp.) where the auxiliary spiral remains in the completed web. Accordingly, some authors (e.g., Stern & Kullmann 1975) distinguish between a structural spiral ('Festi-

Table 1.—List of proposed terms and terms used by other authors to designate certain parts of a spider's web. In English, some authors used the word 'line' or 'strand' in place of 'thread'.

Proposed term	Other terms in English	In German	In French
anchor points	mooring point	Anheftungspunkte Verankerungspunkte	
anchor thread	frame thread guy thread mooring thread	Ankerfaden Haltefaden Spannseil Tragseil Verankerungsfaden	fil d'attache
primary frame	foundation	Begrenzung Rahmen	cadre
secondary frame	auxiliary frame cord inner frame radial Y-structure section thread Y-frame	Sekundärer Rahmen Rahmen 2. Ordnung Hilfsrahmen	cadre secondaire
frame point	frame Y-structure		
bridge thread		Brückenfaden	cable suspenseur fil suspenseur
radius	radial radial thread radiating thread spoke ray	Radialfaden Radialspeiche Radius Speiche Stützfaden	diamètres rayon
proto-radius	primary radius	Ausgangsstrahlen Grundstrahlen	
primary radius	secondary radius		
secondary radius	tertiary radius		
subsidiary radius	secondary radius tertiary radius		
proto-hub	rudimentary hub		
hub		Nabe Warte	moyeu
sticky spiral	capture spiral catching spiral ensnaring spiral outer spiral permanent spiral viscid spiral	Fangspirale Klebfaden Klebspirale	fil spiralaire spire captrice spirale définitive spirale externe spirale gluante
auxiliary spiral	nonsticky spiral preliminary spiral primary spiral provisional spiral scaffolding spiral structural spiral temporary spiral	Festigungsspirale Gerüstspirale Hilfsspirale	spirale auxiliare spirale provisoire spirale sèche
hub spiral	inner spiral strengthening spiral	Befestigungsspirale	spirale interne
U-turn	loop (point of) reversal reverse switchback turnback turning point	Umkehrpunkt Umkehrstellen	coudes en épingle à cheveux grecques retour

Table 1.—Continued.

Proposed term	Other terms in English	In German	In French
signal thread	guide line to retreat	Signalfaden	fil avertisseur fil d'avertissement
retreat	hiding place	Schlupfwinkel Versteck Warte	demeure retraite refuge
stabilimentum		Stabiliment	stabilimentum in hub: revêtement

gungsspirale') which is left in the finished web as opposed to a temporary spiral which is removed during construction of the sticky spiral. Curiously, the term temporary spiral has also been used to describe the auxiliary spiral in webs where the auxiliary spiral is permanent (Eberhard 1975). The hub spiral is the innermost part of the auxiliary spiral which is not removed during construction of the sticky spiral.

Other structures.—In addition to frame, radii and spirals, some orb-webs contain additional structures. Some spiders do not sit on the hub when waiting for prey, but rather they sit hidden in the retreat (e.g., *Zygiella x-notata*). The signal thread connects the hub of the web with the retreat, allowing the spider sitting in the retreat to detect any vibrations occurring in the web and to dash to the center of the web without being slowed by the sticky spiral. Stabilimentum is the name for a variety of additional silk structures on the orb web (for an overview of the different kinds of stabilimenta, see Foelix 1996).

Terminology used by other authors and in other languages.—Table 1 gives an overview of the terms proposed in this note (first column) and the terms used by various other authors in English, German and French. The names are also given in German and French because many of the classic papers on spiders web were written in German (e.g., Wiehle 1927; Peters 1937a, 1937b; Mayer 1952) or in French (e.g., Tilquin 1942; Le Guelte 1964).

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Samuel Zschokke: Dept. of Integrative Biology, Section of Conservation Biology (NLU), University of Basel, St. Johanns-Vorstadt 10, CH-4056 Basel, Switzerland

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